Price Transparency, Media, and Informative Advertising*

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Abstract

We study the effects of a price transparency regulation in Israeli supermarkets. Using price data collected before and after the regulation and a difference-in-differences research design, we show that price levels and price dispersion declined significantly after the regulation. Chains also began setting identical prices in all stores. We use Robert and Stahl (1993) to interpret our findings, showing that low-priced chains extensively used price advertising after prices became transparent. These chains referenced to price-comparison surveys conducted by the media to induce credibility for ads. Our findings highlight the importance of price transparency and the pro-competitive role of informative advertising.

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I Introduction

Information is essential for achieving market efficiency and perfect competition. In recent years, price transparency regulations that require firms to disclose prices online have been instituted in an effort to reduce prices. Gasoline prices are now available online in Germany, Italy, Australia, South Korea, and Chile. Health care providers in the US are 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.

This paper investigates the impact of a price transparency regulation that was implemented in the food retail industry in Israel in June 2015. Supermarkets were thereafter 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 to 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 identical prices among stores in the same chain, and

[1] For 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] See for Argentina, https://www.preciosclaros.gob.ar and Daruich and Kozlowski 2019. More generally, 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 accounted for 8% of total 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/).

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 exploit 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 transparency regulation became effective, these data were obtained from one of the price-comparison platforms launched. To address the second and perhaps more concerning challenge, we rely on four complementary control groups that enable us to identify the effects of transparency 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 small grocery stores, respectively. Although each of the control groups might be subject to critique, they complement each other, to the extent 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 decreased at high-priced supermarket chains, and that generally prices of cheaper products fell more than prices 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 substantially dropped. This latter drop is driven by chains' decision to adopt a uniform pricing strategy, setting 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 of Robert and Stahl (1993), who obtain the following testable predictions regarding the effects of changes in advertising and search costs on prices. First, price advertising increases as the costs of price advertising decline. Second, not all firms advertise prices: low-priced firms advertise prices while high-priced firms do not. Third, prices are lower when firms price advertise more. 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 the price drop is concentrated among high-priced chains. In Section IV we adjust these predictions to a setting involving multi-product retailers, acknowledging that supermarkets cannot advertise the prices of all items that they sell. Instead, supermarket chains can rely on intermediaries that credibly convey such information to inform consumers about their low prices. In practice, Israeli supermarket chains use 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 the surveys improved, the credibility and effectiveness of ads that relied on such surveys rose. Accordingly, supermarket chains that were favorably mentioned in these price surveys benefited 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 media-based ads was greater when prices decreased, and consumers hardly accessed the freely available price-comparison websites. Finally, our findings – showing that price dispersion and price levels fell and that this drop was 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 lower prices in the post-transparency period.

Our paper adds to a growing literature that studies the effects of price transparency regulations. The desirability of such 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. Studies that examine the effects of price transparency regulations primarily focus on single-product markets, such as gasoline, and consider consumer search as the channel through which information reaches the market. Luco (2019) uses price data before and after a price transparency regulation that required Chilean gasoline stations to post prices online. He finds that gasoline margins in regions with low search activity increased after the regulation.[3] 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). Importantly, our paper shows how firms respond to price transparency by changing their advertising strategy, and we do not find evidence for a change in consumer search behavior. Moreover, our results suggest that transparency leads to lower prices and lower price dispersion.[4]

We also contribute to the advertising literature, using an equilibrium framework to show how advertising decisions change as the informativeness of ads improves. We also show that transparency has a differential impact on firms' advertising choices, where low-priced firms potentially benefit more from the quality of price information after the regulation.[5] Relatedly, our findings demonstrate the importance of the media as a reliable and impartial intermediary, 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). Finally, our paper is related to studies that document the prevalence of uniform pricing (e.g., DellaVigna and Gentzkow, 2019; Hitsch et al., 2021; Adams and Williams, 2019; Cavallo, 2018), providing novel evidence on the emergence of uniform pricing.

The remainder of the paper is organized as follows. In Section II we provide necessary background on the Israeli retail food market, describe the data and present relevant descriptive statistics. In Section III we discuss the empirical methodology and the estimation results on prices. In Section IV we describe the relationship between prices, the media, and informative advertising. We also derive testable predictions and subsequently test these predictions. In Section V we discuss our results, and Section VI concludes.

[3]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.

[4]Several papers study the effects of voluntary price disclosure (e.g., Brown and Goolsbee 2002; Brynjolfsson and Smith 2000; Goldfarb and Tucker 2019). The distinction between voluntary and mandatory disclosure is important because selection concerns can be raised regarding the timing of disclosure and which products' prices to disclose.

[5]Milyo and Waldfogel (1999) investigate how removing a ban on advertising prices of alcohol products affected prices. Glazer (1981) exploits a 1978 newspaper strike that 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. Finally, Dubois et al. (2017) develop a structural model to analyze the effects of banning advertising for potato chips.

II Institutional Background, Data, and Descriptive Statistics

The average household expenditure on food in Israel in 2014 accounts for 16.2% of disposable income.[6] 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.[7] Also, the market share of private-label/store-brand products out of total grocery sales is small, about 5% in 2014.[8] 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 share, 68% of supermarket 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).[9]

Food prices in Israel had been rising fast between 2005 and 2011. A special committee on food prices found that the cumulative annual growth rate of food prices between 2005 and 2011 was 5%, compared with 3.2% in OECD countries.[10] The steep rise in prices was a main driver behind the massive social protests that took place in Israel in the summer of 2011 (Hendel et al. 2017). Following the social protests, in March 2014 the Israeli parliament passed the "Food Act".[11] A primary component of the Food Act is a clause requiring each chain to upload price information on all products sold in its stores to an online depository. The transparency clause requires each supermarket chain to upload to 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.[12]

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 and Industry supported a

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

[7] 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=, and Ater and Shany 2022.

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

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

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

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

[12] 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.

large TV advertising campaign, and announced a competition among price-comparison websites, in which the first and second prizes (175K and 75K NIS) would be given to websites that 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 Rami Levy food chain (often referred to as a hard-discount chain), as 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 with the inventors of the application Waze and the developers of the Iron Dome defense system.[13] 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 so than before prices became 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 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.[14] 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 other 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 be ineffective. By referring to surveys by the media, retailers improve the informativeness of their ads. Figure 1 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 chains that are mentioned as having the cheapest basket in the respective price surveys.

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

[14] 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 1: Media-based advertising - an example

The figure shows an ad by the hard-discount Rami Levy supermarket chain. The ad refers to two price-comparison surveys. One survey conducted by [Yedioth Ahronoth], the most popular newspaper in Israel, on September 4, 2015 that concludes that “Rami Levy offers the cheapest basket in Israel“, and another pre-holiday price survey by TV [Channel 2] that concludes that “Rami Levy wins by knockout: Rami Levy offers cheap prices also for non-standard products”.

A Data and descriptive statistics

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

1 Price data

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

Treatment group. The prices of the 69 treatment products were collected by a market-survey firm during the pre-transparency period. The firm collected prices in the last week of July, August, September, October, and December of 2014 and February, March, and April of 2015. In each occasion, mystery shoppers obtained the prices of 69 products sold in 61 stores across Israel. Figure 1.1 in the Online Appendix shows a map of the locations of stores that were sampled and their chain affiliation. Figure 1.2 in the Online Appendix contains the list of products in the treatment group. In the post-transparency period, we obtained the prices of the treatment group from one of the price-comparison websites that became available.

Figure 2 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. The figure shows a declining trend in price levels and price dispersion, which seems to strengthen after prices became transparent. We also use the figure to rank the five chains according to their basket price. The two "premium" chains, Mega and Shufersal offer a more expensive basket and Rami Levy, which is known as a hard-discount chain, offers the cheapest.

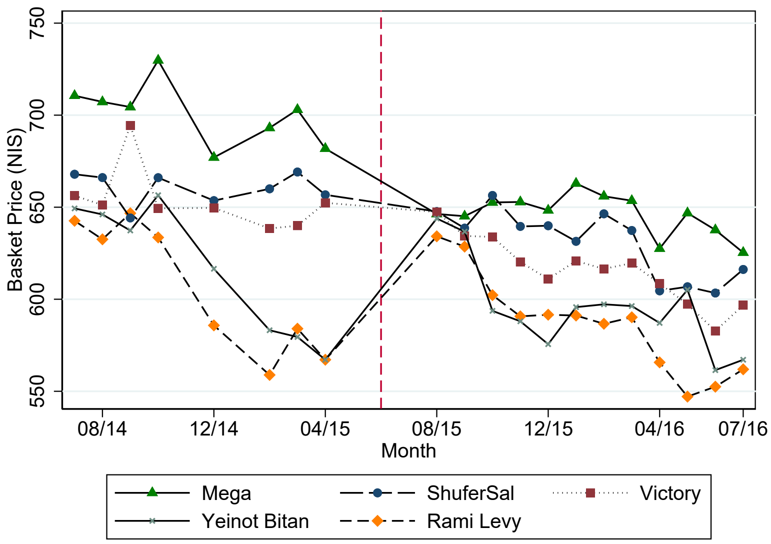

Figure 2: Retailer-Specific Basket Price

Notes: The figure shows a time series of the total basket price for each of the five food retailers. The red dashed vertical line denotes the date on which the transparency regulation came into effect. Monthly basket price is the sum of the products' average price, where the average is taken over a retailer's stores. Missing prices are imputed based on the average price of the product at other retailers in the same month. 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. By contrast, the other two control groups involve prices of products that remained non-transparent before and after the regulation. Below we provide more details on these control groups and explain how to use them 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. The products in this control group are the same products as in the treatment group. The prices were collected on a weekly basis starting in July 2014 from an online platform that allows consumers to purchase grocery items online from each of the five supermarket chains. In the online channel, each of the chains sets identical prices in all the local markets that it offers service (see Ater and Shany 2022 for details). Panel A of Figure 3 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 the online prices 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.

(A) Treatment and Online Prices (B) Comparable Treatment and ICC Products

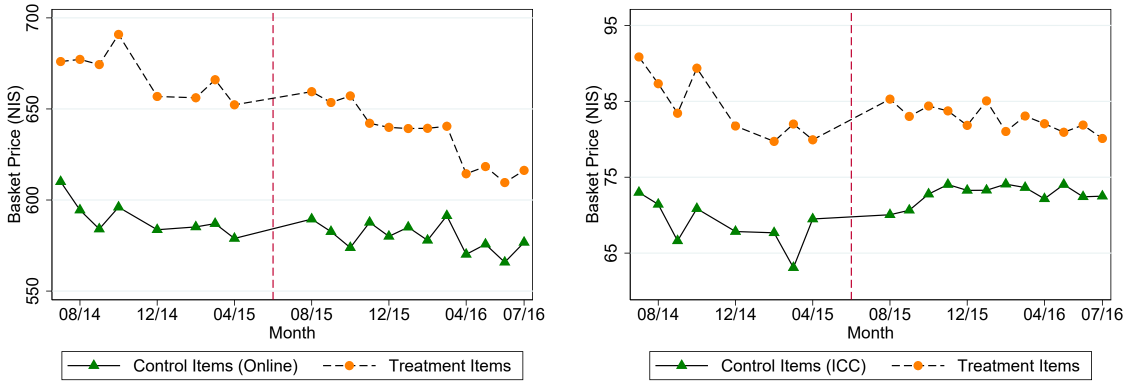

Figure 3: Prices of Treatment and Control Group Products

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 remained the same, whereas the prices of the same products in traditional stores declined. 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 substitute 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, the ICC prices somewhat increased and the prices of treatment products remained stable. In both panels, the red dashed vertical line denotes the date on 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 included in the ICC control group 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 the items collected by the ICC, i.e., that the prices of these items were transparent already before the regulation went into effect.

We use the ICC's monthly reports of prices of products for the period between July 2014 and July 2015. These reports include the prices of all products in the ICC control group, as well as the store address, chain affiliation, and 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 of Figure 3 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.[15] For instance, Sod (750 ml) a Dish-washing liquid included in the ICC group, is matched with Fairy (750 ml), a dish-washing liquid included in the treatment group; a 1.5 liter bottle Coca-Cola in the ICC control group is matched with a 1.5 liter bottle of decaffeinated Coca-Cola in the treatment group; etc. Panel B of Figure 3 shows that prices of products in the ICC control group and in the treatment behaved 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 of Figure 3 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 4 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 was 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 difference between the treatment and control groups diminishes. Figure 1.4 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 in drugstores. The third control group comprises 28 products 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

[15] To create the five 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 1.2 and 1.3 in the Online Appendix.

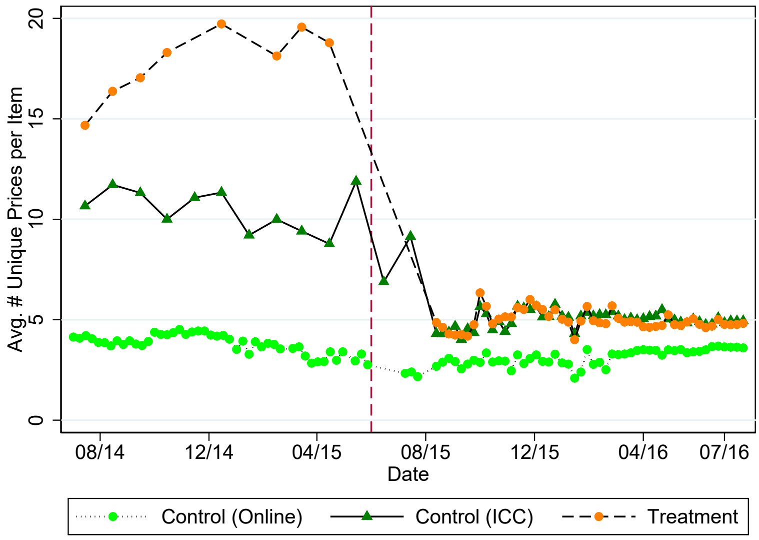

Figure 4: The Number of Unique Prices per Product

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 red dashed vertical line denotes the date on 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.

group because drugstores were exempt from the Food Act and their prices were not available online.[16] Prices at Super-Pharm stores were collected by RAs at two points in the pre-transparency period– 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 drugstore control group.

Control group 4: products sold in grocery stores. 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 of these items did not change over the relevant time period. Thus, the analysis that uses the CBS price data addresses concerns that our results are biased due to a

[16]Starting in July 2017, drugstore chains were also subject to the transparency regulation. Regression results shown in Table 1.2 in the Online Appendix suggest that prices at drugstores 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
Grocery stores	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 on 63 different weeks.

change in the data collection process. 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. Figure 1.3 in the Online Appendix provides more details on the products included in the different groups.

2 Advertising and price-comparison user data

In Section IV 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 information 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, newspaper, radio, Internet), the expenditure on each ad based on list prices and the ad itself. After viewing or listening to all the ads, we further classify the ads based on whether they include a reference to price surveys conducted by the media or not. We define such ads as "media-based" ads.

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

III Empirical Strategy and Results

In this section, we elaborate on our identification strategy and explain why 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. We attribute a significant difference between a change in the treatment group and a change in the control group to the effect of price 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 the 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. Another concern with comparing price change in the treatment group vs. prices in control groups 1, 2 and 3 is that the data-generating process changes before and after price become transparent. However, the analysis that uses the price data collected by the Israeli Central Bureau of Statistics is not susceptible to this concern. 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. Section C describes additional tests we performed to demonstrate the robustness of our results. More generally, the fact that we obtain similar qualitative and quantitative results from different control groups, provides further support to our claim that our estimates are driven by the transparency regulation rather than by other changes in the market.

A Estimation

1 Price levels

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

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

where an observation is a product–store–date tuple, and the dependent variable is the log(price) of product i sold in store s on 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 week 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% in October 2015 and the minimum wage in Israel increased in April 2016. Although these changes might have affected chains' pricing decisions, they should nevertheless 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 accommodate the possibility of pricing trends that may vary across products 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 $Treatment$ 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. Based on the above discussion regarding the use of 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. Figure 1.6 in the Online Appendix presents evidence that concerns the parallel trend assumption. The evidence suggests that the time trend for prices of products in the treatment group exhibit similar patterns to the time trends of products' prices in the Online and the ICC Comparable basket control groups.

In separate regressions, we examine how the impact of transparency varies with the pre-transparency price level. To test how prices in high-priced chains changed following the transparency regulation, we modify Equation (1) by interacting the $After \times Treatment$ variable in Equation (1) with a premium or discount indicator for the type of the supermarket chain. Specifically, we consider the two chains that offer the least expensive basket on average 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 lowest-priced chain. We also conduct similar regression analyses after slicing the data into 4 quartiles of products, based on the average price of the product in the pre-transparency period. Finally, in Section 2 in the Online Appendix we examine how 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 therefore include a much larger set of products and stores (355 items sold in 589 stores).

2 Price dispersion and price uniformity

To capture changes in price dispersion, we aggregate the product–store–date data to the product–date level and in some specifications to the product–chain–date level. We present results for two measures of price dispersion: the number of distinct prices that product i is sold for in period t, and the coefficient of variation of product i in period t.[17] Formally, we estimate the following equation:

$$PD_{it} = \mu_i + \gamma_t + \beta \times After_t \times Treatment_i + \epsilon_{it}, \quad (2)$$

where the dependent variable is a measure 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-level 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 the 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.

B Estimation results on prices

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 prices became transparent, prices in traditional supermarkets decreased by 4% to 5% relative to the prices in the control groups. The analysis in Column (4) focuses on the prices 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%. We also estimate Equation (1) using the products in the "comparable basket" (see Figure 3) and obtain similar 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).

[17] The coefficient of variation of a product on a given date is defined by the ratio between the standard deviation of the prices of that product on that date and its average price. The corresponding average, 25^{th} and 75^{th} percentiles

Table 2: The Effect of Price Transparency on Price Level

	(1) log(Price)	(2) log(Price)	(3) log(Price)	(4) log(Price)
After*Treatment	-0.051	-0.052	-0.040	-0.022
	(0.008)	(0.005)	(0.014)	(0.007)
Store + Item + Date F.E.	✓	✓	✓	✓
Control Group	Online	ICC	Drugstores	Grocery Stores
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. Time period covered is 7/2014-6/2016. Errors are clustered by store and we include a linear item-specific time trend. 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 a 0.8% increase in disposable income. Alternatively, this amounts to a nearly 1.5% increase in median wage.[18]

Table 3 presents point estimates obtained from estimating a modified 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 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 2). Finally, in Table 4 we present estimation 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 bottom two quartiles by 9%. For discount chains, we find that prices of products in the bottom two quartiles fell by 5%. Table 1.5 in the Online Appendix shows regression results that examine how the effect of transparency depends on the level of local competition. The results suggest that stores located in more concentrated markets lowered prices more than stores facing stronger competition.

of the coefficient of variation are 0.09, 0.05 and 0.14, respectively.

[18] http://www.cbs.gov.il/statistical/mb158h.pdf. Section 2 in the Online Appendix shows that prices of more popular products declined less than those of less popular products. Accordingly, the impact on spending is likely smaller than that obtained based on the analysis shown in Table 2, which assumes equal weights for all products.

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	-0.061	-0.058	-0.045
	(0.008)	(0.006)	(0.014)
Discount Chain: After*Treatment	-0.015	-0.026	0.011
	(0.009)	(0.007)	(0.015)
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 a linear item-specific time trend. Time period covered is 7/2014-6/2016.
The table presents the 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 significantly declined in stores of premium chains and did not significantly change in stores of discount chains. We do not have a chain identifier in the CBS data and hence do not run this analysis for the grocery store control group. We obtain qualitatively similar results when performing this analysis at the chain level (Table 1.4 in the Online Appendix).

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

	(Q1) log(Price)	(Q2) log(Price)	(Q3) log(Price)	(Q4) log(Price)
Panel A: by Quartile				
After*Treatment	-0.080	-0.082	-0.022	-0.012
	(0.016)	(0.029)	(0.016)	(0.012)
R^2	0.88	0.54	0.55	0.79
Panel B: by Quartile and Chain Type				
Premium Chain: After*Treatment	-0.086	-0.094	-0.038	-0.018
	(0.016)	(0.029)	(0.015)	(0.012)
Discount Chain: After*Treatment	-0.050	-0.042	0.039	0.008
	(0.017)	(0.030)	(0.018)	(0.014)
R^2	0.88	0.54	0.55	0.79
P-Val: Premium = Discount	0.00	0.00	0.00	0.02
Store + Item + Date F.E.	✓	✓	✓	✓
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. Errors are clustered by store and we add a linear item-specific time trend. Time period covered 7/2014-6/2016.
The table presents the 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 products fell by about 8% whereas prices of products in the top 2 quartiles did not significantly change after the regulation. The results in Panel B suggest that the drop in prices was driven primarily by premium chains, although discount chains also reduced prices of cheap products.

2 Price dispersion

The regression results of Equation (2) are shown in Panel A of Table 5. The table reports point estimates of the parameter of interest and the average value of the dependent variable for the four control groups. Although the magnitude of the change 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, the results in Columns (5)–(8) 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. Table 1.6 in the Online Appendix further shows similar qualitative results when we use a third measure of price dispersion, the percentage price range of product i in period t.

3 Uniform pricing and intra-chain price dispersion

Panel B of 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. Focusing on the number of distinct prices a product is sold for and using the online control group (Column 1), we find that the number of distinct prices fell on average by 2.75 relative to an average value of 4.5. Table 1.7 in the Online Appendix further shows that the drop in the number of distinct prices occurred in all five chains. Table 1.8 in the Online Appendix shows that inter-chain price dispersion also fell after the regulation, consistent with our finding that premium chains reduced their prices more than discount chains.

C Robustness

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

Different sampling frequencies. Our results are potentially affected by the different frequencies at which the price data were collected before and after prices became transparent. For instance, in the pre-transparency period prices of the ICC control group were sometimes collected on different days of the month. In the post-transparency period, prices were collected on the same day of the same month 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, shown in Table 1.9 in the Online Appendix, suggest that these concerns are not driving our results.

Placebo tests. Our results are potentially affected by unobserved factors that took place around the time that prices became transparent. To alleviate such concerns, we consider alternative earlier fictitious dates for the transparency regulation. The results, presented in Table 1.10 in the Online Appendix, show that alternative dates are less likely to be driving the price changes.

Table 5: The Effect of Price Transparency on Price Dispersion

Panel A: Price Dispersion	# Unique Prices				Standard Deviation/Avg.			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
After*Treatment	-10.72	-8.10	-15.92	-1.46	-0.10	-0.05	-0.08	-0.04
	(0.54)	(0.81)	(1.70)	(1.17)	(0.01)	(0.01)	(0.02)	(0.02)
Control Group	Online	ICC	Drugstores	Grocery stores	Online	ICC	Drugstores	Grocery stores
DV Mean Value	16.3	17.3	19.1	9.9	0.2	0.2	0.2	0.2
R^2	0.8	0.8	0.8	0.8	0.4	0.6	0.5	0.9
N	9636	6176	1525	400	9345	6120	1510	400

Panel B: Intra-chain price dispersion	# Unique Prices			Standard Deviation/Avg.		
	(1)	(2)	(3)	(4)	(5)	(6)
After*Treatment	-2.75	-1.62	-4.62	-0.11	-0.08	-0.12
	(0.10)	(0.17)	(1.18)	(0.01)	(0.01)	(0.02)
Control Group	Online	ICC	Drugstores	Online	ICC	Drugstores
DV Mean Value	4.5	4.2	4.6	0.2	0.2	0.2
R^2	0.5	0.6	0.7	0.4	0.5	0.5
N	37685	25978	6120	17575	25211	5828

Notes : Panel A: The unit of observation in Columns (1), (3), (4), (5), (7) and (8) is item i on date t in treatment/control group. The unit of observation in Columns (2) and (6) is item i on date t. Panel B: The unit of observation in Columns (1), (3), (4) and (6) is item i on date t in treatment/control group. The unit of observation in Columns (2) and (5) is item i on date t. We do not use the grocery store control group since we do not have a chain identifier in the CBS data. Time period covered is 7/2014-6/2016. In the regressions we include item, time, and chain fixed effects and add a linear item-specific time trend. Errors are clustered by product. The table presents the estimation results for Equation (2). Panel A focuses on price dispersion and Panel B on intra-chain price dispersion. The results suggest that price dispersion fell after prices became transparent and that chains adopt uniform pricing.

Strategic response of prices in drugstores. 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 the drugstores in our control group as "close" or "far", based on their proximity to a supermarket store. We then checked whether price changes in "close" Super-Pharm stores differ from price changes in "far" stores. The results, presented in Table 1.11 in the Online Appendix, alleviate concerns about a strategic response.

Over-identification test using the CBS price data. We use price data for 27 products included in the ICC control group and regularly collected by the CBS to perform an over-identification test. We compare the price changes in grocery stores (which were non-transparent throughout) to price changes in the same ICC products in supermarkets. We expect that the price differences in these 27 products will not change following the price transparency, since ICC prices in supermarkets were transparent throughout. Indeed, we find that it did not (p-value = 0.64), providing support to our claim that that the ICC control group is a valid control group.

IV Price Transparency, Media, and Informative Advertising

Our estimation results indicate that the increased availability of price information in the post-transparency period was driving the changes in prices. In this section we explore the role of informative advertising and the media in driving these changes, using the framework developed by Robert and Stahl (1993). We discuss potential explanations for the shift to uniform pricing in Section V. We consider the mechanisms driving the shift to uniform pricing and the reduction in prices separately because they are conceptually different and – as shown in Figure 5 – because the change in uniform pricing occurred several months before other changes in prices materialized.

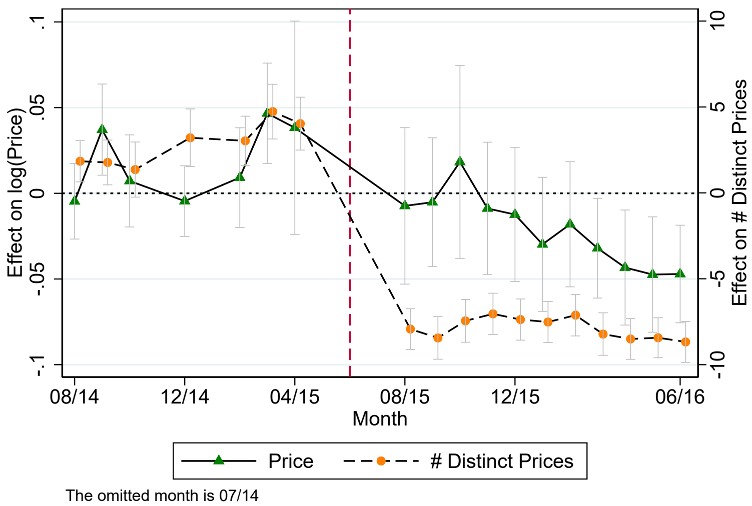

Figure 5: Monthly Effects on Price Level and Number of Unique Prices

Notes: The figure shows the monthly fixed effects from estimating variants of Equations 1 (price levels) and 2 (number of unique prices), using the online control group. For each monthly estimate the 95% confidence interval is presented. The red dashed vertical line denotes the date on which the transparency regulation came into effect. The figure shows that the change in price dispersion/number of unique prices (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.

A Theoretical framework

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 consumers' 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 either from a 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.[19] The share of informed consumers depends 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 they do not advertise or select a low price that they do advertise. Thus, high-priced firms do not advertise and they sell to uninformed consumers, whereas low-priced firms do advertise and informed consumers buy only at these stores.[20]

An important difference between Robert and Stahl's model and the setting in this paper is that their 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. In particular, 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 be 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 aggregate prices over multiple goods into a single representative price. Under the assumption that consumers view the price-comparison surveys conducted by the media as representative and accurate, we can use the predictions that were developed for single-product firms for a setting that involves firms that sell multiple products.

B Testable predictions and empirical support

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. By contrast, chains that set low prices will use informative advertising.*

Following the transparency regulation, the costs of conducting large price-comparison surveys

[19] 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 consumers incur the cost of visiting a store. Renault (2015) provides a simplified version of their model. Other theoretical papers that consider both search and advertising include Butters (1977), Choi et al. (2018), Board and Lu (2018), and Janssen and Non (2008). 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 observe prices and learn through costly search about the match value of products. Janssen and Non (2008) study a homogeneous goods model where firms choose prices and advertising levels. They assume that the cost of visiting a store is negligible, whereas in Robert and Stahl consumers pay search costs when buying from a firm that advertises.

[20] Our findings regarding uniform pricing strategy are unrelated to the Robert and Stahl's framework, which does not consider pricing decisions by multi-store firms.

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. We conjecture that as the scope of the price surveys increased, consumers viewed these surveys as more reliable. In turn, retailers that received favorable media coverage in these price surveys had an incentive to use price advertising that reference these favorable price surveys. By contrast, retailers that set high prices had no incentive to rely on these media reports, and would cater to consumers who were 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 variables of interest in this analysis.

Figure 6 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, the expenditures by the low-priced chain increased significantly after the transparency regulation. By contrast, the combined expenditures on media-based ads by the other four supermarket chains practically vanished once prices became accessible online.[21]

To further demonstrate the differential effect of transparency on the use of media-based advertising, we use a regression framework to compare Rami Levy's use of media-based ads against the corresponding usage of media-based ads by the other four chains. Specifically, we estimate:

$$Media - based\ Ads_{it} = HD_i + \gamma_t + \beta \times After_t \times HD_i + \epsilon_{it}, \tag{3}$$

where the variable HD (indexed by i) takes the value one for the hard-discount Rami Levy observations, and the value zero for observations of the other four supermarket chains combined. The dependent variable is either the weekly share of spending on media-based ads out of total ad spending, or the total weekly expenditure on media-based advertising. The $After$ indicator is like in Equation (2) and we include HD and weekly fixed effects. The coefficient of interest, β, captures the differential effect of the transparency regulation on media-based advertising between Rami Levy and the other supermarket chains combined. The regression results, presented in Columns (1) and (2) of Table 6, confirm the patterns in Figure 6 - expenditures on media-based ads by Rami Levy

[21] The low-priced chain increased its average monthly media-based advertising expenditure from approximately a quarter million NIS in the pre-transparency period to nearly 950K NIS on average in the post-transparency period. The other four supermarket chains combined decreased their average monthly media-based advertising expenditure from 6.3 million to 263 thousand NIS. Spending on media-based ads by these chains in the pre-transparency period was primarily in reference to the ICC basket. Similarly, the average monthly share of spending on media-based advertising out of the total ads spending increased for the low-priced chain from 44% to 67%, whereas the corresponding figures for the other four chains sharply decreased from 17.6% to 1.6%.

sharply increased relative to the expenditures by other supermarket chains. The regression results support H1 and H2.[22]

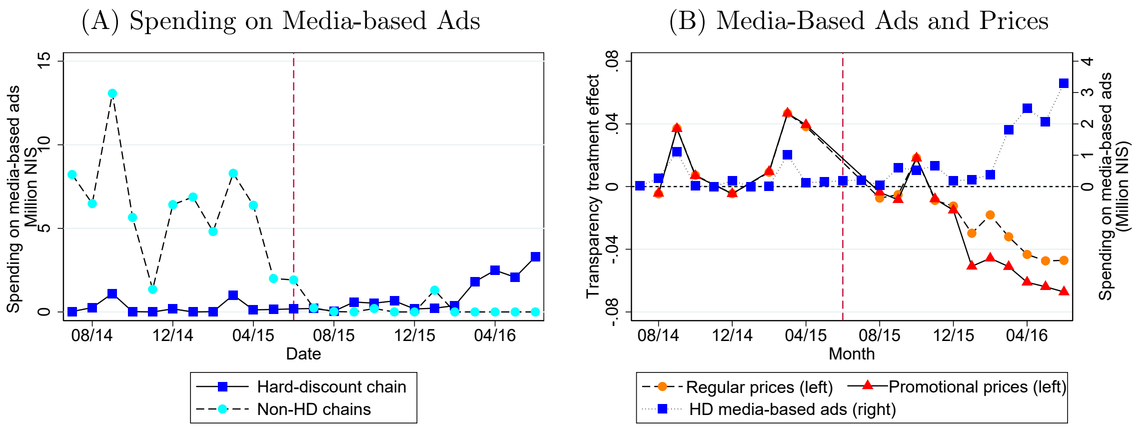

Figure 6: Media-Based Ads, Transparency and Prices

Notes: Panel A of Figure 6 shows (in blue) the monthly expenditures on media-based ads by Rami Levy, the primary hard-discount,low-priced chain in Israel, and (in light blue) the combined monthly expenditure on media-based ads by other supermarket chains. The red dashed 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 of Figure 6 shows the relationship between spending on media-based ads by Rami Levy and the estimated monthly effects on prices using the online control group. The panel shows a clear negative relationship between the level of media-based ads (in blue) and the estimated monthly price effects (regular prices in orange, and promotional prices in red). Similar patterns arise if we use the basket price instead of the monthly coefficients.

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

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 of Figure 6 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 1.5 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 $After \times Treatment$ in the original specification with a measure of expenditures on media-based ads by Rami Levy in a given month. More formally, we standardize Rami Levy's expenditures on media-based ads, and assign the minimum value of this standardized variable to control group observations and

[22] 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.

Table 6: Media-Based Ads, Transparency and Prices

	Media-based Ads % of total ads	Media-based Ads Spending (Mil. NIS)	Log (Price)	Log (Promotional Price)
	(1)	(2)	(3)	(4)
Hard Discount * After	48.8	1.6		
	(9.4)	(0.2)		
Hard Discount*Media-Based Ad*After			-0.013	-0.018
			(0.004)	(0.004)
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) on week t. We estimate a difference-in-differences specification, where Rami Levy is the treated chain and the 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 a linear item-specific time trend. Time period covered is 7/2014-6/2016.
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 is 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.

to treatment group observations in the pre-transparency period (just as the $After \times Treatment$ variable takes the value 0 in the original specification). Thus, the coefficient on this variable should be interpreted as the effect of an increase of one standard deviation in Rami Levy's spending on media-based ads on the outcome variable. We present the results using either regular or promotional prices, respectively in Columns (3) and (4) in Table 6. The results support H3, indicating that expenditures on media-based ads increase at times when 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, visit one store and do not continue searching thereafter. This result arises because high-priced stores reduce prices to a level that dissuades these consumers from searching further.[23] Admittedly, it is difficult to show that consumers do not engage at all in search.[24] Nevertheless, we can show that relatively few consumers accessed the price-comparison websites that became freely available after the trans-

[23] 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.

[24] 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 study in which consumers face start-up search costs.

parency regulation. To make this point, we use data on the usage of the three price-comparison websites. The monthly average numbers of unique visitors to Pricez.co.il and Zapmarket.co.il between October 2015 and July 2016 were 21,414, and 16,992, respectively.[25] These figures combined account for about 2% of the number of 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.

Finally, Robert and Stahl consider the effect of a reduction in the costs of informative advertising and search on price levels and on price dispersion. 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 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.[26]

V Discussion

Our findings suggest that price transparency regulation reduce prices in an environment where firms sell thousands of products. While we focus on the supermarket industry, there are many other settings where firms sell multiple goods, such as electronics, travel, health, and apparel. Studying how price transparency operates in such environments requires understanding how consumers gather price information about multiple products, and how firms respond to transparency. From the consumers' perspective, the costs of gathering price information on multiple products are likely large, and may also involve non-trivial startup search costs (Byrne and de Roos Forthcoming). The accuracy and credibility of price information is another issue that can hinder consumer search, especially when firms engage in obfuscation (e.g., Ellison and Ellison 2009; Ellison and Wolitzky 2012; Spiegler 2016; Allender et al. 2021; Carlin 2009).[27] From the firms' perspective, our findings

[25] The main line of business of Mysupermarket.co.il, the third price-comparison website, is online grocery service so we could not disentangle customers who visit Mysupermarket to shop online from visitors who want to obtain price information in traditional stores. However, the average monthly number of total visitors to Mysupermarket marginally declined from 182k in the year preceding the regulation to 176K in the year after.

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

[27] Recent theoretical papers also examine the accuracy and credibility of ads. Rhodes and Wilson (2018) and Drugov and Troya-Martinez (2019) analyze situations where firms may use advertising to falsely overstate the value

may suggest that in a multiple-product setting the potential for a coordination-enhancing effect is limited. Existing studies argue that information requirements for successful tacit coordination are demanding (Harrington 2017). These requirements are probably larger in a multi-product setting.

Our findings suggest that the effect of transparency is not uniform across firms: low-priced firms potentially gain from price disclosure, whereas high-priced retailers potentially suffer. Given the high costs that consumers face in acquiring price information, the effect on prices is likely driven by a media-facilitated advertising mechanism, where low-priced firms rely on price surveys conducted by the media to make price advertising more credible. A possible policy implication is that policy-makers should proactively encourage impartial third-party certifiers, such as media outlets, to generate relevant information and make it easily accessible to consumers. Montag and Winter (2019) who study the effects of price transparency in gasoline prices in Germany, provide additional support to this recommendation, showing that the margins of gasoline stations decreased further when a local radio reported about petrol prices. This policy recommendation is also related to growing evidence on consumer inattention, where changes in the saliency of information presented to consumers may generate a considerable impact on market outcomes (see Ater and Orlov 2015 and Bradley and Feldman 2020) for two examples from the airline industry).

Our findings that chains adopted a uniform pricing strategy shortly after prices became transparent are related to recent papers that document a large degree of similarity in prices among stores in the same retail chain (DellaVigna and Gentzkow 2019; Hitsch et al. 2021; Adams and Williams 2019; Cavallo 2017). These findings are at odds with standard economic models that predict that pricing decisions should take into account local consumer and market characteristics. 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) suggest that the price similarity is based on similarity in demand, and the difficulty of distinguishing among and obtaining precise price estimates at the store level. Conclusively identifying the correct explanation(s) is beyond the scope of this paper. However, we suggest that brand-image or fairness concerns might explain why retailers set identical prices across stores. In particular, after prices became transparent consumers could more easily find out that the same products were being sold at different prices in different stores of the same chain. Retailers set identical prices in all their stores to avoid consumers' antagonism toward these arguably unfair price differences. To support our conjecture that fairness or brand-image concerns are important, we mention that fairness concerns were an integral part of the public debate on food prices in Israel. Media reports

of their products. De Corniere and Taylor (2019) examine situations where consumers rely on a biased intermediary's advice. Other papers examine how firms choose the content of ads. Anderson and Renault (2006) examine the ad content by a monopoly firm that can provide information about either prices or product attributes. 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.

denounced price differences for similar products sold in different stores of the same chain.[28] In addition, 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.

VI Concluding Remarks

The introduction of price transparency regulations have become quite common in recent years as policy-makers try to enhance competition. 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. The supermarket industry is important as consumers spend about one–sixth of their income on food. We find that average prices fell by 4%–5% after the transparency regulation came into effect. The price fall is particularly pronounced in cheaper products and in stores affiliated with more high-priced chains. The magnitude of the effect of transparency on prices is not trivial, and back-of-the envelope calculations that uses the 5% reduction estimate suggest that the average household saved about $27 per month, which was nearly 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.

Overall, our findings support the introduction of price transparency regulations. Nonetheless, 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 firms. For instance, transparency can also potentially alter retailers' bargaining power vis-â-vis suppliers. In addition, transparency may affect the frequency at which retailers adjust their prices, their price promotion strategies, or

[28]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. Also, a legislative attempt requiring food retailers to identical prices in all stores of the same chain nearly passed in the Israeli parliament (www.ynet.co.il/articles/0,7340,L-4252811,00.html).

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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