Price Transparency, Media and Informative Advertising*

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Abstract

We study the effects of a regulation requiring supermarket chains in Israel to post prices online. Using price data collected before and after the regulation went into effect and a differences-in-differences research design, we show that both price levels and price dispersion declined after the regulation was instituted. These patterns were driven primarily by price reductions in high-priced chains. Chains also nearly eliminated within-chain price dispersion, by setting identical prices in all stores. We use the framework by Robert and Stahl (1993) to interpret our findings. Consistent with their model, we show that after prices became transparent low-priced chains used extensively price advertising, referencing to price-comparison surveys conducted by the media to induce credibility. Our findings highlight the importance of the media in facilitating credible informative advertising and the pro-competitive role of advertising.

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1 Introduction

Information is essential for achieving market efficiency and perfect competition. Recently, several price transparency regulations requiring firms to disclose prices online have been instituted in many countries in an effort to reduce prices. Gasoline prices are now available online in Germany, Italy, Australia, South Korea and Chile. Health care providers are now required to disclose price information online.[1] Also, food retailers in Argentina, Uruguay and Mexico are required to post the prices of many of their products online.[2] Despite the increasing popularity of price transparency regulations, little is known empirically about their effects on market outcomes. Additional evidence is particularly needed since theoretical models offer opposing predictions: some show that price transparency could facilitate tacit collusion and increase prices, while others demonstrate that price transparency could enhance competition and lower prices.[3]

This paper investigates the impact of a price transparency regulation that was implemented in the food retail industry in Israel in June 2015. Supermarket were hereafter required to upload prices onto an online depository on a daily basis. Shortly thereafter, independent websites began to offer consumers free price-comparison services. We take advantage of these changes to examine the impact of price transparency on price levels and price dispersion. Our analysis shows that both price levels and price dispersion fell after prices became transparent. Our preferred estimates suggest that after prices became transparent average prices fell by 4-5%, and the coefficient of variation fell by 50%. These patterns were driven by high-priced chains reducing their prices. Low-priced chains did not significantly change their prices. In addition, chains began setting identical prices among stores in the same chain. We combine these pricing patterns with data on advertising to show that low-priced chains extensively relied on ads the emphasize their prices after the transparency regulation came into effect. To promote credibility for these ads, low-priced chains mentioned in their ads results from large price-comparison surveys that media outlets conducted. These price-comparison surveys became increasingly popular as the cost of collecting price data significantly dropped after the transparency regulation came into effect. We use the framework by Robert and Stahl (1993) to interpret our findings, and to explain how media coverage, advertising and search choices jointly determine market equilibrium. We also discuss explanations for the decision to set

[1] In the US, see https://www.federalregister.gov/documents/2019/06/27/2019-13945/improving-price-and-quality-transparency-in-american-healthcare-to-put-patients-first, and worldwide www.economist.com/business/2019/05/21/the-global-battle-over-high-drug-prices?cid1=cust/dailypicks/n/bl/n/20190521n/owned/n/n/dailypicks/n/n/NA/243352/n.

[2] In 2015, the Argentinian government forced retailers to submit daily prices for a basket of goods to be posted on a website that allows consumers to compare prices (see https://www.preciosclaros.gob.ar and Daruich and Kozlowski (2019)).

[3] The adoption of price transparency regulations is likely to expand given that sales in brick-and-mortar stores account for 85-90% of retail sales. In the US e-commerce account for 8% of total US retail sales in 2016 (https://www.census.gov/content/dam/Census/library/publications/2018/econ/e16-estats.pdf). In the UK, e-commerce in 2017 was 16.4% of total retail sales (https://ecommercenews.eu/ecommerce-in-uk-grew-to-e15-6-billion-in-2017/).

identical prices among stores in the same chain, and propose that concerns around fairness might be driving this strategy of uniform pricing.

Any attempt to reliably identify the impact of transparency on prices must overcome several challenges. First, it is necessary to obtain price data corresponding to the period before the change in transparency, a period for which data might not be readily available. Second is the need to control for additional factors that might affect pricing decisions (e.g., local competition, costs, seasonality). Because these factors may change over time, it is inherently difficult to attribute changes in prices to a change in transparency over a given time period. To address the first challenge, we exploited the fact that the transparency regulation went into effect more than a year after it passed in the parliament and hired a survey firm to collect prices in physical stores over the course of that year. The price data were collected at several points in time and for multiple products sold in multiple stores and chains throughout Israel. After the price transparency regulation went into effect, we obtained data from one of the price-comparison platforms launched after the transparency regulation became effective. To address the second, and perhaps more concerning challenge, we rely on four complementary control groups which enable us to identify the effects of the transparency regulation on prices.

The first control group consists of products that are identical to those in the treatment group, but sold through the online channel of the supermarket chains whose in-store products are included in the treatment group. Products sold online are potentially a useful control group because their prices were transparent both before and after the transparency regulation became effective. The second control group consists of prices of products that were periodically collected by the Israeli Consumer Council (ICC) before the regulation and were often cited in the media and in chains' ad campaigns as a reliable source of price data. Thus, effectively, the ICC products constitute a set of products whose prices were transparent before and after the transparency regulation went into effect. The ICC products differ from those in the treatment group but are sold in the same brick-and-mortar stores. The third and fourth control groups consist of products that are similar to the products in the treatment group, but are sold in brick-and-mortar stores that were exempt from the transparency regulation: drugstores and mom-and-pop grocery stores, respectively. Although each of the control groups might be subject to critique, they complement the other, such that when taken together they enable us to rule out many alternative explanations. Notably, our analysis yields similar results across the four control groups, giving us confidence that our results indeed reflect the impact of transparency on prices.

Our initial set of results concerns the impact of transparency on price levels. The regression results indicate that after the regulation took effect, prices of products in the treatment group decreased by 4-5% relative to prices of products in the different control groups. We also find that

prices primarily decrease at high-priced supermarket chains, and that generally prices of cheaper products fell more than price of pricier products. Next, we examine the impact of transparency on price dispersion. We first show that inter-chain price dispersion fell significantly, where the coefficient of variation fell by 50% after the regulation. We also show that price dispersion within a given chain also substantially dropped. This latter drop is driven by chains' decision to set identical prices across stores affiliated with the same chain.

The findings from the difference-in-differences analysis suggest that price transparency led to lower prices and lower price dispersion. To shed light on potential mechanisms driving these findings, we rely on the framework by Robert and Stahl (1993), who consider how both advertising and consumer search affect price levels and price dispersion. Robert and Stahl characterize a unique price-dispersion equilibrium, and derive testable predictions that concern changes in advertising and search costs. First, price advertising increases as the costs of price advertising decline. Second, not all firms advertise prices. In particular, high-priced firms do not price advertise, while low-priced firms do advertise prices. Third, prices are lower when price advertising is higher. Fourth, consumers do not engage in search, irrespective of the cost of search. Fifth, both price levels and price dispersion decline as search and advertising costs drop, and finally the price drop is concentrated among high-priced chains.[4] In section 4 we modify these predictions to a setting involving multi-product retailers, acknowledging that supermarkets cannot advertise the prices of all items that they sell. Instead, multi-product retailers, such as supermarket chains, who want to inform consumers about their low prices can rely on intermediaries that credibly convey such information. In practice, Israeli supermarket chains used price-comparison surveys conducted by the media as such intermediaries. After prices became available online, the cost of taking these surveys dramatically fell and Israeli media outlets began conducting comprehensive price-comparison surveys, which cover hundreds of items and stores. As the accuracy and availability of surveys improve, the credibility and effectiveness of ads that rely on these surveys rise. Accordingly, supermarket chains who are favorably mentioned in these price surveys benefit from mentioning such surveys in their ads.

To examine the modified predictions of Robert and Stahl (1993), we use detailed ad-level data, and identify ads that specifically include references to price-comparison surveys conducted by the media. We show that after the transparency regulation came into effect, low-priced supermarket chains extensively used ads that include references to media-conducted price-comparison surveys. High-priced chains, which did not receive positive media coverage, did not use price advertising in the post-transparency period. Our analysis also supports other predictions of the model: the use of the media-based ads was greater when prices decreased, and consumer hardly accessed the

[4]The intuition for the last prediction is that after search costs fall high-priced chains reduce prices to dissuade consumers from searching further.

freely available price-comparison websites. Finally, our findings from the difference-in-difference analysis, showing that both price dispersion and prices fell and that this drop is driven by high-priced retailers' pricing decisions, are also consistent with the model's predictions. Thus, our findings strongly indicate that advertising, facilitated by price transparency and the media, was a key factor driving the more competitive environment and the lower prices in the post-transparency period.

This is one of the first papers that examine the effects of a price transparency regulation. To our knowledge, we are the first to examine the effects of such regulation in a multi-product industry. Perhaps more importantly, we use an equilibrium framework to explain the effects of transparency and examine how retailers differently respond to changes in search and advertising costs. From a policy perspective, our findings suggest that policies that focus on reducing search costs might not be sufficient to enhance competition in markets where retailers sell multiple products. In such settings, greater emphasis should be given to firms' incentives to raise consumer attention, and to proactively inform consumers about low prices. Intermediaries, such as the media, can have an important role by credibly conveying price comparisons across retailers. More concretely, our paper offers several contributions to the literature. First, we contribute to the advertising literature by providing novel evidence on how advertising decisions change as the reliability of ads increases.[5] Our analysis builds on an equilibrium framework, and examine which firms choose to advertise, which do not advertise and how these decisions depend on the cost and accuracy of ads.

Second, our paper contributes to the understanding of the effects of mandatory disclosure regulations. The desirability of price transparency regulations is ex-ante ambiguous because transparency could help consumers find the cheapest price and enhance competition, or alternatively help firms monitor their rivals' prices and facilitate tacit collusion.[6] The few studies that examine the effect of price transparency regulations focused on gasoline markets, where retailers sell a single homogeneous good. Notably, Luco (2019) uses price data before and after a price transparency regulation that required Chilean gasoline stations to post prices online. Luco finds that gasoline margins, especially in regions with low search activity, increased after the regulation.[7] In contrast,

[5] Related papers are Glazer (1981), Milyo and Waldfogel (1999) and Devine and Marion (1979) who exploit intertemporal variation in the cost of advertising to examine its impact on prices. Milyo and Waldfogel (1999) investigate how removing a ban on advertising prices of alcohol products affected prices. Glazer (1981) exploit a 1978 newspaper strike which limited the availability of ads to examine the effect on food prices, and Devine and Marion (1979) study the effect of forced advertising on prices. More recently, Dubois et al. (2017) develop a structural model to analyze the effects of banning advertising for potato chips.

[6] Ben-shahar and Schneider (2011) explores the "failure of the single most common technique for protecting personal autonomy in modern society: mandated disclosure." Several papers studied the effects of voluntary price disclosure (e.g., Brown and Goolsbee (2002), Brynjolfsson and Smith (2000) and survey by Goldfarb and Tucker (2019)). The distinction between voluntary and mandatory disclosure is important because selection concerns regarding the decision to disclose prices, the timing of disclosure and the prices of which products are disclosed.

[7] Also related are Rossi and Chintagunta (2016) who study the impact of mandatory highway signs on gasoline prices in Italy, and Montag and Winter (2019) who investigate the gasoline price transparency regulation in Germany. Byrne and De Roos (2019) use price data from a post-transparency period to study how gasoline stations learn to coordinate prices over a period of 15 years, Brown (2019) who study how the introduction of a website that reports prices of medical imaging procedures in New Hampshire affects prices, and Albek et al. (1997) who use wholesale post-transparency prices to study how the prices of ready-mixed concrete changed.

our paper studies a market-wide price transparency regulation in the supermarket industry, where firms sell thousands of products, advertise more and enjoy high price-cost mark-ups (Arcidiacono et al. (2020)). Our results regarding the effects of transparency on price dispersion and price levels differ from the results in the gasoline market, and we highlight the role of advertising in providing relevant price information. Third, recent studies (e.g., DellaVigna and Gentzkow (2019), Hitsch et al. (2021)) show that prices that retailers set in different markets are not correlated with local market characteristics, as standard text book models predict. Adams and Williams (2019) and Cavallo (2018)) present evidence that retailers set identical prices in different stores that face different demand conditions. We show that retailers began setting identical prices across stores affiliated with the same chain, shortly after the transparency regulation. In Section 4.2, we suggest that this decision might be driven by fairness or brand-image concerns, which were exacerbated once consumers could easily observe the prices of similar items sold at different stores of the same chain. Notably, our findings that retailers adopted a uniform pricing strategy are unrelated to the Robert and Stahl's framework, which does not consider pricing decisions by multi-store firms. Finally, this study adds to the media literature by showing how multi-product retailers use the media to promote credibility for ads. Our findings highlight the importance of the media as a reliable and impartial source of data, and speak both to the persuasive role of the media (DellaVigna and Gentzkow (2010)) and to papers on certification (e.g., Jin and Leslie (2003)).

The remainder of the paper is organized as follows. In Section 2 we provide the necessary background on the Israeli food retail market. In Section 3 we discuss the data that we use, the empirical methodology and the estimation results concerning prices. In Section 4 we derive testable predictions for the mechanisms underlying our results and subsequently test these predictions. In Section 5 we present robustness results. Section 6 concludes.

2 Institutional Background, Data and Descriptive Statistics

The average household expenditure on food in Israel in 2014 accounts for 16.2% of disposable income.[8] The Israeli retail food market was ranked 7th among OECD countries according to the CR3 criterion (OECD (2013)). Online grocery sales are growing but account for a small share of total food sales, about 4% in the relevant time period.[9] Also, the market share of private-label/store-brand products out of total grocery sales is small, about 5% in 2014.[10] Herein we consider five large supermarket chains: Shufersal, Mega, Rami Levy, Yeinot Bitan and Victory. We selected these chains, ordered by annual turnover, because of their substantial joint market

[8] See https://www.cbs.gov.il/he/publications/doclib/2016/1644/t01_02.pdf

[9] https://cdn-media.web-view.net/i/wdtxacphsu/20160608_TASC_2016_ecommerce_newsletter.compressed_n_0.pdf?utm_source=activetrail&utm_medium=email&utm_campaign=.

[10] https://www.storenext.co.il/wp-content/uploads/2016/01/Summary-of-2015-English.pdf.

share, 68% of supermarkets sales in 2014, and because each of these chains offers an online grocery service (prices in the online segment are one of the control groups that we use).[11]

Food prices in Israel had been rising fast between 2005 and 2011. The steep rise in prices was a main driver behind the massive social protests that took place in Israel in the summer of 2011. In these protests, hundred of thousands of Israeli protesters demanded the adoption of policies that would lower the cost of living. A direct consequence of the social protests was the formation of a committee on food prices' which found that the cumulative annual growth rate of food prices in Israel between 2005 and 2011 was 5%, compared with 3.2% in OECD countries for the same period.[12] The recommendations of the committee were the basis for the "Food Act" enacted in the Israeli parliament in March 2014.[13] A primary component of the new legislation was a transparency clause requiring each chain to upload price information on all products sold in its stores onto an online depository. The regulation requires each supermarket chain to upload to a designated website files, one for each store, containing information about prices and promotions for each product sold in each store. The files are updated on a daily basis if no price changes have occurred, and within an hour if a price change has occurred during the day.[14]

On May 20, 2015, the transparency regulation went into effect, and retailers began uploading price data to dedicated websites. Given that the raw price data are not easily comparable, independent websites began making the data more accessible to consumers. During August 2015, websites began providing "beta" versions of price-comparison services for food products sold by different supermarket chains in different brick-and-mortar stores across Israel. As of 2016, three websites offered food price-comparison services. These websites offer free-of-charge standard features such as the option to follow a fixed grocery list and use the same address when returning to the website. To increase consumer traffic to these websites, the Ministry of Economy supported a large TV advertising campaign, and announced a competition among price-comparison websites, in which the first and second prizes (175K and 75K NIS) will be given to websites that will have more than 300K and 75K monthly users, respectively. Despite these efforts, the websites failed to attract considerable traffic.

The Israeli media has an important active role in supporting pro-market agendas, exposing attempts to gain market power and denouncing price increases. Following the social protests in 2011, media coverage of the food market became more substantial and influential. For instance, In 2012, TheMarker, a prominent business newspaper in Israel, selected Rami Levy, the owner and manager of the low-priced food chain Rami Levy (often referred to as a hard-discount chain) as

[11] https://www.bdicode.co.il/en/category/eng_commerce/eng_commerce_supermarket/.

[12] See page 8 in https://www.gov.il/he/Departments/publications/reports/food_products_prices_kedmi_report_2012.

[13] https://www.nevo.co.il/law_html/law01/501_017.htm

[14] The Ministry of Economy and Industry lists on its website links to the designated website of each chain. See, https://www.gov.il/he/Departments/legalInfo/cpfta_prices_regulations.

the most influential figure in Israel in that year. Three years later, on Israel's Independence day in 2015, Rami Levy received one of the most prestigious national symbols, along the inventors of the application Waze and the developers of the Iron Dome defense system.[15] The Israeli media coverage also involves comparisons of prices across different supermarket stores. Before the transparency regulation, reporters had to physically visit stores and wander through the aisles to find the price of each product. After the regulation went into effect, the costs of collecting and comparing prices dropped significantly, providing the media with ample opportunities to report on price differences across numerous stores and products, much more than before prices were transparent. For instance, on April 7, 2016, Ynet, the most popular Israeli website in Israel, published a comprehensive price comparison across dozens of supermarket stores throughout the country. The comparison, based on data from a price-comparison website included information from 18 geographic regions; for each region, the names and the addresses of the three stores that offered the cheapest basket were reported. The number of products included in the basket varied across regions, ranging between 130 and 210.[16]

Price-comparison surveys by the media are useful not only for consumers but also for retailers that want to credibly inform consumers about their low prices. This aggregating feature of the media is particularly important because supermarket chains, like many multi-product firms, cannot advertise all the items that they sell. Moreover, advertising prices of a subset of items might be considered unrepresentative by consumers and hence ineffective. By referring to surveys by the media, retailers improve the informativeness of their ads. Figure 1.1 in the Online Appendix provides an example of such an ad. In the analysis below we define such ads as media based-ads. Not surprisingly, chains that use media-based ads are those that are mentioned as having the cheapest basket in the respective price surveys.

2.1 Data and descriptive statistics

In this section we describe the price data that we use to identify the effect of transparency on prices. Next, we discuss the data on advertising expenditures and on the usage of price-comparison websites.

2.1.1 Price data

We use price data for a treatment group of products and for four control groups of products.

Figure 1 presents a time series of the average basket price for each of the five supermarket chains in our data, for the year prior to the regulation and for the year after. As can be observed in the

[15] www.haaretz.com/israel-celebrates-67th-independence-day-1.5354235

[16] See http://www.globes.co.il/news/article.aspx?did=1001108062 and http://www.yediot.co.il/articles/0,7340,L-4858377,00.html for additional examples.

figure, there is a declining trend in price level and price dispersion, which arguably strengthens after prices became transparent. The figure can also be used to rank the five chains according to basket price. The basket price for the two largest "premium" chains: Mega and Shufersal is more expensive than its price at the other chains; in particular, the basket price at Rami Levy, which is known as a hard-discount chain, is the cheapest.

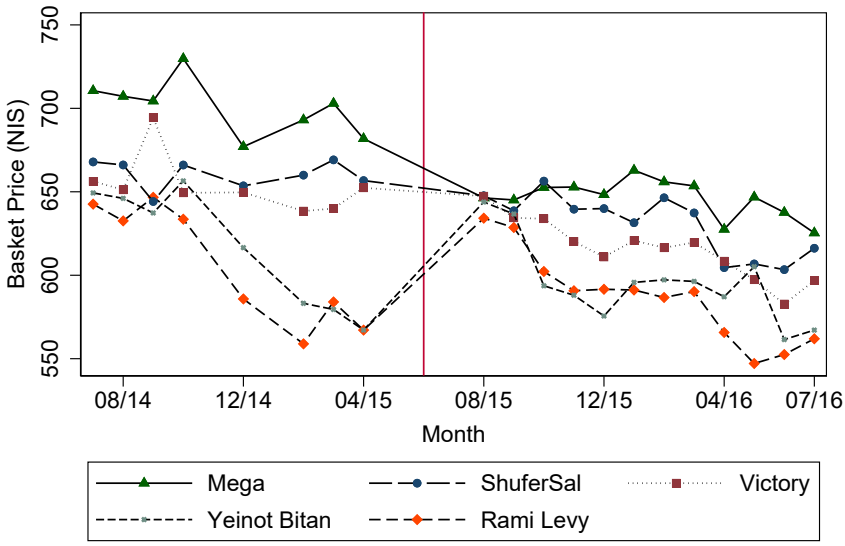

Figure 1: Retailer-Specific Basket Price

Notes: The figure shows a time series of the total basket price for each of the five food retailers. The vertical line denotes the date in which the transparency regulation came into effect. Monthly basket price is the sum of products' average price, where the average is taken over a retailer's stores. Missing price are imputed, and products with more than 6 missing values are excluded. The figure suggests that both price dispersion and price levels decreased after prices became transparent.

The patterns observed in the figure suggest that transparency led to lower prices and lower price dispersion. However, these patterns might be driven by other factors besides price transparency. To take these factors into account, we collected data on four control groups of products. These control groups can be divided into two sets. The first two control groups involve prices of products that were arguably transparent before and after the transparency regulation became effective. In contrast, the two other control groups involve prices of products that remain non-transparent before and after the regulation. Below we provide more details on these control groups and explain how using them is useful to arguably identify the effects of transparency on prices.

Control group 1: products sold online. The first control group contains products that are sold through the online grocery channel of each of the five supermarket chains. Since the prices of products in the online channel were transparent both before and after the transparency regulation, these prices offer a useful comparison. Since July 2014 we began collecting the prices of the products that are included in the treatment group but are sold through the online channel of each

of the five chains. Specifically, the prices were collected on a weekly basis from an online platform that allows consumers to purchase grocery items online from each of the five supermarket chains. Notably, in the online channel, each of the five chains sets identical prices in all the local markets that it serves (see Ater and Shany (2021) for details). Panel A in Figure 2 presents a time series of the total price of a basket of products in the treatment group and a time series of a basket of the same products sold online, starting in July 2014 and ending in July 2016; each data point represents the average basket price across all stores in the respective group. The figure reveals that prices online are generally cheaper than the prices of the same products sold in brick-and-mortar stores. In the pre-transparency period, prices in the online channel and in traditional stores show a similar declining trend. More importantly, we see that after the prices in traditional stores became transparent, the prices in traditional stores show a downward trend whereas prices in the online channel are generally quite stable.

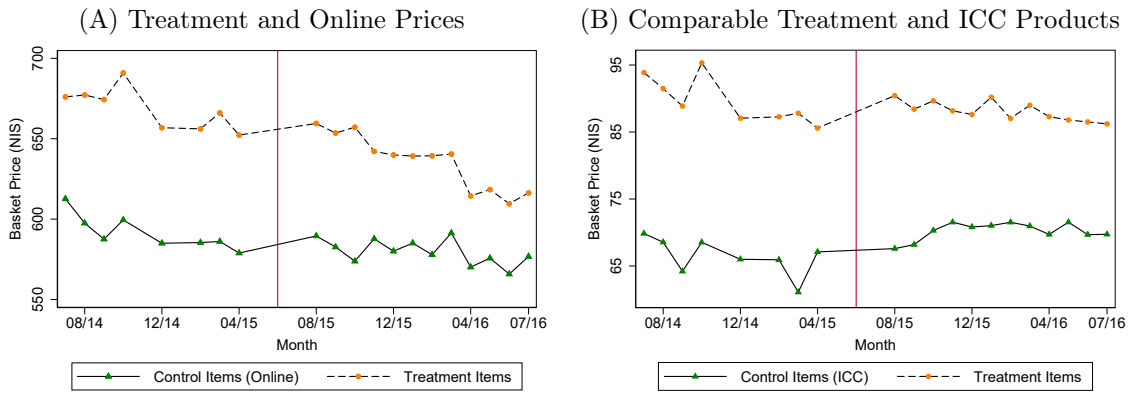

Figure 2: Prices of Treated and Control Group Products

Notes: Panel A shows a time series of the total basket price, divided into the online (control group) channel and the brick-and-mortar (treatment group) channel. In each channel, prices are averaged across stores and chains. Missing prices are imputed. The figure shows that the online basket is cheaper than the same basket sold in traditional stores. Yet, after prices became transparent, the online prices remain the same, whereas the prices of the same products in traditional stores decline. Panel B shows a time series of the total price for two baskets of products. One basket consists of five ICC control items and the other consists of five close substitutes items from the treatment group. For instance, a 200-gram jar of Nescafé Taster's Choice instant coffee, included in the ICC group, is matched to a 200-gram jar of Jacobs Kronung Coffee (another quality brand of instant coffee), included in the treatment group. After prices became transparent, ICC prices somewhat increase and the prices of treatment products remain stable. In both panels, the red vertical line denotes the date in which the transparency regulation came into effect.

Control group 2: ICC products. The ICC control group comprises 45 products whose prices were regularly collected by the ICC, the largest consumer organization in Israel. The products collected by the ICC do not overlap with the products in our treatment group, and we focus on prices of products that are sold in the same 61 stores from which we collected the prices for the treatment group. The ICC began collecting prices in March 2013 in an effort to promote competition among supermarkets and to inform consumers about the price of a standard fixed basket of products sold in hundreds of stores across Israel. The prices of the products in the ICC

basket were frequently cited in media reports. For instance, a TV program called "Saving Plan", one of the top-rated programs in Israel, devoted a weekly segment to updating the public about the ICC's price collection and comparison initiative. In addition to media reports, supermarket chains often mentioned reports by the ICC as a credible reference when advertising their own low prices. Mega, the second-largest supermarket chain, dedicated about 40% of its advertising budget in 2014 to ads that refer to the ICC price-comparison initiative. We take the ICC initiative and the associated publicity as an indication that supermarket chains and consumers were aware of the prices of items collected by the ICC, or in other words, that the prices of these items were transparent already before the regulation went into effect.

We use ICC's monthly reports of products' prices for the period between July 2014 and July 2015. These reports include the prices of all products collected by the ICC, including the store address, chain affiliation and the week of collection. For the post-transparency period, we obtain the price data for the same products sold in the same stores from a price-comparison website. Panel B in Figure 2 presents a time series of five products from the treatment group and a time series of five comparable products from the ICC control group. Each product in one group has a close substitute in the other group.[17] For instance, a Dish-washing liquid 'Sod' (750 ml) included in the ICC group, is matched to a dish-washing liquid Fairy (750 ml) included in the treatment group; a 1.5 liter Coca-Cola bottle in the ICC control group is matched with a 1.5 liter decaffeinated Coca-Cola bottle in the treatment group. Panel B in Figure 2 shows that prices of products in the ICC control group and in the treatment behave quite similarly in the pre-transparency period. However, after prices became transparent, prices of products in the ICC control group somewhat increased, while prices in the treatment group remained stable. Overall, panels A and B in Figure 2 suggest that the mandatory disclosure of prices resulted in lower prices. Nevertheless, the figures do not account for time and item specific changes that may have occurred over the relevant time period.

In Figure 3 we present a time series of the average number of distinct prices per product in the treatment group and in the online and ICC control groups. As seen in the figure, before the regulation went into effect, the average number of different prices per item in each of the two control groups is smaller than in the treatment group. Shortly after the regulation became effective, the average number of unique prices in the treatment group fell abruptly, and the differences between the treatment and the control groups diminishes. Figure 1.5 in the Online Appendix shows a similar graph when the coefficient of variation is used instead of the number of unique prices.

Control group 3: products sold at drugstores. The third control group comprises 28 products

[17] To create the 5 pairs of products, we use the following criteria: two same-pair products are in the same sub-product category, and are produced by the same manufacturer or have the same size/quantity. The pairs are shown in figures 1.3 and 1.4 in the Online Appendix.

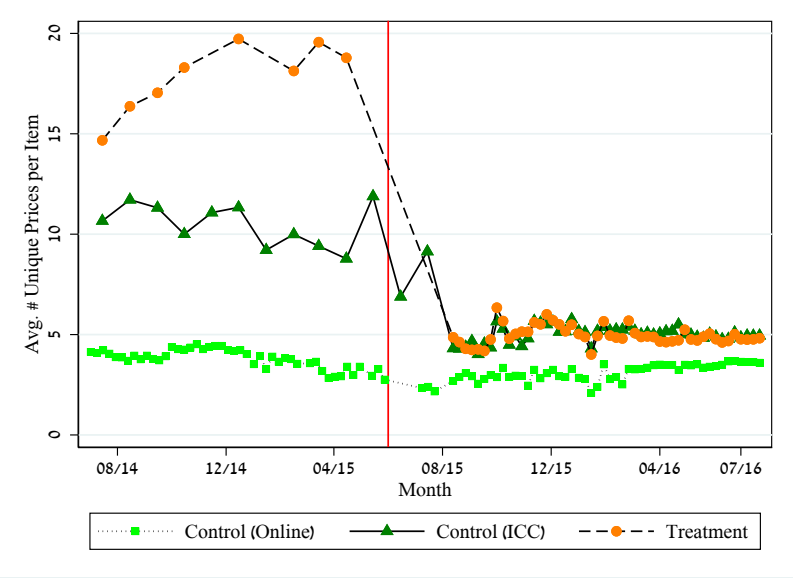

Figure 3: The Number of Unique Prices Per Product

Notes: The figure shows a time series of the average number of unique prices a product is sold for in the treatment group (orange), the online control group (light green) and the ICC control group (dark green). The vertical line denotes the date in which the transparency regulation came into effect. According to the figure, the number of unique prices per treated product in all stores fell abruptly shortly after prices became transparent.

sold in 31 stores affiliated with Super-Pharm, the largest drugstore chain in Israel. These 28 products, which are a subset of products included in the treatment group, provide a useful control group because drugstores were exempt from the Food Act and their prices were not available online.[18] Prices at Super-Pharm stores were collected by RAs at two points before the transparency regulation law came into effect — in late October 2014 and in late April 2015— and at two points in the post-transparency period — in late October 2015 and in late April 2016. Given that drugstores do not sell the full array of products sold in supermarkets, we do not have full overlap between products in the treatment group and products in the Drugstores control group.

Control group 4: products sold in groceries. Our fourth control group includes 8 products, whose prices are regularly collected by the Central Bureau of Statistics ('CBS') for the Israeli consumer price index. The prices are collected from small unaffiliated grocery stores and from supermarkets across Israel. Like drugstores, small grocery stores were not subject to the transparency regulation. For each product, the monthly CBS data include a product identifier, price, store identifier and an indication of whether the store belongs to a chain or is an unaffiliated grocery store. We use these data to examine how the regulation affected prices in supermarkets, which were subject to the regulation, relative to prices in small grocery stores, which were not subject to the regulation. The CBS price data is particularly helpful because the data collection process used to collect the prices

[18]Starting in July 2017, drugstore chains also became subject to the transparency regulation. Table 1.2 in the Online Appendix presents regression results demonstrating that prices and price dispersion at Super-Pharm declined after prices became transparent.

Table 1: Descriptive Statistics

Data Source	# Stores	# Items	# Data Pulls	N
Treatment group	61	69	58	159,276
Online	5	69	99	29,421
ICC	61	45	63	118,952
Groceries	73	8	25	4,249
Drugstores	31	28	4	2,789

Notes: The table presents information on the number of stores, items and periods for which prices have been collected in the treatment and control groups. For instance, the 118,952 prices of the 45 items in the ICC control group were collected in 61 stores at 63 different weeks.

of these items did not change over the relevant time period. Accordingly, when we use the CBS data both the treatment and control groups are based on the same data source. Unfortunately, due to confidentiality concerns and limited information on variables such as chain identity, store location and advertising expenditures we cannot use this group for all the analyses. Table 1 presents summary statistics for the number of products and observations in the treatment group and in the different control groups. Figures 1.3 and 1.4 in the Online Appendix provide more details on the products included in the treatment and each of the control groups.

Additional data for the price analyses. For the post-transparency period, we also obtain more expansive and finer-grained data from a price-comparison website. Specifically, we use weekly reports on the prices of nearly 355 products sold in 589 stores of the 5 chains. Finally, in some specifications, we use measures of local competition which are based on the number of stores operated by rival chains within a certain distance of a given store.[19]

2.1.2 Advertising and price-comparison websites data

In Section 4 we examine the roles of firm advertising and consumer search in explaining our findings. We use the following data on advertising and on access to the price-comparison websites.

Advertising data. We obtain ad-level data for the five supermarket chains in our data. These data, collected by 'Ifat', the leading Israeli company for tracking and monitoring advertising, contain detailed data on advertising content and expenditures for the time period from July 2014 to June 2016. For each ad, the company provides the following information: the advertising retail chain; the date that the ad was posted; media channel used (e.g., television, newspapers, radio, Internet), the expenditure on each ad based on list prices, the ad itself, and a classification into promotion/image ads. After viewing or listening to all the ads, we further classify the ads based on whether the ads include a reference to price surveys conducted by the media or not. We define

[19]The methodology to determine the level of local competition is described in https://www.gov.il/he/departments/publications/reports/foodlawmethodology.

such ads as "media-based" ads.

Price-comparison websites data. We obtain data from Similarweb, a digital market intelligence, on three price-comparison platforms (*MySupermarket.co.il, Pricez.co.il* and *ZapMarket.co.il*). These platforms were active between July 2014 to June 2016 and for each platform we have information on the monthly number of viewers and pages viewed.

3 Empirical Strategy and Results

Identifying causal effects of transparency on prices is a challenging task for several reasons. First, such an endeavor requires an exogenous shock to transparency. In the absence of such a shock, it would be difficult to argue that a change in transparency is the source of observed price changes. Furthermore, if price transparency is endogenously determined by firms, then selection is another concern. For instance, the products that firms choose to post their prices may not be representative, and therefore the analysis of the effect of transparency on prices would be biased. Second, given an exogenous shock to transparency, identifying its impact requires data from both before and after the regulation. Collecting post-transparency data is likely to be straightforward; however, obtaining data from a period in which such information was not readily available is likely to be more complex. Third, pricing decisions take into account various factors, such as cost, local competition and seasonality. These factors may very well change alongside the change in transparency. Thus, to identify the impact of transparency on prices one needs to also account for potential changes in other determinants of pricing decisions that might have taken place concurrently with the change in transparency. Finally, supermarkets sell thousands of product, which may be subject to different pricing considerations. Accordingly, to obtain a reasonable estimate of the overall impact of transparency on prices, it is necessary to investigate a large sample of products.

In this section, we elaborate on our identification strategy, and explain why we think that we can arguably identify the causal impact of transparency on prices. To identify the effect of transparency, we compare price changes in the treatment group before and after the regulation took effect, with the corresponding changes in each of the control groups. A significant difference between a change in the treatment group and a change in the control group can arguably be attributed to the effect of transparency. Importantly, while concerns can be raised regarding the validity of each of the control groups, the use of other control groups helps to mitigate such concerns. For instance, a difference between the treatment group and control group 1 (i.e., the online channel) might actually be a result of an unobserved change that took place in the online segment at the time the transparency regulation took effect. Control group 2 — comprising the ICC items that are sold in the same traditional store as items in the treatment group — is not

vulnerable to this concern. Similarly, a significant change in the prices of products in the treatment group relative to the prices of products in the ICC control group might be related to intertemporal changes in the marginal costs of the different products in the two groups, rather than to changes in transparency. Control groups 1, 3 and 4 are not susceptible to this concern, as they contain the same products as the products in the treatment group. Finally, one might be concerned that our results using control group 3 (drugstore prices) are biased because the transparency regulation changed the level of competition between supermarket chains and drugstores. Yet, the estimation using control group 2 which focuses on different products sold in the same store is less vulnerable to this concern. In the robustness section we present additional findings and analyses that further show that such concerns are unlikely to affect our results. More generally, the use of different control groups and given that that we obtain similar qualitative results using alternative control groups, provide further confidence that our estimates are driven by the transparency regulation rather than by other changes in the market.

3.1 Estimation

3.1.1 Price levels

We use the following difference-in-differences specification to identify the impact of transparency on price levels:

$$log(price_{ist}) = \mu_i + \eta_s + \gamma_t + \beta \times After_t \times Treatment_{is} + \epsilon_{ist} \quad (1)$$

where an observation is a product-store-date tuple, and the dependent variable is the log(price) of product i sold in store s in week t. The $After$ indicator equals one if the time period t in which the product's prices were collected is after May 2015 (when the transparency regulation took effect), and zero otherwise. The $Treatment$ indicator takes the value of one for observations in the treatment group, and zero for observations in the control group. We include time period (γ_t), store (η_s) and item (μ_i) fixed effects to control for other factors that potentially affect prices. The weekly fixed effects capture the impact of seasonality on pricing and other regulatory changes that might have affected chains' costs and pricing decisions. For instance, the value-added tax in Israel dropped from 18 to 17 percent in October 2015 and the minimum wage in Israel increased in April 2016. These changes have might affected chains' pricing decisions, but nevertheless should be captured by the week fixed effects. The store fixed effects capture time-invariant local competition conditions and the socio-demographic characteristics of local customers. We also accommodate the possibility of pricing trends that may vary across items by incorporating linear product-specific time trends. Finally, we cluster standard errors at the store level.

The main parameter of interest is β which is the coefficient on the interaction between the $After$ and the $Treatment$ indicators in equation 1. The identifying assumption is that the only systematic difference between the control groups and the treatment group is the amount of price-related information available to consumers before the law took effect. Put differently, price changes of products in the control groups which take place after prices became transparent do not undermine our identification strategy. Per our discussion above regarding the use of the different control groups, and given that the treatment and control groups contain a substantial number of products in several categories, with overlapping manufacturers and different retailers, we believe that this is a reasonable assumption.

In separate regressions, we also examine how the impact of transparency varies with the pre-transparency price level and local market conditions. To test how prices in more expensive chains changed following the transparency regulation, we modify Equation 1 by interacting the $After \times Treatment$ variable in Equation 1 with a premium/discount indicator for the type of the supermarket chain. Specifically, we consider the two chains that offer the average cheapest basket in the pre-transparency period as discount chains and the other three chains as premium chains. We obtain similar qualitative results when focusing only on the cheapest chain. We also conduct similar regression analyses after slicing the data into 4 quartlies of products, based on the average price of the product in the pre-transparency period. Finally, in section 5.1 we examine prices of different types of products (e.g., private label vs. branded products, more vs. less popular products) changed in the post-transparency period. In these analyses we use prices collected only after the transparency regulation went into effect, and can therefore include a much larger set of products and stores (355 items sold in 589 stores).

3.1.2 Price dispersion and price uniformity

To capture changes in price dispersion, we aggregate the price-store-date data to the product-date level and in some specifications to the product-chain-date level. We use three measures of price dispersion: the number of distinct prices that a given product i is sold for in a given period t, the coefficient of variation of a given product i in a given time period t, and the percentage price range of a given product i in a given time period t. In each regression, we compare the treatment group to a different control group. Formally, we estimate the following equation:

$$PD_{it} = \mu_i + \gamma_t + \beta \times After_t \times Treatment_i + \epsilon_{it} \tag{2}$$

where the dependent variable is one of the three measures of price dispersion. The $After$ and $Treatment$ indicators are like in Equation 1, and we include fixed effects for the product and the

time period in which prices were collected. We also include chain fixed effects when we focus on within-chain price dispersion. The product and chain fixed effects capture time-invariant characteristics of each item or chain, such as the mean cost of production or a chain's fixed pricing policy. The time period fixed effects capture the impact of seasonality on pricing and other changes that might have affected chains' costs and pricing decisions. Similar to the price levels specification, here we also include linear product-specific time trends. Standard errors are clustered at the product level. In some specifications, we also include the number of times that a price of each product was collected in each period as an additional control variable. The coefficient of interest, β captures the change in price dispersion in the treatment group after prices became transparent relative to the corresponding change in dispersion in the control group. In the Online Appendix, we present additional results for the effect of transparency on the inter-chain price dispersion.

3.2 Estimation results on prices

3.2.1 Price levels

Table 2 presents regression results of Equation 1 regarding the effect of transparency on price levels. The point estimates of the main parameter of interest are negative and significant across the different control groups. The estimates in columns 1-3 indicate that after the transparency regulation went into effect prices in traditional supermarkets decreased by 4 to 5 percent relative to the prices in the control groups. The analysis in column 4 focuses on price information of 8 products sold in grocery stores and supermarkets, and there we obtain that the drop in prices is more modest and is only 2 percent. We also estimate equation 1 using the products in the "comparable basket" (see Figure 2) and obtain similar qualitative results (table 1.1 in the Online Appendix). We also derive similar estimates when price promotions are taken into account (table 1.3 in the Online Appendix).

Table 2: The Effect of Price Transparency on Price Level

	(1) log(Price)	(2) log(Price)	(3) log(Price)	(4) log(Price)
After*Treatment	-0.05**	-0.05**	-0.04**	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)
Store + Item + Date F.E.	✓	✓	✓	✓
Control Group	Online	ICC	Drugstores	Groceries
R^2	0.94	0.96	0.91	0.98
N	186810	278228	58358	9472

Notes: The unit of observation is item i in store j on date t.
Errors are clustered by store, and we include linear item-specific time trend.
Time period covered is 7/2014 - 6/2016. * $p < 0.05$, ** $p < 0.01$
The table presents regression results of Equation 1 using the 4 control groups, showing that prices declined after prices became transparent.

The magnitude of the effect we find is not trivial. Given that consumers spend about one sixth of their disposable income on food, a reduction of 5% in prices is equivalent to 0.8% increase in disposable income. Alternatively, this amounts for nearly 1.5% increase in median wage in Israel.[20]

Table 3 presents point estimates obtained from estimating a modification of Equation 1 in which we distinguish between premium and discount supermarket chains. The regression results indicate that the reduction in prices was concentrated among premium chains. For discount chains we do not find strong evidence that prices decreased after the transparency regulation went into effect. Table 1.4 in the Online Appendix presents regression results when we include a chain-specific interaction variable. Similarly, we find there that the effect of transparency was large and negative for high-priced chains and considerably smaller for low-priced chains (per the ranking of the total average basket price shown in figure 1).

Table 3: The Effect of Price Transparency on Prices in Different Chains

	(1) log(Price)	(2) log(Price)	(3) log(Price)
Premium Chain: After*Treatment	-0.06**	-0.06**	-0.04**
	(0.01)	(0.01)	(0.01)
Discount Chain: After*Treatment	-0.01	-0.03**	0.01
	(0.01)	(0.01)	(0.01)
P-Val: Premium = Discount	0.00	0.00	0.00
Store + Item + Date F.E.	✓	✓	✓
Control Group	Online	ICC	Drugstores
R^2	0.94	0.96	0.91
N	186810	278228	58358

Notes: The unit of observation is item i in store j on date t.

Errors are clustered by store, and we add linear item specific time trend.

Time period covered is 7/2014 - 6/2016. * $p < 0.05$, ** $p < 0.01$

The table presents regression results of a version of Equation 1 in which the post-transparency indicator is interacted with a chain-type dummy (premium/discount). The regression results suggest that prices have significantly declined in stores of premium chains and did not significantly change in stores of discount chains. We do not have chain identifier in the CBS data and hence do not run this analysis for the groceries control group. We obtain qualitatively similar results when performing this analysis at the chain level (table 1.4 in the Online Appendix).

Finally, in Table 4 we present heterogeneous results, where we divide the 69 products in the treatment group into 4 quartiles, based on their average price in the pre-transparency period. In panel A we examine how prices in each quartile changed after the transparency regulation. In panel B, we repeat this analysis and also distinguish between the effect of transparency on prices in premium and discount chains. The results suggest that prices of cheaper products fell by 8%, whereas prices of more expensive products did not significantly change. Moreover, most of the effect comes from premium chains reducing prices of products in the lower two quartiles by 9%.

[20] http://www.cbs.gov.il/statistical/mb158h.pdf. Note that the regression analysis assumes equal weights for all products. In section 5.2 we show that the prices of more popular products declined less than less popular products. Accordingly, the impact on actual spending is likely smaller than the estimates reported in table 2.

For discount chains, we find that prices of products in the lower quartile fell by 5%.[21]

Table 4: The Effect of Price Transparency on Price - by Price Levels and Chain Type

	(1) log(Price)	(2) log(Price)	(3) log(Price)	(4) log(Price)
Panel A: by Quartile				
After*Treatment	-0.08***	-0.08***	-0.02	-0.01
	(0.02)	(0.03)	(0.02)	(0.01)
R^2	0.88	0.54	0.54	0.78
Panel B: by Quartile and Chain Type				
Premium Chain: After*Treatment	-0.09**	-0.09**	-0.04*	-0.02
	(0.02)	(0.03)	(0.02)	(0.01)
Discount Chain: After*Treatment	-0.05**	-0.04	0.04	0.01
	(0.02)	(0.03)	(0.02)	(0.01)
R^2	0.88	0.54	0.54	0.78
P-Val: Premium = Discount	0.00	0.00	0.00	0.02
Store + Item + Date F.E.	✓	✓	✓	✓
Group of Products	Q1	Q2	Q3	Q4
Control Group	Online	Online	Online	Online
N	48287	49595	45624	43304

Notes: The unit of observation is item i in store j on date t. Time period covered is 7/2014 - 6/2016. Errors are clustered by store, and we add linear item specific time trend. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. The table presents regression results of Equation 1, where each column uses one quarter of the products in the initial sample, based on the mean price of the product in the pre-transparency period. Accordingly, column 1 includes 17 products with the lowest mean prices and column 4 the 17 most expensive products. Panel A examines the effect of transparency on prices of products in different quartiles, whereas in panel B we also distinguish between prices of these products in premium vs. discount chains. The results in panel A suggest that prices of cheaper prices fell by about 8% whereas prices of products in the top 2 quartiles did not significantly change after the regulation. Results in panel B suggest that the drop in prices comes primarily from premium chains, though discount chains also reduce prices of cheap prices.

3.2.2 Price dispersion

The regression results of Equation 2 are shown in panel A of Table 5. We present results using three measures of price dispersion: the number of unique prices, the coefficient of variation and the percentage price range. For the four control groups, the table reports point estimates of the parameter of interest and the average value of the dependent variable. Although the magnitude varies across dispersion measures and control groups, the results indicate that the transparency regulation had an economically and statistically significant negative effect on price dispersion. For instance, columns 5-8 focus on the coefficient of variation for each product. The results suggest that the coefficient of variation dropped substantially after the transparency regulation. According to columns 5 and 7, this drop is roughly 50% relative to the average value.

[21] Table 1.5 in the Online Appendix shows regression results that examine how the effect of transparency on prices depends on the level of local competition a store faces. The regression results suggest that stores located in more concentrated local markets lowered their prices more than stores facing stronger local competition.

3.2.3 Uniform pricing and intra-chain price dispersion

Panel B in table 5 presents estimation results that focus on within-chain price dispersion. The results suggest that intra-chain price dispersion dropped significantly after the transparency regulation. In particular, focusing on the number of distinct prices a product is sold for and using the online control group in column 1, we find that the number of distinct prices fell on average by 2.75 relative to an average value of 4.5.[22]

4 Possible Mechanisms

Our findings regarding price levels and price dispersion indicate that the increased availability of price information in the post-transparency period was driving the changes in prices. Yet, the exact channel through which consumers obtained this information is unclear. In this section we consider two mechanisms that likely drive our findings regarding the effects of transparency, first on price levels and inter-chain price dispersion and then on uniform pricing. In section 4.1 we explore the role of informative advertising and the media in driving the changes in price levels and inter-chain price dispersion. We show how our findings can be rationalized based on the equilibrium framework developed by Robert and Stahl (1993). Next, in section 4.2 we discuss why we think that fairness concerns might explain retailers' decision to adopt uniform pricing. We separately consider the two mechanisms because they are conceptually different and also – as shown in Figure 4 – because the change in uniform pricing occurred several months before other changes in prices materialized.

4.1 Media, informative advertising and prices

Robert and Stahl (1993) were the first to consider how optimal consumer search and informative advertising affect market outcomes, such as price levels and price dispersion. Unlike many papers in the search literature, where exogenous consumer heterogeneity generates price dispersion, the model by Robert and Stahl aims to derive price dispersion in a setting where consumes' information is endogenously determined along with prices, advertising and profitability. In the model, firms sell a homogeneous good and simultaneously set prices and advertising levels. Consumers are ex-ante identical and are unaware of prices. Consumers can learn about prices through either costly sequential search or from exposure to information about prices that appears in firms' ads. Consumers who are exposed to these ads become informed about prices in these stores, while consumers who are not exposed to ads are uninformed.[23] The share of informed consumers depends

[22] Table 1.6 in the Online Appendix further shows that the drop in the number of distinct prices occurred in all five chains. Table 1.7 in the Online Appendix also displays results for inter-chain price dispersion, suggesting that price dispersion fell after the regulation. This latter finding is consistent with our finding that more expensive chains reduced their prices more than discount chains.

[23] Bagwell (2007) writes that the model fits an established industry, like the supermarket industry, where consumers are aware of firms' or stores' existence but unaware of prices. In such a setting, both informed and uninformed

Table 5: The Effect of Price Transparency on Price Dispersion

Panel A: Price Dispersion	# Unique Prices				Standard Deviation/Avg.				Perc. Range ($100 * \frac{P_{max}-P_{min}}{P_{max}}$)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
After*Treatment	-10.7***	-8.1***	-15.9***	-1.7	-0.1***	-0.1***	-0.1***	-0.04*	-27.4***	-12.7***	-33***	-10.04**
	(0.54)	(0.80)	(1.67)	(1.15)	(0.01)	(0.01)	(0.02)	(0.02)	(1.67)	(2.47)	(6.08)	(3.55)
Control Group	Online	ICC	Drugstores	Groceries	Online	ICC	Drugstores	Groceries	Online	ICC	Drugstores	Groceries
DV Mean Value	16.3	17.3	19.1	9.8	0.2	0.2	0.2	0.2	55	55.6	57.7	38.8
R^2	0.8	0.8	0.8	0.8	0.4	0.6	0.4	0.9	0.5	0.7	0.6	0.8
N	9636	6176	1525	400	9345	6120	1510	400	9636	6176	1525	400

Panel B: Intra-chain price dispersion	# Unique Prices			Standard Deviation/Avg.			Perc. Range ($100 * \frac{P_{max}-P_{min}}{P_{max}}$)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
After*Treatment	-2.75***	-1.63***	-4.65***	-0.11***	-0.08***	-0.12***	-25.2***	-13.4***	-26.8***
	(0.10)	(0.17)	(1.18)	(0.01)	(0.01)	(0.02)	(1.11)	(1.75)	(4.21)
Control Group	Online	ICC	Drugstores	Online	ICC	Drugstores	Online	ICC	Drugstores
DV Mean Value	4.5	4.2	4.6	0.2	0.2	0.2	31.4	29.9	32.1
R^2	0.5	0.6	0.7	0.4	0.4	0.5	0.5	0.5	0.6
N	37685	25978	6120	17575	25211	5828	37685	25978	6120

Notes: Panel A: the unit of observation in columns 1, 3, 4, 5, 7, 8, 9, 11 & 12 is item i on date t in treatment/control group. The unit of observation in columns 2, 6 & 10 is item i on date t.

Panel B: the unit of observation in columns 1, 3, 4, 6, 7 & 9 is item i on date t in treatment/control group. The unit of observation in columns 2, 5 & 8 is item i on date t.

We do not use the groceries control group since we do not have chain identifier in the CBS data.

Time period covered is 7/2014 - 6/2016. In the regressions we include item, time, chain fixed effects and add linear item-specific time trend. Errors are clustered by product.

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

The table presents the estimation results for equation 2. Panel A focuses on price dispersion and panel B on intra-chain price dispersion.

Results suggest that price dispersion fell after prices became transparent and that chains adopt uniform pricing.

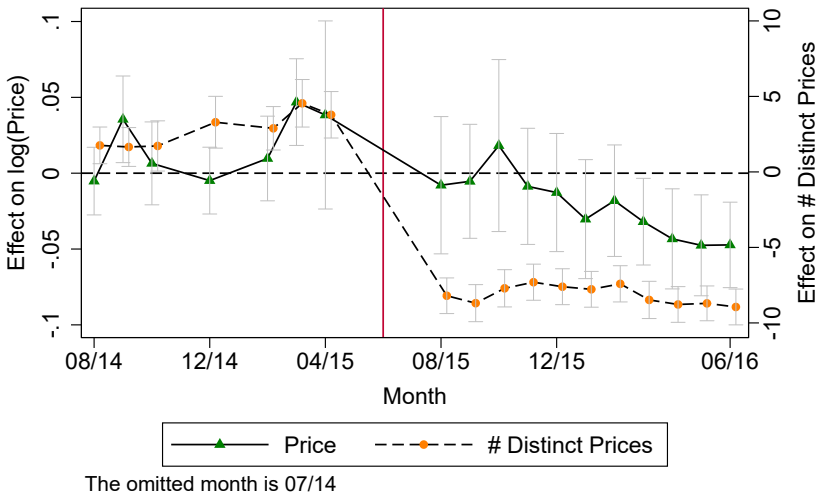

Figure 4: Monthly Effects on Price Level and Number of Unique Prices

Notes: The figure shows the monthly fixed effects from estimating variants of Equations 1 and 2, using the online control group. For each monthly estimate the 95% confidence interval is presented. The figure shows that the change in price dispersion (in orange) occurred shortly after the regulation became effective, and that the change in price levels (in green) materialized later, at the beginning of 2016.

on the level of advertising, chosen by firms to maximize profits. Robert and Stahl characterize a unique and symmetric price-dispersion equilibrium in which firms either charge a high price that is not advertised or select a low price which they advertise. Thus, high-priced firms do not advertise and sell to uniformed consumers, whereas low-priced firms do advertise and mostly sell to informed consumers.

An important difference between Robert and Stahl's model and the setting in this paper is that the model considers firms that sell one good, while supermarkets sell thousands of goods. Accordingly, consumers need to aggregate price information for multiple goods and likely incur substantial costs in doing so. Multi-product firms also face difficulties that differ from those experienced by single-product firms. First, firms that set high prices may try to obfuscate prices thereby making it harder for consumers to understand the full price of products (e.g., Carlin (2009); Spiegler (2016)). Second, low-priced firms find it prohibitively costly to credibly inform consumers about their prices: advertising the prices of all items is likely infeasible, and advertising the prices of a selected set of products might be considered unrepresentative by consumers, and hence ineffective. We view price-comparison surveys conducted by the media as a means to overcome the difficulties that low-priced chains face. In particular, these surveys aggregates price information over multiple goods into one "representative" price. Under the assumption that consumers view the price-comparison surveys conducted by the media as representative and accurate, we can modify

consumers incur the cost of visiting a store. Renault (2015) provides a simplified version of their model.

the predictions that were developed for single-product firms into a setting involving firms that sell multiple products. Thus, we obtain the following hypotheses:

Hypothesis 1 (H1): *The use of informative advertising will rise as the costs of providing it fall.*

Hypothesis 2 (H2): *In equilibrium, chains that set high prices will not use informative advertising. In contrast, chains that set low prices will use informative advertising.*

Following the transparency regulation, the costs of conducting large price-comparison surveys fell significantly. Reporters could use the price-comparison platforms to obtain comprehensive price information on hundreds of items sold in hundreds of stores across Israel. As the scope of the price surveys increases, consumers view these surveys as more reliable. In turn, retailers that receive favorable media coverage in these price-surveys have an incentive to use price advertising that reference to these favorable price surveys. In contrast, retailers that set high prices have no incentive to rely on these media reports, and will cater to consumers who are not exposed to these ads (uninformed consumers). Thus, the transparency regulation reduced the media's cost of covering supermarket prices, and indirectly facilitated the use of informative advertising by chains that set low prices. To test H1 and H2, we use the advertising data and identify "media-based" ads. That is, ads that refer to price-surveys conducted by the media. We use the timing of these media-based ads, the identity of the advertising chain, and the monetary cost of these ads to generate our variable of interests in this analysis.

Figure 5 presents the expenditures on media-based advertising for the year before and for the year after the transparency regulation came into effect, separately for the low-priced/hard-discount chain in our sample (Rami Levy) and for the other chains combined. As can be seen in the figure, after the transparency regulation the expenditures by the low-priced chain increased significantly. In contrast, the combined expenditures on media-based ads by the 4 other supermarket chains practically zeroed once prices became accessible online.[24] Regression results presented in columns 1 and 2 of table 6 confirm these patterns, showing that expenditures on media-based ads by Rami Levy sharply increased relative to the expenditures by other supermarket chains. In column 1 we use the share of spending on media-based ads relative to the total spending on ads, while in column 2 we use the absolute spending on media-based ads as the dependent variable. These results support H1 and H2.[25]

Robert and Stahl also examine the association between informative advertising and prices. They predict that in equilibrium:

[24] Spending on media-based ads in the pre-transparency period was primarily in reference to the ICC basket.

[25] As a falsification test, we checked that the expenditures on non-price ads by Rami Levy did not increase relative to the expenditures on such ads by the other retailers. In other words, the increase in media-based ads is not driven by an aggregate change in advertising spending by Rami Levy but rather by a change in spending devoted to media-based ads.

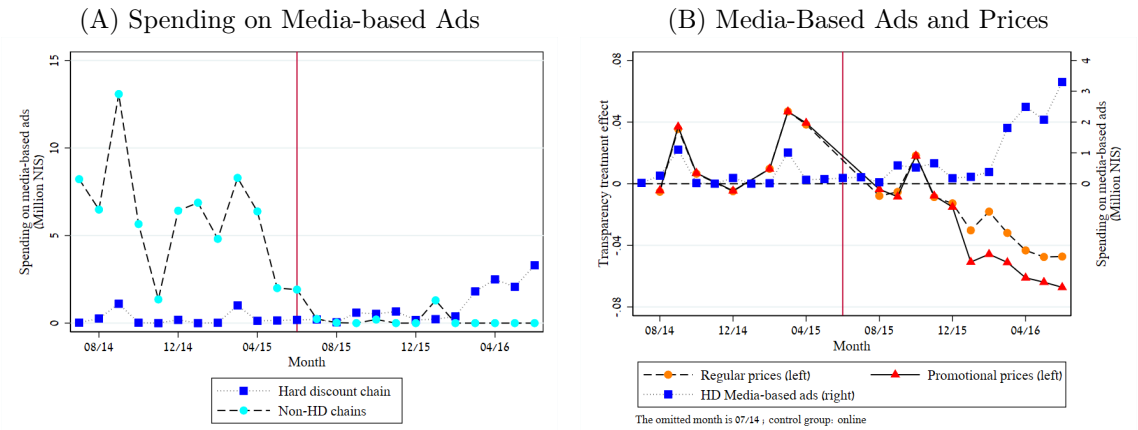

Figure 5: Media-Based Ads, Transparency and Prices

Notes: Panel A shows (in blue) the monthly expenditures on media-based ads by Rami Levy, the primary hard-discount/low-priced chain in Israel, and (light blue) the combined monthly expenditure on media-based ads by other supermarket chains. The vertical line corresponds to the date on which the transparency regulation became effective. The figure shows that after the transparency regulation, the expenditure on media-based ads by the hard-discount chain increased, and nearly disappeared for the other chains. Panel B shows the relationship between spending on media-based ads by Rami Levy (blue) and the estimated monthly effects on regular and promotional prices (orange and red, respectively). The figure shows a clear negative relationship between the level of media-based ads and the estimated monthly price effects (regular or promotional). Similar patterns arise if we use the basket price instead of the monthly coefficients.

Table 6: Media-Based Ads, Transparency and Prices

	Media-based Ads % of total ads	Media-based Ads Spending (Mil. NIS)	Log(Price)	Log (Prom. Price)
	(1)	(2)	(3)	(4)
HD×$After$	48.8***	1.6***		
	(9.4)	(0.23)		
Media-based Ads×$HD \times After$			-0.013***	-0.02***
			(0.00)	(0.00)
R^2	0.79	0.81	0.94	0.93
N	191	191	186810	186810

Notes: The unit of observation in columns 1 and 2 is chain type (hard-discount or otherwise) in week t. We estimate a difference-in-differences specification, where Rami Levy is the treated chain and other chains combined are the control group. Chain and week fixed effects are included. In columns 3 and 4 the unit of observation is item i in store j on date t. We estimate a treatment intensity version of Equation 1, where spending on media-based ads is the main control variable. We use the online control group and include date, item and store fixed effects and add item-specific linear time trend. Time period covered is 7/2014 - 6/2016. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Columns 1 and 2 present regression results concerning the change in media-based ads by the hard-discount/low-priced chain after the transparency regulation became effective. The results show that spending on media-based ads by the hard-discount chain increased significantly relative to other chains after the transparency regulation. These results hold either when the dependent variable is the fraction of spending on media-based ads out of total ad spending (column 1) or when we use absolute spending on media-based ads (column 2). These results lend support to (H1) and (H2). In columns 3 and 4 we present regression results examining the relationship between price levels and informative advertising. We estimate a treatment intensity version of Equation 1, using prices in the online channel as a control group. The intensity considered is the monthly expenditure on media-based ads by the hard-discount retailer. The dependent variable we use are regular prices (column 3) and promotional prices (column 4). In both specifications we find a negative relationship between prices and spending on media-based ads by the hard-discount chain. The regression results support (H3) and indicate that media-based ads were more heavily used in time periods in which prices were lower.

Hypothesis 3 (H3): *Informative advertising will be used more heavily when advertising chains set lower prices.*

According to H3, we should find a negative relationship between prices and spending on media-based ads. Panel B in Figure 5 illustrates this negative relationship well. According to the figure, when spending on media-based ads by the hard-discount chain increased, prices declined. This relationship is even more pronounced when we use promotional prices instead of regular prices. Figure 1.6 in the Online Appendix shows that this negative relationship holds also when we use the average prices of the basket instead of the monthly regression coefficients. This relationship also holds when we estimate a treatment intensity version of Equation 1, replacing the transparency indicator in the original specification with a measure of expenditures on media-based ads by Rami Levy in a given month. We present the results using either regular or promotional prices, respectively in columns 3 and 4 in Table 6. Thus, the results support H3 indicating that expenditures on media-based ads increase at times that prices fall.

Hypothesis 4 (H4): *In equilibrium, consumer search is limited.*

The intuition for H4 stems both from the use of ads by low-priced chains, and from pricing decisions by high-priced chains. Consumers who are exposed to ads learn where to find cheap products and hence do not engage in search. Consumers who are not exposed to ads, also visit one store, and will not continue searching thereafter. This result arises because high-priced stores reduce prices to a level that dissuade these consumers from searching further (see below H5).[26]

Admittedly, it is difficult to show that consumers do not engage at all in search. Nevertheless, we are able to show that the use of the price-comparison websites that became freely available after the transparency regulation is limited.[27] To make this point, we use the data described in subsection 2.1.2 on usage of the three price-comparison websites. The monthly average number of unique visitors to Pricez.co.il and Zapmarket.co.il between October 2015 and July 2016 was 21,414, and 16,992, respectively.[28] These figures combined account for about 2% of the number Israeli households. These numbers may overstate the increase in search activity for food prices since some of those who accessed these websites used to search in stores in the pre-transparency period. Thus, consistent with H4 we tend to conclude that consumer search activity is limited in the post-transparency period.

[26]The sequential search assumption is sensible because consumers need to visit other stores to learn about prices in these stores, or because they need to learn about prices of more products in a given store. See also Ke et al. (2016) for a related theoretical model.

[27]The no-search prediction arises in other standard search cost models for homogeneous goods. Introducing product or consumer heterogeneity often leads to some level of consumer search in equilibrium. See Moraga-González et al. (2017) for a model that considers heterogeneous search costs, and Byrne and de Roos (Forthcoming) for a paper that examines a setting in which consumers face start-up search costs.

[28]Mysupermarket.co.il, the third price-comparison website, offers as its main business an online grocery service so we cannot disentangle customers who visit Mysupermarket to shop online (e.g., at Shufersal online) from visitors who want to obtain price information in traditional stores. Yet, we note that the average number of total visitors to Mysupermarket has marginally declined from 182k in the year preceding the regulation to 176K in the year after.

Finally, Robert and Stahl also consider the effect of a reduction in the cost of informative advertising and search cost on price levels and on price dispersion. In particular, they hypothesize that:

Hypothesis 5 (H5): *As advertising and search costs decline, average prices will fall. The fall in prices will be greater in chains that set higher prices.*

Hypothesis 6 (H6): *As advertising and search costs decline, price dispersion will fall.*

High-priced chains will reduce their prices more than discount chains because they want to dissuade uninformed consumers who visit their stores from searching further. Indeed, tables 2 and 3 show that after the transparency regulation average prices fell. Moreover, the reduction in prices was larger among high-priced chains. The reduction in intra-chain price dispersion is intuitive given that high-priced chains reduce their prices more than discount chains.[29]

4.1.1 Related theoretical studies

Following Stigler's seminal paper, "The Economics of Information", (Stigler (1961)) large theoretical literatures emerged on consumer search and firm advertising. In this section, we briefly discuss how our findings relate to some of the theoretical papers in these literatures, emphasizing mainly papers in the advertising literature and papers that consider both channels.[30]

First, the accuracy and credibility of ads attracted recent attention by economists. Rhodes and Wilson (2018) and Drugov and Troya-Martinez (2019) analyze situations where firms may use advertising to falsely overstate the value of their products. Rhodes and Wilson (2018) show that a positive level of false advertising exists also under optimal policy. De Corniere and Taylor (2019) examine situations where consumers rely on a biased intermediary's advice. In this paper, we argue that following the price transparency regulation, price-comparison surveys conducted by the media are more comprehensive and accurate. Accordingly, ads that reference to these surveys are found to be more trustworthy by consumers and valuable for firms. Second, another related strand of the literature concerns firms' obfuscation strategies (e.g. Ellison and Ellison (2009), Ellison and Wolitzky (2012), Spiegler (2016), Allender et al. (2018) and Carlin (2009)). These papers, motivated by empirical evidence from online markets, explain why firms may want to make price comparisons costly for consumers. Our analysis suggests that price transparency makes obfuscation strategies harder to implement. Moreover, the presence of a maverick firm could foil attempts by other firms to keep prices complex.

[29] Robert and Stahl predict also that in a post-transparency equilibrium profits drop. Though we do have data on retailers' profits, we note that Mega, the second largest chain, filed for bankruptcy in 2016. The effects of transparency and lower prices likely contributed to Mega's failure.

[30] See Bagwell (2007) and Renault (2015) for comprehensive surveys of the advertising literature.

Third, our setting involves supermarket chains that sell thousands of products. Recent theoretical papers examine implications of these settings on prices and other market outcomes. For instance, Zhou (2014) shows that a reduction of one product's price can boost the demand for the firm's other products. Accordingly, firms in a multi-product search environment have an extra incentive to lower their prices compared to the single-product case, and market prices can decline with search costs. Rhodes (2014) examines an environment with multi-product firms and shows that when a firm advertises a low price on one product, consumers rationally expect it to charge somewhat lower prices on other products as well. Finally, theoretical papers that examine how both search and advertising affect market outcomes include Butters (1977) who was probably the first to consider both advertising and search. Butters however does not model optimal search. Choi et al. (2018) consider an oligopoly model in which consumers engage in sequential search based on partial product information and advertised prices. In Board and Lu (2018), consumers also observe prices and learn through costly search about the match value of products. In our setting, consumers do not learn about the match value of a product but on prices themselves. Learning about prices themselves seems sensible in settings where consumers by multiple products each time, the products themselves are familiar to consumers and are repeatedly purchased. More related to our setting is Janssen and Non (2008). Like Robert and Stahl, they study a homogeneous goods model where firms choose prices and the level of advertising. A main difference is that Janssen and Non (2008) assume that the cost of visiting a store are negligible, whereas in Robert and Stahl consumers pay search costs when buying from a firm they got an advertisement from. Finally, some papers examine how firms choose the content of ads. In particular, Anderson and Renault (2006) examine the choice of ad content by a monopoly firm that chooses to provide information about prices and/or product attributes. Also, Boleslavsky et al. (2019) explore how firms choose the amount of information to provide in ads, and the degree to which this decision interacts with pricing decisions and competition. These papers do not model consumer search.

4.2 Brand-image concerns and uniform pricing

Recent papers document a large degree of similarity in prices among stores in the same retail chain. DellaVigna and Gentzkow (2019) and Hitsch et al. (2021) find that local prices are not correlated with local demand conditions. Adams and Williams (2019) and Cavallo (2017) show that firms set identical prices in different stores. These findings are at odds with standard economic models that predict that pricing decisions should take into account local consumer and market characteristics. According to DellaVigna and Gentzkow (2019), the median chain sacrifices $16m of annual profit relative to a benchmark of optimal prices. Our analysis shows that before the transparency regulation, supermarket chains set different prices for similar products sold in different

stores of the same chain.[31] Shortly after the regulation, chains adopted a uniform pricing strategy, setting identical prices for products sold in different stores affiliated with the same chain.

DellaVigna and Gentzkow (2019) discuss potential explanations for uniform pricing, and highlight managerial inertia and brand-image concerns as two primary explanations. Hitsch et al. (2021) suggests that the price similarity is based on similarity in demand, and the difficulty to distinguish among and to obtain precise price estimates at the store level. We propose that in our setting brand-image or fairness concerns might explain why retailers set identical prices across stores. In particular, after prices became transparent consumers (or the media) can easily find out that the same products are sold at different prices in different stores of the same chain. Retailers, to avoid consumers' discontent towards these arguably unfair price differences, choose to set identical prices in all stores. Interestingly, Kahneman et al. (1986) in a seminal paper on fairness concerns in pricing decisions, report that 76% of survey respondents view a deviation from uniform pricing as unfair.

While we certainly cannot offer conclusive evidence for the role of fairness in driving retailers' decision to set uniform pricing, we mention the following. First, fairness concerns were an integral part of the public debate regarding food prices in Israel. Media reports denounced price differences for similar products sold in different stores of the same chain.[32] Second, compliance costs are unlikely driving the decision to adopt uniform pricing. Supermarket chains upload separate files of list prices and of promotional prices for each store they operate. Accordingly, even when chains set identical prices across stores, they need to update the specific price files of all these stores.

5 Additional Results and Robustness

5.1 Effect of transparency across products in post-transparency period

In this section we report additional results using a larger set of products and stores which are available only in the post-transparency period. To undertake this analysis we use weekly price data on 355 products from 589 stores. We further rely on our finding that the change in price levels became significant only in the beginning of 2016, few months after prices became transparent. We exploit this finding to carry out a series of differences-in-differences analyses. In these analyses, the comparisons are made between the prices of products sold in traditional stores (the treatment group) and the prices of the same products sold online by the same chain (as a control group).

[31] Other studies that examine prices in the Israeli retail market (e.g., Eizenberg et al. (2021), Lach (2002) and Ater and Gerlitz (2017)) in the pre-transparency time period find similar patterns.

[32] Such reports often emphasize that prices in rural and poorer areas are more expensive than prices of the same items sold in affluent areas. For instance, www.themarker.com/consumer/1.2291031. Echoing the critique, a legislative attempt requiring food retailers to set the same price in all stores of the same chain nearly passed in the Israeli parliament. www.ynet.co.il/articles/0,7340,L-4252811,00.html and www.knesset.gov.il/protocols/data/rtf/kalkala/2012-07-24-02.rtf.

We also note that while we think that these additional results offer insights on the effect of the transparency policy, we are aware of the limitations of relying on post-transparency data and therefore cautiously interpret the results from this analysis.

In the first analysis, we evaluate the overall extent to which price levels dropped in 2016. We obtain similar results to the results reported in Table 2. That is, among traditional stores, the price difference between the January-August, 2016 period and the August-December, 2015 period was 3.2% lower compared to the corresponding price difference of the same items sold through the online channel. This finding is shown in column 1 of Table 7. Next, we examine how the observed price reductions correlate with product popularity. To this end, we assign each product a popularity score which is based on a list of the top 500 selling items at Mysupermarket.co.il.[33] We then interact this measure of popularity with a dummy variable indicating whether the item's price corresponds to the period before or after January 2016 and add this interaction variable to the estimated specification. The regression results are shown in column 2 of Table 7. The results suggest that the prices of more popular products declined less than the prices of less-frequently-bought products. We now turn to evaluating whether price changes varied between private-label and branded products in the same category. To capture this difference, we estimate an equation similar to Equation 1 and also include two interaction terms. One term is an interaction between an indicator for the post-January-2016 period and an indicator for a private-label product. The second term is an interaction between an indicator for the post-January-2016 period and a branded-product indicator. In this specification the sample of products consists only of the 12 categories that contain private-label products. The results, presented in column 3, indicate that the prices of branded products dropped significantly more than the prices of private-label products. These findings may suggest that following the transparency regulation, consumers found it easier to compare the prices of branded products than to compare the prices of private-label products, which differ across chains.

5.2 Robustness

This section describes several tests which demonstrate the robustness of our findings. Additional results mentioned in the text are available in the Online Appendix.

5.2.1 Parallel time trends

To mitigate concerns regarding the parallel trend assumption, we estimate specifications using log(price) as the dependent variable and add month-specific effects for each specification (treat-

[33] Because more than half of the products in our sample are not included in the top 500 products, we cannot directly match the list with each product. Instead we use a more coarse classification for popularity. The results are robust to different classifications.

Table 7: The Effect of Price Transparency on Prices of Different Types of Products

	Baseline	Popularity	Private Label
	(1)	(2)	(3)
After*Treatment	-0.032**		
	(0.009)		
After*Treatment (w/o property)		-0.046**	-0.030**
		(0.009)	(0.010)
After*Treatment (w/ property)		-0.003	-0.010
		(0.009)	(0.010)
P-Val: Property w = w/o		0.000	0.000
Store + Date + Item F.E.	✓	✓	✓
R^2	0.98	0.98	0.98
N	4981472	4981472	1005062

Notes: The unit of observation is item i in store j on date t. Time period covered is 8/2015 - 6/2016
Data set is based on 355 items and 589 stores. Errors are clustered by store. * $p < 0.05$, ** $p < 0.01$
The table presents regression results using only data from the post-transparency period, focusing on the changes in the prices of 355 items sold in 589 stores affiliated with the five supermarket chains used in the main analysis. In this analysis, the control group comprises from the same items sold through the online channel of each the chains. The post-transparency period begins in January 2016. In column 1, we estimate Equation 1 and find results qualitatively similar to the ones shown in Table 2. In column 2, we examine the change in prices of items that are classified based on their popularity. In column 3 we examine the change in prices of private label and branded products including only categories with private label products.

ment group vs. control group). The results, plotted in Figure 1.7 in the Online Appendix, demonstrate that the treatment group time trend exhibits similar patterns to the time trends of the corresponding control groups.

5.2.2 Different sampling frequencies

Our results are potentially affected by the different frequencies that the price data that we use were collected before and after prices became transparent. For instance, in the pre-transparency period prices of the ICC control group were collected in the same month, though not necessarily on the same day. In the post-transparency period, the prices were collected on the same day which may mechanically lead to a higher number of unique prices in the pre-transparency period. To address this concern, we simulate the post-transparency period to also be at the monthly level. The results for several such specifications, and for three measures of price dispersion, are shown in Table 1.8 in the Online Appendix. In all specifications, the qualitative results are unchanged.

5.2.3 Placebo tests

Our results are potentially affected by other unobserved factors that took place at the same time period. To alleviate this concern, we consider alternative earlier fictitious dates for the transparency regulation. The results, which show no significant effect of the fictitious regulation, are presented in Table 1.9 in the Online Appendix.

5.2.4 Strategic response of prices in the Drugstores control group

Another potential concern is that prices of products in the control groups may have reacted to the transparency regulation. For instance, if drugstore prices increased after the regulation then our results may overstate the impact of the regulation. To address this concern, we classified Super-Pharm stores in our sample as 'close' or 'far', according to their proximity to a supermarket store. We then checked whether the price changes in 'close' Super-Pharm stores differed from the price changes in 'far' stores. The estimation results, presented in Table 1.10 in the Online Appendix, provide no evidence for such a relationship.

5.2.5 Over-identification test using the CBS control group

Our final test uses price data for 27 products which are included in the ICC control group but are also regularly collected by the CBS to generate the CPI. We use these price data to compare prices changes in grocery stores (which were non-transparent throughout) with price changes of the same products sold in supermarket stores (which were transparent throughout). This over-identification test of the ICC control group implies that we should find that the difference in the prices of these 27 products at supermarkets and grocery stores should not change after the transparency regulation. Indeed, we do not find an effect (p-value = 0.64), giving us more confidence that the ICC control group is a valid control group.

6 Discussion and Concluding Remarks

The introduction of price transparency regulations became quite common in recent years as regulators try to enhance competition in retail markets. These regulations often take advantage of the Internet as an effective, cheap means to disseminate price information. The lack of empirical evidence on the effectiveness of such regulations, and mixed theoretical predictions about the directions of these effects, make the study of such regulations of interest to consumers, firms, and policy-makers alike.

In this paper, we study the impact of a price transparency regulation in the Israeli food retail market. We find that prices fell significantly after the transparency regulation came into effect. The price fall is particularly pronounced in cheaper prices and in stores affiliated with more pricey chains. Our estimates suggest that the magnitude of the effect of transparency on prices is not trivial. Relying on the 5% price reduction estimate and back-of-the envelope calculations, we find that the average household saved about $27 per month which is about 1.5% of the median wage in Israel in 2015. Our findings highlight the important role of the media and ads that use the media as a reliable and credible source of price information. In particular, we show that low-priced chains

extensively referenced to price surveys conducted by the media in their ad campaigns. Our findings provide strong support to the theoretical model by Robert and Stahl (1993) and suggest that price advertising contributed to the decline in prices after the transparency regulation became effective. We also show that following the transparency regulation chains adopted a uniform pricing strategy, setting identical prices across different stores affiliated with the chain.

Our findings therefore suggest that price transparency regulation can effectively reduce prices in an environment where firms sell thousands of products. The supermarket industry is important as consumers spend about one sixth of income on food. Other settings where firms sell multiple goods include electronics, travel, health and apparel. Studying how price transparency operates in such environments requires understanding how consumers gather price information about multiple products. These costs are likely large, and may potentially also involve non-trivial startup search costs (Byrne and de Roos (Forthcoming)). One important policy implication from our study is that policy-makers should proactively encourage consumers to obtain relevant price information, or perhaps better induce impartial third-party certifiers, such as media outlets, to generate relevant information and make it easily accessible for consumers. Montag and Winter (2019) who study the effects of price transparency in gasoline prices in Germany, provides additional support for this recommendation, showing that the margins of gasoline stations decreased further if a local radio reported about petrol prices. This policy recommendation is also supported by growing evidence on consumer inattention, where changes in the saliency of information presented to consumers generate considerable impact on market outcomes (see Ater and Orlov (2015) and Bradley and Feldman (2020) for two examples from the airline industry). In that regard, promoting disclosure mechanisms should take into account that disclosure policies could have heterogeneous effects on firms. Low-priced firms potentially gain from price disclosure, whereas high-priced retailers potentially suffer.

We are not aware of other empirical studies that examine the effects of price transparency regulation in a multi-product setting. While our findings may support the adoption of similar transparency policies, we also stress that our analysis focuses on a relatively short time period, and that the results regarding the change in prices may change in the long run. Furthermore, information disclosure requirements have the potential to affect other decisions made by the firms. For instance, transparency can also potentially alter retailers' bargaining power vis-a-vis suppliers. In addition, transparency may affect the frequency at which retailers adjust their prices, their price promotion strategies or product availability. The change in the competitive landscape may also result in exit of inefficient chains and consolidation. We leave these issues for future research.

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