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The Effects of Mandatory Disclosure of Supermarket Prices

by

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The Effects of Mandatory Disclosure of Supermarket Prices*

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Abstract

We study how mandatory online disclosure of supermarket prices affects prices and price dispersion in brick-and-mortar stores. Using data collected before and after a transparency regulation went into effect in the Israeli food retail market, multiple complementary control groups and relying on a differences-in-differences research design, we document a sharp decline in price dispersion and a 4-5% drop in prices following the transparency regulation. We discuss alternative explanations and highlight the roles of the media and advertising by showing that hard-discount chains changed their advertising strategy by referring extensively to the credible price-comparison surveys conducted by the media.

JEL: D83; L81; L66
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1 Introduction

Numerous online platforms provide information on prices, product availability and quality measures, and the availability of such information has had a tremendous impact on retail markets, consumers and firms. As is often the case, the public sector has been quite slow to adapt to these technological changes and government agencies and legislators have only recently begun to embrace measures that take advantage of the Internet as a means to disclose and disseminate information. Such regulatory initiatives include laws mandating that public entities must publish information online about their practices,[1] in addition to regulations that require firms to disclose real-time prices. For instance, in Argentina, Uruguay and Mexico, governments require retailers to post online the prices of many of the products that they sell. In other countries, such as Germany, Italy, Australia, South Korea and Chile, gasoline prices are now available online.

The motivation behind these transparency regulations is typically to foster competition and incentivize retailers to lower prices. Yet, the availability of price information can also be detrimental to competition, as firms can use this information to coordinate and subsequently increase prices. If the pro-competitive impact of price transparency is stronger than its anti-competitive impact, then policy makers should advance policies that mandate price disclosure. If, however, such initiatives actually help firms to tacitly collude, then such policies should be abandoned. Surprisingly, though this issue is central to economics in general and specifically to the field of IO, very little empirical evidence is available regarding the impact of mandatory online disclosure of prices. More specifically, little is known about the impact of transparency on price levels, price dispersion as well as on retailers' tendency to price discriminate and on their advertising strategies.

In this paper, we begin to fill these gaps by studying the impact of a mandatory price disclosure regulation in the Israeli supermarket industry. The food retail industry is a meaningful domain in which to begin to unpack the economic effects of mandatory information disclosure, given that consumers spend about one-sixth of their disposable income on food, and that fluctuations in food prices have the potential to drive profound societal effects.[2] In Israel, social protests in 2011 regarding, among other concerns, the high prices of food ultimately culminated in the legislation of the Food Act in March 2014. According to the Food Act, supermarket chains were required starting in May 2015 to post online the prices of each and every item sold in their stores and to update these prices continuously. In August 2015, independent websites began to offer price comparison services, which continue to be freely available to consumers. We take advantage of these changes

[1] The aim of these transparency regulations is often to increase accountability and curtail spending. For instance, as of 2014, the DATA Act requires the U.S. federal government to transform its spending into open data (https://www.datacoalition.org/issues/data-act). Also in 2014, the Centers for Medicaid Services disclosed payment information for the first time as part of its Open Payment program.

[2] Between 2005 and 2011 food prices worldwide underwent a steep increase, an increase that was associated with social unrest in both developed and developing countries (Bellemare (2015)).

to evaluate the effects of transparency on retail prices and to examine how these effects vary across stores and products. We also consider alternative channels through which effects on prices have materialized, and emphasize the important role of the media and informative advertising.

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 such data might not be readily available. A second challenge is to control for additional factors, aside from transparency, 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. Our research design enables us to address these concerns. To address the first challenge, we exploited the fact that the Food Act 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 covered multiple items sold in multiple stores and chains throughout Israel. For the period after the regulation went into effect (the post-transparency period), we collected data from one of the price comparison platforms that began to operate after the transparency regulation became effective. To address the second, and perhaps more concerning challenge, we rely on several distinct complementary control groups which enable us to identify the effects of the transparency regulation. That is, the identification comes from comparing changes in prices among a group of "treatment" items, that is, items collected by the survey firm in the pre-transparency period and whose prices became transparent after the regulation, against price changes in four distinct control groups, as follows.

The first control group consists of the same products included in the treatment group, but sold in the online channels of the supermarket chains whose products are used in the analysis. These items constitute a useful control group because their prices were transparent both before and after the transparency regulation became effective. The second control group consists of products that are sold in traditional stores and do not overlap with the products in our treatment group and whose prices are periodically collected by the Israeli Consumer Council (ICC). The prices of these products are often cited in the media and mentioned in chains' ad campaigns as a reliable source of price data. Thus, effectively, the ICC products constitute a set of items whose prices were transparent before and after the transparency regulation went into effect. The third and fourth control groups consist of products that overlap with the items in the treatment group, but are sold in 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 one another, such that when taken together, they enable us to rule out many alternative explanations for any effects observed. Notably, our analyses yield consistent results

across the four control groups, giving us confidence that the results indeed reflect the impact of transparency on prices.

Our first set of results concerns the impact of transparency on price dispersion. We show that prices within chains were diverse before the regulation, and that shortly after prices became transparent price dispersion fell abruptly, and that prices across different stores affiliated with a single chain became highly similar to one another. Figure 1 presents a time series of the average number of distinct prices per item in the treatment group and for the first and second control groups, i.e., items that were sold through chains' online channels, and items in the ICC basket. According to the figure, before prices in the treatment group became transparent, the average number of distinct prices in each of the two control groups was smaller than the number of distinct prices in the treatment group. Quickly after the regulation went into effect, the differences between the treatment and the control groups diminished. As we elaborate in Section 5.1, we claim that fairness concerns, exacerbated by the transparency regulation, contributed to chains' decisions to adopt a nearly uniform pricing policy across all the stores affiliated with the chain.

Next, we turn to the impact of transparency on price levels. Our results indicate that, after the regulation took effect, prices of items in the treatment group decreased 4 to 5 percent more than did the prices of items in the various control groups. We also find that prices primarily decreased among chains that are considered more expensive, and that prices declined less in supermarkets that faced fiercer local competition. We also characterize the impact of transparency across different types of products. To do so, we use data from the post-transparency period, instead of limiting the analysis to products for which both pre- and post-transparency data are available. This enables us to rely on data for a large number of products (specifically, 355 products), and a much wider set of stores (589 stores). The findings of this analysis suggest that the prices of more expensive and less popular products decreased to a greater extent compared with those of less expensive and more popular products. We also find that the prices of branded products decreased more than did the prices of "similar" private-label products.

Our findings regarding the decline in prices are generally consistent with a reduction in search costs. Prices fall as search costs decline and the decline is smaller among stores that can be characterized by a higher level of consumer search, already in the pre-transparency period (see Sorensen (2000) and Lach (2007) for related arguments). Yet, it is still unclear how exactly price transparency translate into lower prices. We explore two possible explanations. First, we consider a direct channel in which consumers gain price information by accessing price-comparison websites. Consistent with this explanation, we show that store prices in a given month are negatively associated with the extent to which customers use the price comparison websites in that month. Second, we highlight the subtle linkages between supermarket chains' advertising content and the

media's coverage of supermarket prices. In particular, we show that after prices became transparent, media outlets performed more extensive price-comparison surveys, and that hard-discount supermarket chains capitalized on these price-comparison surveys by allocating more resources to ad campaigns that mention these surveys. Moreover, prices declined in periods in which chains used these ad campaigns more heavily. Finally, we also jointly consider the explanatory power of the two channels and find that the media-advertising channel explains about 1/3 of the drop in prices and the price-comparison website channel explains the rest.

Economic theory provides conflicting predictions regarding the consequences of mandatory disclosure of prices. On the one hand, standard search models show that as search costs decline, both price levels and price dispersion are expected to decrease (e.g., Salop and Stiglitz (1977); Stahl (1989); Stigler (1961)). On the other hand, studies in industrial organization (e.g., Green and Porter (1984), Rotemberg and Saloner (1986), Campbell et al. (2005)) have shown that better access to price information can help retailers monitor their rivals' prices and adjust their own accordingly, thereby facilitating tacit collusion and higher prices. To our knowledge, only two empirical studies have explored this question thus far, both focusing on gsoline markets, in Chile (Luco (2017)) and in Italy (Rossi and Chintagunta (2016)). These studies found opposite findings regarding the effect of transparency on price levels, and inconclusive evidence regarding the impact on price dispersion.[3]

Our paper differs from these studies for several reasons. First, we focus on the food retail market, in which consumers purchase a bundle of goods rather than one relatively homogeneous product. This difference may affect firms' capacity to coordinate prices. In Section 4.4, we exploit the specific properties of the food retail market to examine why prices of certain products fell more than prices of other products. Second, thus far, studies examining the impact of price transparency have not sought to disentangle the underlying mechanisms driving their results. In our paper, we highlight the important roles of the media and advertising as a primary channel through which price competition intensifies. We further stress that we are not aware of previous studies that acknowledged the linkage between transparency, advertising and media coverage. We do note that the theoretical literature has investigated the linkages between search costs and informative advertising as two sources of information (e.g., Wang (2017), Robert and Stahl (1993)). According to Wang (2017)'s model, transparency regulations might result, as we find, in increased levels of informative advertising. Finally, our data and research design enable us to use both pre- and post-transparency price data to examine how the effect of the regulation depends on the pre-transparency market conditions.

[3]Other related studies are Byrne and Roos (2017) and Albek et al. (1997) who use prices collected after a transparency regulation was imposed to study firms' behavior. In addition, Mas (2017) examined the effects of pay transparency regulations, and Jin and Leslie (2003) examine the impact of mandatory disclosure of quality.

In contrast to the dearth of evidence on the effects of mandatory price disclosure, quite a few papers have examined the effects of voluntary price disclosure (e.g., Brynjolfsson and Smith (2000), Ellison and Ellison (2009), Milyo and Waldfoegel (1999)). Many of these studies focus on industries in which actual transactions are conducted online, and assume away selection issues with regard to the types of retailers who begin or expand their online operations. Brown and Goolsbee (2002) study how firms' decisions to post their prices online affect prices in traditional markets. Their study was focused on a single product and did not examine how local market conditions affect firms' pricing decisions, and which firms choose to post prices online.

Our study is also related to studies on the retail industry in general (Basker (2016), DellaVigna and Gentzkow (2017), Hitsch et al. (2017)) and the supermarket industry in particular (e.g., Matsa (2011), Pozzi (2013)). Several studies have focused on the Israeli supermarket industry. Hendel et al. (2017) studied Israeli consumers' boycott of cottage cheese in the summer of 2011. Eizenberg et al. (2017) studied price dispersion in the period ranging from 2005 to 2007 in the Israel supermarket industry, and Ater and Gerlitz (2017) studied how a ban on non-zero price endings affected price rigidity. Finally, our work also relates to papers in the macroeconomic literature that examine the similarities between prices of items sold online and in traditional stores (Cavallo (2017), Gorodnichenko et al. (Forthcoming), Goolsbee and Klenow (2018)). Our results show that the differences between online and off-line prices declined substantially once off-line prices became transparent.

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 describe the research design and the data, and in Section 4 we present the results. We discuss the potential mechanisms driving the results in Section 5. Section 6 concludes.

2 Institutional background

The average household expenditure on food items in Israel accounts for 16% of disposable income. The Israeli retail food market is considered quite concentrated and was ranked 7th among OECD countries according to the CR3 criterion, and 5th according to the CR2 criterion (OECD (2013)). Herein we consider five large Israeli supermarket chains. Shufersal, the largest chain in the country, operated 283 stores at the end of 2014, and Mega, the second largest chain, operated 197 stores at the end of 2014. These two chains operate in many localities throughout Israel, and each has several sub-formats. The other chains we consider operated fewer stores at the end of 2014: Rami Levy, a hard-discount chain, operated 27 large stores; Victory operated 28 stores and Yeinot Bitan operated 67 stores. We selected these supermarket chains because of their substantial collective

market share, 73% of supermarkets sales in 2014, and because each of these chains also offers an online grocery service (prices in the online segment are one of the control groups that we use). Online grocery sales in Israel are growing but still account for only a small share of total food sales, about 3% in the relevant period. In addition, sales of private label items are growing but still account for a relatively small fraction of total grocery sales in the Israeli food market, about 5% in 2014.

Food prices in Israel had been rising fast between 2005 and 2011.[4] The steep rise in prices was a main driver behind the social protests that took place in Israel in the summer of 2011. It is often said that, following the social protests, Israeli consumers became more price-conscious and more likely to search for low-priced items. One measure that likely captures the change in the competitive food retail landscape before and after the social protests is the gross profits of the two largest supermarket chains, Shufersal and Mega. In the second quarter of 2011, before the summer protests, the gross profit percentages of Shufersal and Mega were 26.6 percent and 27.5 percent, respectively. In contrast, in the second quarter of 2014, the two chains' gross profit percentages fell to 23 percent and 24.9 percent, respectively. Moreover, during the same time period, the hard-discount chains were able to increase their market shares. Following the change in the competitive landscape and other managerial issues, Mega, the second largest chain, faced increasingly profound financial difficulties. In June 2016, towards the end of our sample, the Israeli antitrust authority allowed Yeinot Bitan, another large chain, to purchase Mega.

A direct consequence of Israel's 2011 social protests was the formation of a special committee on food prices (the Kedmi Committee). Following the recommendations of the committee and a long legislation process, in March 2014 the Israeli parliament passed the "Food Act". A primary component of the new legislation was a transparency clause requiring each chain to upload real-time price information on all products sold in all its stores to a publicly available database. During the legislation process of the transparency regulation and soon afterwards, managers of supermarket chains, politicians, and academics have all raised their concerns regarding the effectiveness of the new regulation. The head of the economic committee in the Israeli parliament, MP Professor Avishay Braverman remarked "I am not convinced that transparency will result in good news. I hope that prices will go down in the process, though I doubt it and hope to be wrong."[5] Eyal Ravid, CEO of Victory argued that online transparency would facilitate collusion. Likewise, Itzik Aberkohen, the CEO of Shufersal noted that "there is a concern that transparent prices will be used as a platform to coordinate prices under the law". Finally, in an op-ed, Prof. Yossi Spiegel

[4] According to the Kedmi Committee report, the cumulative annual growth rate of food prices between was 5%, compared with 3.2% across all OECD countries for the same period. See page 8 in http://economy.gov.il/publications/publications/documents/kedmireport2012.pdf.

[5] See http://www.globes.co.il/news/article.aspx?did=1000921890. Interestingly, in his academic career, Braverman published an important study on consumer search (Braverman (1980)).

called on the government "to reconsider the mass experiment that consumers are subjected to."[6]

On May 20, 2015, the transparency clause went into effect, and retailers began uploading price data to dedicated websites. Given that the raw price data uploaded by each chain were not easy to use, independent websites began making the data more accessible to consumers. During July and August 2015, websites began providing "beta" versions of price comparison services for food items sold in brick-and-mortar retail food stores across Israel. Information from personal communications indicates that food retailers and suppliers also obtained data from these websites. As of 2016, at least three websites offered food price comparison services: MySupermarket.co.il, Pricez.co.il and Zapmarket.co.il. Figures 1 ans 2 in the online Appendix present photos taken from Mysupermarket.co.il. Figure 1 shows a price comparison of a single item and Figure 2 shows a price comparison of a basket consisting of 42 items. The different websites offer visitors several features such as the option to follow a fixed grocery list and use the same address when they return to the website.

3 Methodology and data

Identifying causal effects of transparency on prices is a challenging task for several reasons. First, such an endeavor requires an exogenous shock to the level of 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 valid concern. That is, the firms that choose to advertise their prices, and the products they choose to advertise may not be representative of all firms or all products. This selection issue is likely to bias the analysis of the effect of transparency. Second, given that an exogenous shock to transparency has taken place, identifying the impact of this shock 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 changes in transparency. Thus, to identify the impact of transparency on prices one needs to account for potential changes in other determinants of pricing decisions that might have taken place concurrently with the implementation of the transparency regulation. Finally, supermarkets offer a challenging setting for the study of pricing decisions, as they sell thousands of items, which may all 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 items. Our data and differences-in-differences research design, discussed in detail below, offer a unique opportunity to

[6] See http://www.themarker.com/opinion/1.2506245.

address these empirical challenges.

3.1 Data and descriptive statistics

We collected price data for a treatment group of products, as well as for four control groups of products. We also supplemented these data with rich post-transparency data that correspond to a larger array of products and stores, in addition to data on local competition and on products' characteristics. Finally, we also obtained data on the advertising expenditures and content by supermarket chains, and on the usage of the price-comparison websites. Below we provide more details on the data and their sources.

3.1.1 Price Data

Treatment group: The treatment group comprises 69 products sold in 61 stores located in 27 different cities and operated by the 5 supermarkets chains under consideration. Figure 3 in the Online Appendix shows the locations of these stores across Israel. The treatment group products belong to several product categories (e.g., dairy products, drinks, prepared meals, household cleaning, health and beauty) and different price levels. Our reliance on such a large set of items and stores mitigates concerns that the price changes are driven by unobserved local trends or changes that are relevant to specific type of products. During the pre-transparency period, we used a market survey firm to collect the prices of these items. The data collection by the market survey firm was carried out during the last week of the following 8 months: July, August, September, October and December 2014, and February, March and April 2015. Post-transparency prices for these products and stores were obtained on a weekly basis from one of the price comparison websites.[7] In Section 4.4 we restrict attention to the post-transparency time period, when we obtain the data from a price transparency platform. In this analysis, we can therefore use a much larger set of stores (580 stores) and items (355 items) including, for instance, private-label products.

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 in the year after. As can be observed in the figure, there is a declining trend in prices. In addition, chains' average prices seem to have converged shortly after prices became transparent. The figure can also be used to rank the five chains according to basket price. The prices of the basket at the two largest chains: Mega and Shufersal are higher than at the other chains; in particular, the basket price at Rami Levy, the hard-discount chain, is the cheapest. The patterns observed in the figure might be driven by other factors besides price transparency. To take these factors into account, we collected data on four

[7] A potential concern with the data that we use is that we rely on two different data sources for the pre and the post periods. To address this concern, in Section 4.5.1 we rely on the same data source for the pre- and post- time periods and show that the results are qualitatively similar.

control groups of products described below.

Control group 1: products sold online. The first control group relies on the fact that each of the chains we consider also offers an online retail service. The prices of products available through these online channels were transparent both before and after the transparency regulation. Unlike prices at brick-and-mortar stores, which were often determined locally and vary across stores (even within a single chain), prices of items sold online by a given chain are determined at the national level and are not dependent on the customer's location. Since July 2014 we have been collecting on a weekly basis the prices of all the items included in the treatment group but sold online through the websites of each of the five grocery chains. The prices were collected from an online platform that allowed consumers to compare and purchase grocery items from the various chains that offered an online grocery service. Figure 4 in the Online Appendix shows a screen shot from the online platform, where consumers can compare and choose among the online retailers. Figure 3 presents a time series of the total price of a basket of items in the treatment group and a time series of a basket of items in control group 1 (products sold online), starting in July 2014 and ending in July 2016; each data point represents the average across all stores in the respective group. The figure reveals that prices online are generally cheaper than the prices of the same items sold in brick-and-mortar stores. One potential reason for this difference is that online prices were transparent in the pre-regulation period, and this transparency led to fiercer competition in the online channel. More importantly, we also see that the price gap between online and traditional stores diminished after May 2015, when prices in traditional stores became transparent.

Control group 2: ICC products. This control group comprises 48 products sold in hundreds of stores throughout Israel, whose prices are collected by the ICC, the largest consumer organization in Israel. These products do not overlap with the products in our treatment group. We obtained the ICC's monthly reports of the products' prices for the period between July 2014 and July 2015, and for the post-transparency period we obtain the price data from the price comparison website. Importantly, the 61 treatment-group supermarkets, i.e. the stores where the market survey firm visited, are a subset of the stores from which the ICC collected the price data. The prices of the products in the ICC basket are frequently cited in media reports informing consumers about the prices of food items. 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 the media reports, supermarket chains often mentioned the ICC reports as a credible reference point when advertising their own low prices. Mega, the second-largest supermarket chain, dedicated about 40% of its advertising budget in 2014 to ads mentioning the ICC price comparison initiative. Finally, the ICC website offered a weekly comparison of basket prices across the stores visited. Accordingly, it is reasonable to assume that

supermarket chains and consumers are well aware of the price of items collected by the ICC, or in other words, that the prices of these items were already transparent before the regulation went into effect.[8] Figure 4 presents a time series for a subset of seven items from the treatment group and for a subset of seven comparable items from the control group 2. In other words, it presents time series of two groups of products that can be considered substitutes for each other. For instance, we match a 200- gram jar of Nescafé Taster's Choice instant coffee, included in the ICC group to a 200- gram jar of Jacobs Kronung Coffee (another quality brand of instant coffee), included in the treatment group. Similarly, we match a 700- ml bottle of Hawaii shampoo in the ICC group to a 700-ml bottle of Crema Nourishing Cream Wash in the treatment group.[9] In this figure, we observe that pre-transparency prices of products in the control group ICC and in the treatment behave quite similarly. Furthermore, after prices became transparent, prices of items in the treatment group declined substantially more than did the items in the ICC group.

Control group 3: products sold at Super-Pharm. The third control group comprises 28 products sold at 32 stores affiliated with Super-Pharm, the largest drugstore chain in Israel. These items provide a useful control group because drugstore chains were exempt from the Food Act.[10] The prices at Super-Pharm stores were collected by our 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 items in the treatment group and the items in the Super-Pharm control group. *Control group 4: products sold in mom-and-pop grocery stores.* Our fourth control group includes 8 products, whose prices were collected by the Central Bureau of Statistics from both mom-and-pop grocery stores and supermarkets across Israel; the mom-and-pop grocery stores, like drugstores, were not subject to the transparency regulation. Given the small number of items in the latter group, unavailable information (e.g., on the identity of the specific supermarket chain in which the products were sold at) and confidentiality concerns, we cannot use this group in all of our analyses. Thus, we present results corresponding to this control group only in the robustness section. Table 1 present summary statistics for the number of products and observations in the treatment group and in the first three control groups.

Additional data for the price analyses. Most of our analyses rely on the data collected for the treatment and control groups, as elaborated above. After the transparency regulation went into

[8]Further evidence that the ICC basket prices can serve as a reasonable transparent control group is that the prices of items in the ICC basket declined in 2013 after the ICC began collecting the prices of these items.

[9]The choice of these paired-items also follow from a more systematic measure of distance across product characteristics.

[10]Starting in July 2017, drugstore chains also became subject to the transparency regulation. In Table 1 of the Online Appendix we present preliminary regression results demonstrating that prices at Super-Pharm declined soon after its prices became transparent.

effect, the price collection became less cumbersome; therefore, for this period, we were able to obtain from a price comparison website more expansive and finer-grained data for further investigation. Specifically, we use weekly reports on the prices of nearly 355 products sold in 589 stores of the 5 chains, including the chains' online stores. The 355 products include the treatment group products and other items, such as private-label goods. In addition to obtaining price data, we also constructed measures of local competition. These measures are based on the number of supermarkets operated by rival chains within a certain distance of a given store.

3.1.2 Price-comparison websites and advertising data

In Section 5.2 we use the following data sources to discuss alternative explanations for our findings on the changes in prices.

Price comparison websites data. To examine to what extent consumers gained price information by using the price comparison websites, we obtained from Similarweb, a digital market intelligence company, data on the number of viewers and the total number of pages viewed on each of the three websites that were offering price comparison services during the data collection period (`MySupermarket.co.il`, `Pricez.co.il` and `ZapMarket.co.il`). These data, at the monthly level, cover the time period from July 2014 to October 2016. In Section 5.2.1, we use these data to examine the relationship between the use of the price comparison websites and the observed price changes.

Advertising data. To investigate the joint role of the media and retailers' advertising strategy, we collected from 'Ifat', the leading Israeli company for tracking and monitoring advertising, detailed data on all advertising expenditures by the five supermarket chains in our data. These data cover the time period from July 2014 to June 2016 and include for each ad the following information: the name of the ad campaign, the advertising retail chain; the date that the ad was posted; media channel used (e.g., television, newspapers, radio, Internet), a classification of the ad into promotion/image classification, the expenditure on each ad based on list prices, and the ad itself. We further viewed all the ads and classified the ads based on whether they include a reference to media coverage, such as price surveys carried by a media outlet. We define such ads as media-based ads. Figures 5 and 6 in the Online Appendix include examples of newspaper ads that refer to price comparison surveys conducted by the media. Figure 7 in the Online Appendix includes an example of a similar price ads, yet one that does not mention any particular media source. In Section 5.2.2, we use these data to examine the relationship between the use of the price comparison websites and the observed price changes.

3.2 Identification and research design

The graphical illustration presented in figures 3 and 4 is encouraging and suggests 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 this section, we elaborate on our identification strategy, which enables us to determine whether these preliminary observations indeed reflect the effects of mandatory disclosure of prices. To identify how the transparency regulation affected price dispersion and price levels, we observe price changes in the treatment group after versus before the regulation took effect, and compare these changes to the corresponding changes in each control group. A significant difference between a change in the treatment group and a change in the control group should be attributable to the effect of the transparency regulation. The nature of this difference can shed light on whether the transparency regulation enhanced competition or promoted collusion. Importantly, each of the control groups helps to mitigate concerns about the validity of the causal interpretation of the estimation. For instance, a difference between the treatment group and control group 1 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 items that were sold in traditional stores — is not vulnerable to this concern. Similarly, a difference between control group 2 and the treatment group — which includes different products — might be related to differences in the marginal costs of the products that the two groups contain, rather than to changes in transparency. Control groups 1, 3 and 4 are not susceptible to this concern, as they contain the same items as the treatment group. More generally, the use of the different control groups, and the fact that we obtain similar results using these alternative control groups, can provide confidence that our estimates are indeed driven by the transparency regulation rather than by other changes in the market.

3.2.1 Price dispersion

Our first specification focuses on the relationship between transparency and price dispersion. In the regression analysis, 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 single control group. Formally, we estimate the following equation:

$$y_{it} = \mu_i + \gamma_t + \beta \times After_t \times Treatment_{it} + \epsilon_{it} \tag{1}$$

where the dependent variable is one of the three measures of price dispersion. 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.[11] The equation also includes fixed effects for the product and for the time period in which the prices were collected. The product fixed effects capture time-invariant characteristics of each item, such as its mean cost of production. The time period fixed effects capture the impact of seasonality on pricing and other regulatory changes that might have affected chains' costs and pricing decisions. We also accommodate the possibility of pricing trends that may vary across items by incorporating linear product-specific time trends. Standard errors are clustered at the product level. The coefficient of interest, β captures the change in price dispersion in the treatment group of items after prices became transparent relative to the corresponding change in dispersion in the control group.

3.2.2 Price levels

To identify the impact of transparency on price levels, we use the following difference-in-differences specification:

$$log(p_{ist}) = \mu_i + \eta_s + \gamma_t + \beta \times After_t \times Treatment_{is} + \epsilon_{ist} \tag{2}$$

In this specification 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. To control for other factors that potentially affect prices we also include time period (γ_t), store (η_s) and item (μ_i) fixed effects. The time period 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 likely affected retail chains' pricing decisions. Yet, such an effect on pricing 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. Finally, we cluster the 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 2. 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. Per our discussion above regarding the use of the different control groups, and given that the treatment and control groups

[11] Since the dispersion of prices might also depend on the number of observations per product-date, we verify that the results are similar if we add as a control variable the number of times that a price of a certain product was recorded in each period.

contain a substantial number of products in several categories, with overlapping manufacturers and different retailers, we believe that this is a reasonable assumption.

3.2.3 Additional specifications

We subsequently introduce several modifications into Eq. 2 to delve deeper into the nature of the price changes that took place. First, we examine whether the change in prices varies across the different supermarket chains. To do so, we interact the $After * Treatment$ variable in Eq. 2 with an indicator for the type of the five supermarket chains (premium/discount). Second, we examine how the local market conditions affected price levels in the wake of the transparency regulation. To do so, we interact the $After * Treatment$ variable in Eq. 2 with a measure of local competition that we constructed based on the number of other food retailers operating in the local market. We construct two such measures. One is a binary variable indicating whether a store's local environment is characterized by high versus low competition (i.e., store concentration above versus below the median). The other is a continuous measure of local competition. Notably, in this analysis we explore whether stores that are affiliated with the same supermarket chain but face different local competitive conditions respond differently to the transparency regulation. In this analysis, we compare pricing decisions by same-chain brick-and-mortar stores; therefore, we only use control group 2 (the ICC basket) in this exercise.

We further carry out an analysis that examines whether transparency differently affected the price levels of different categories of products. In this analysis we exploit the fact that changes in price levels only began to be observed in January 2016, several months after the regulation went into effect (see the findings in Section 4.3). The gradual impact of the regulation enables us to do two things. First, we can rely on the prices collected only after the regulation went into effect, and include in our sample a much larger set of items and stores (355 items in 589 stores). Second, we can re-estimate the change in prices attributed to the transparency regulation using a newly defined periods of pre-transparency periods (between August and December 2015) and post-transparency period that lasts from January to July 2016.[12] In particular, we re-estimate Equation 2 with interaction terms capturing different product characteristics, and compare price changes of these items to those of a control group comprising the same products sold online by the same chains (similar to control group 1). For instance, in this set of analyses we compare the price changes of private-label products and branded-products in the same category of products. Further details on the product characteristics that we include in this analysis are described in Section 4.4.

[12]While we think that these analyses offer valuable insights on the effect of the transparency policy, we are also aware of the potential limitations of this approach and therefore cautiously interpret the results of this analysis.

4 Results

4.1 Price dispersion

The regression results of Equation 1 are shown in Table 2. The table includes the estimates for each of the three measures of price dispersion: the number of unique prices, the coefficient of variation and the percentage price range. Each of the three columns includes not only the point estimate of the parameter of interest but also the average value of the dependent variable. Although the magnitude of the transparency effect varies across dispersion measures and control groups, the table indicates that transparency had an economically and statistically significant negative effect on price dispersion. For instance, in columns 1-3 we observe that, after the transparency regulation went into effect, the number of distinct prices charged for a product in a given time period decreased by 8 to 16 distinct prices, depending on the control group that we use. This decrease is quite substantial, given that the average number of distinct prices for a product in the pre-transparency period was between 16 to 19. In Table 2 in the Online Appendix we present the estimation results of a specification that captures the effect on the number of unique prices for each of the chains. The table reveals significant effect for each of the chains, suggesting that no single chain is responsible for the results shown in Table 2.

4.2 Price levels

Table 3 presents the regression results of Equation 2, which reflects the the effect of mandatory disclosure of prices on price levels. The point estimates of the main parameter of interest are roughly similar across the three control groups, and 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.[13][14]

Table 4 presents the point estimates obtained for a modification of Equation 2 that simultaneously estimates the transparency effect, once we distinguish between premium and discount supermarket chains. The regression results illustrate that the reduction in prices attributed to the transparency regulation took place among the premium chains. For the discount chains we do not find strong evidence that prices decreased after the transparency regulation went into effect. Table 5 in the Online Appendix presents the results when we include a chain-specific interaction variable. We find that the effect of the transparency was large and negative for the chains that set

[13] We also estimated the same equation using subsets of the treatment group and of control group 2 (the ICC group), namely the "comparable baskets" of goods discussed above (see Figure 4). We obtain nearly identical qualitative results (presented in Table 3 in the Online Appendix). We also obtain similar estimates when price promotions are taken into account (see Table 4 in the Online Appendix).

[14] Note that the regression analysis assumes equal weights to all the products. As we later show, the prices of more popular products have declined less than less popular products. Accordingly, the impact on consumers' actual spending may have been smaller than the estimates reported in the table.

relatively high prices and smaller for the chains that set relatively low prices (see the ranking of the total basket price, shown in figure 2). Table 5 presents the results of an analysis that accounts for the possibility that the effect of transparency on prices depends on the degree to which a store faces local competition. Column 1 presents the results of a specification in which competition is captured by a binary variable reflecting whether the market in which the focal store is operating is more (or less) concentrated than the median degree of concentration. Column 2 presents the results of a second specification, which imposes a linear effect of local market concentration on the effect of transparency on prices. The regression results suggest that post-transparency changes in prices were significantly greater in stores that faced weaker competition. Overall, these findings could suggest that the effect of transparency on prices was smaller in stores that, already before prices became transparent, catered to customers with relatively low-search costs.

4.3 How quickly do prices adjust?

Upon observing the effects of the transparency regulation on price dispersion and on price levels (Tables 2 and 3), it is natural to examine the pace at which these effects took place and their relative order. To this end, we conducted an analysis estimating the monthly effect of price transparency for each month included in our sample. We estimated the month-specific effects using modified versions of Equations 1 and 2. Figure 5 presents the monthly effects of the transparency regulation on the number of distinct prices (as a measure for price dispersion) and on the (log) price levels. The figure demonstrates that price dispersion diminished quite immediately after the transparency regulation went into effect, whereas the effect of transparency on price levels was essentially indistinguishable from zero for several months. Only at the beginning of 2016 did the effect of transparency on price levels become negative and statistically significant. These observations suggest that supermarket chains responded to the mandatory disclosure of prices in two phases: First, they reduced the number of distinct prices for each item while maintaining the average price unaffected. Later, they decreased the levels of prices that they charged.

4.4 Differences across products

Above we showed that the negative effect of transparency on prices materialized only several months after the transparency regulation became effective, i.e., at the beginning of 2016. We now exploit this fact and carry out a series of differences-in-differences analyses for the post-transparency period using panel price data on 355 products from 589 stores. As noted above, we obtain these weekly data from a price comparison website beginning in August 2015, and in these analyses the comparisons are made between the prices of products sold in traditional stores (the treatment group) and the price of the same products sold online by the same chain (as a control group).

In our first analysis in this series, we evaluate the overall extent to which price levels dropped in 2016. We obtain similar results to the those reported in Table 3. 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, shown in column 1 of Table 6, suggests that our initial sample of treatment products is largely representative of the products sold in supermarkets.

Next, we use a regression framework to characterize which products experienced a greater drop in prices during 2016, relative to the control group. First, we divide the 355 products into 10 price deciles based on their mean price and estimate a specific treatment effect for the set of products within each of the mean price deciles. As shown in Figure 6, we find a strong negative relationship between the price level and the corresponding decline in price. 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`.[15] 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 6. As can be seen in the table, the results suggest that the prices of more popular products declined less than the prices of less-frequently-bought items. One potential explanation for this finding is that in the pre-transparency period consumers paid closer attention to products that they purchased more frequently. As a result, prices for these products were a priori relatively low, and the impact of the transparency regulation on prices was greater for less popular goods. Furthermore, these findings might suggest that estimating a quantity-weighted regression of the effect of transparency would indicate that the effect of the policy is somewhat smaller than the effect we report in Section 4.2.[16]

We now turn to evaluate whether price changes differed between private-label products and branded products in the same category. To capture this difference, we estimate an equation similar to Equation 2 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,

[15] 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.

[16] Unfortunetely, store or chain level quantity data is unavailable in Israel.

which differ across chains.

Finally, we also examine the prices of products that are likely to have been characterized by a high degree of consumer search, even prior to the transparency regulation. We expect that frequently-searched products are likely to have undergone smaller price reductions following the transparency regulation compared with similar, less search-intensive products. In particular, for a given product category, we compare price changes among products that offer the most stringent kosher requirement ("Mehadrin Kosher") with price changes among corresponding products carrying the regular kosher label only. For example, we match a 25-gram package of Osem Bamba peanut snack in the Mehadrin kosher set with a 100-gram package of Osem Bamba peanut snack in the regular kosher set. Ceteris paribus, the majority of Israeli consumers are indifferent between the two kosher options. Yet, certain groups of religious Jewish consumers purchase only goods that fulfill the more stringent kosher requirement, and are thus likely to track their prices. The results, presented in column 4, suggest that the prices of Mehadrin kosher goods decreased significantly less than did those of the corresponding regular kosher products. Overall, these results may suggest that the prices of products that were likely to have been characterized by a high degree of search before the transparency regulation decreased less compared with the prices of less-searched-for products.

4.5 Research design validation

4.5.1 Grocery stores as an additional control group

Our regression analysis indicates that after the transparency regulation went into effect, prices of items in the treatment group fell 4-5 percent more than did the prices of items in the different control groups. A potential concern with our results is that they might have been affected by the changes in the sources of data used for the analysis. For example, the source of data for the treatment group in the pre-transparency period was a market survey firm, whereas after the regulation the treatment group data came from a price comparison website. Thus, if there are systematic measurement errors associated with one of these methodologies then our results are potentially biased. In particular, if (due to the collection method) the prices recorded in the treatment group during the pre-transparency period were systematically higher than the actual prices, then our results are potentially biased upward (in absolute values). To alleviate this concern, we obtained data collected by the Israeli Central Bureau of Statistics ("CBS") for the same time period as our main analysis. These data correspond to the prices of eight items, which are regularly collected by the CBS to construct the Israeli consumer price index. Importantly, the methodology to collect the prices of these items did not change over the relevant time period. The CBS data include, for each item, a product identifier, price, store identifier, city name, the month in which

the price was collected, and an indication of whether the store belongs to a supermarket chain or is a mom-and-pop grocery store. Overall, the CBS data include nearly 9,500 observations from 110 supermarkets and 73 grocery stores. For confidentiality, these data do not include a specific address, chain affiliation or exact date. Thus, we cannot directly compare this data set with the other sources of data that we use. Nevertheless, we can use the CBS data to examine how the regulation affected prices in supermarkets (which were subject to the regulation) relative to prices in mom-and-pop grocery stores (which were not subject to the regulation). More specifically, we estimated Equations 1 and 2 using the price data on the eight items collected by the CBS. The results of these analyses, which are presented in Table 7, indicate that after the transparency regulation went into effect, both price dispersion and price levels decreased to a greater extent in supermarket chains than in mom-and-pop grocery stores. The magnitude of the estimated effect on prices s 2.2%. Given that the sample of items used in this analysis is a small subset of the products that we used in the main analysis, we view these results as providing additional support for the findings presented in the main analysis. Using the prices in grocery stores as a control group is also useful because, as we further discuss in Section 4.5.4, it seem unlikely that the owners of these small, independent stores would have responded strategically to the transparency regulation by changing their prices.

4.5.2 Parallel time trends

The identifying assumption in a differences-in-differences research design is that the control and treatment groups share the same time trend. Given the multiplicity of control groups used here, we find it useful to graphically demonstrate that the control groups shares a similar time trend with the treatment group. To this end, we estimated specifications using log(price) as the dependent variables and also add month-specific effects for each specification (treatment group vs. control group). The results are plotted in Figure 8 of the Online Appendix. The figure demonstrates that the treatment group time trend follow a similar time trend as the corresponding control group time trend. Formally, we cannot reject the null hypothesis that the two time trends follow the same pattern when using the online control group. We obtain similar qualitative results when using the ICC control group.

4.5.3 Placebo tests

A potential threat to identification when using a differences-in-differences research design is the possibility that the estimated effects are not driven by the treatment, but rather by other unobserved factors. To address this concern, we conducted a placebo test by considering a sample that started on July 2014 and ended on July 2015, just before the price comparison websites offered

their services. We then re-estimated the regression in which (log) price level is used as the dependent variable (Equation 2), defining a fictitious date for the "effective" date of the transparency regulation. Since the treatment group was sampled eight times in the (actual) pre-transparency period, and given that we want the placebo pre-regulation period and the placebo post-regulation period to incorporate at least two data pulls each, we are left with at most five possible points in time at which to set the fictitious regulation dates. We conducted the test for both the online and the ICC control groups. The results, which show no significant effect of the fictitious regulation, are presented in Table 6 of the Online Appendix. These results mitigate the concern that another event that occurred prior to the implementation of the regulation explains our findings.

4.5.4 Strategic response by Super-Pharm

Another potential concern with the interpretation of our findings is that prices of items in the control groups may have reacted to the transparency regulation. This could mean that our results regarding price levels are driven by a post-transparency increase in prices in the control group rather than by a post-transparency decrease in prices in the treatment group but rather by higher prices in the control group. This concern is applicable to our analyses with control group 3 (products sold in Super-Pharm) because Super-Pharm may have strategically responded to the transparency regulation. In particular, if following the transparency regulation, Super-Pharm decided to target price-insensitive consumers by raising its prices, then our results may overstate the impact of the regulation. While we believe that it is unlikely that Super-Pharm would raise its prices in the wake of a regulation enabling consumers to more easily compare prices across different retailers, it is not theoretically impossible. 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. Arguably, if the above concern holds, we should expect prices in the former to rise more compared with prices in the latter. The estimation results, presented in Table 7 in the Online Appendix, provide no evidence for such a relationship. Second, as mentioned in Section 4.5.1, we use prices of items sold in individual grocery stores as an additional control group and find qualitatively similar results. This analysis further suggests that our main results are not driven by a strategic response by Super-Pharm.

4.5.5 Anticipation of the policy change

One might be concerned that because the Food Act was enacted about a year before the transparency regulation came into effect, supermarket chains might have lowered prices before the actual implementation of the policy. If this is indeed the case then our estimates might be biased. We

believe this concern is unfounded for several reasons. First, the abrupt change in price dispersion that takes place shortly after the policy came into effect strongly suggests that chains responded shortly after the regulation became effective (not months before it was effective). Second, from a profit-maximizing perspective it is not obvious why chains should set lower prices well before prices become transparent. Finally, if chains did set lower prices well before the regulation came into effect then our estimates are potentially biased downward.

5 Potential Mechanisms

In this section we discuss potential underlying mechanisms that may have contributed to our findings. We begin by discussing potential drivers of the effects of transparency on price dispersion, and then discuss mechanisms that are more relevant to the effects on price levels.

5.1 The effect on price dispersion

We propose that fairness concerns best explain the observed effect of transparency on price dispersion and the stark decline in the number of unique prices that each chain set for a given product. That is, retailers reduced the number of unique prices they set for each product because they were concerned that consumers would find price differences across same-chain stores to be unfair, and that a public outcry would take place if consumers observed that chains were engaging in that practice.[17] There are three reasons why we think fairness is a main factor in our setting. First, fairness was an integral part of the public debate regarding retail food prices in Israel in the relevant time period. Many media reports publicized the fact that prices of similar products sold by different stores affiliated with the same chain tend to differ from one another, and that prices in affluent areas were often cheaper than prices in rural and poor areas. Retail chains tried to address the public critique by attributing the price differences to higher transportation costs to rural areas and also by declaring that they would reduce the price differences.[18] Moreover, before the transparency regulation came into effect, a legislative attempt to require food retailers to set uniform prices across all their stores almost passed in the Israeli parliament.[19] Second, the fact that the changes in price dispersion and in the number of unique prices occurred shortly after the regulation came into effect also suggests that these changes were not driven by consumers' usage of the price comparison websites or by coordination among chains. Finally, the fact that already before the transparency regulation the prices that retail chains set in their online channels were

[17] DellaVigna and Gentzkow (2017) discuss fairness and fixed costs of managerial decisions as potential explanations for retailers' decision to set uniform pricing in U.S retail chains. See also Argentesi et al. (2018) who document price uniformity in the retail food sector in Europe.

[18] E.g., https://www.themarker.com/advertising/1.1613349.

[19] http://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.

nationally uniform, further suggests that chains recognized the reputational costs associated with charging different "transparent" prices in different markets.

5.2 The effects of transparency on price levels

5.2.1 Usage of price comparison websites

It seems natural to attribute the influence of transparency on price levels to the fact that transparency offers consumers greater access to price information, which they subsequently exploit. Consistent with this notion, we observe that the number of visitors to price comparison websites increased over the relevant time period.[20] The total monthly number of pages viewed on Pricez.co.il, the only website whose core business relies on comparison of prices across traditional stores, increased from about 100k before the regulation to above 300k in September and October 2016. The average number of pages viewed per visitor increased from about 2 pages per visit before the regulation to 8 pages per visit towards the end of the period.

To further explore the impact of the price-comparison website channel, we estimated a treatment intensity version of Equation 2, replacing the transparency indicator in the original specification with a standardized measure for the number of pages viewed in a given month on Pricez.[21] Thus, we examined the impact on prices of a change in the number of page views, measured in standard deviations. The regression results, obtained using the online control group and shown in Table 8, support our conjecture. An increase in access to price information leads to lower prices in traditional stores. According to the estimates in column 1, an increase of one standard deviation in the number of monthly pages viewed result in a price decrease in traditional stores that is 2.4% greater than the corresponding decrease in the online channel. When we exclude the prices set at Rami Levy, the hard-discount chain, we observe that the reduction in prices associated with an increase of one standard deviation is 2.7%.[22]

While this latter analysis supports the argument that better access to price information leads to price reductions, we are quite hesitant to conclude that consumers' usage of price comparison websites was the only channel through which the transparency regulation affected prices. This is because the overall number of visitors to the three websites is rather low (less than 2% of Israeli households). Instead, we propose that advertising campaigns, indirectly driven by the Israeli media,

[20] Data on the number of visitors are available for MySupermarket and for Pricez also in the pre-transparency period. The reason for this is that MySupermarket's main business is in the online grocery segment, and Pricez offered a price comparison service based on consumer reports.

[21] We standardize the usage variable to facilitate the comparison with the media-based ad channel discussed below. We use data only from Pricez because we are unable to disentangle customers who visit MySuperMarket to shop online (e.g., at Shufersal online) from visitors who want to obtain price information in traditional stores. ZapMarket, the third website, began operating only in November 2015.

[22] Further evidence supporting the online channel is presented In Table 8 in the Online Appendix. There we show regression results that exploit cross-sectional variation across cities in the usage of Pricez. We find a negative relationship between the per-capita number of Pricez' users in a given city and the transparency effect on prices in that city.

also contributed to the reduction in prices. Interestingly, the theoretical literature also recently explored the potential link between transparency regulation, lower search costs and informative advertising (e.g.,Wang (2017)). We discuss the role of advertising in the next subsection.

5.2.2 Media-based advertising

For many years now, the Israeli media has been actively involved in supporting pro-market agendas, criticizing attempts to gain market power and denouncing price increases. News outlets report regularly on consumer issues, typically taking a pro-consumer point of view. In particular, following the social protests in 2011 and the cottage cheese boycott, media coverage of the food market became substantial and influential. In 2012, for instance, TheMarker, a prominent business newspaper in Israel, selected Rami Levy, the man who owns and manages the hard-discount chain Rami Levy (the third largest supermarket chain in Israel) as the most influential figure in Israel in that year. Three years later, on Israel's Independence day in 2015, Rami Levy was awarded the Israel Prize, Israel's most prestigious honor for Israelis who have made a difference to society. The media seems to embrace its role in highlighting market-related concerns: The year 2017, was the first in which a reporter covering consumer issues has won the Israel's Journalists' Association's prestigious life-time achievement award.

The Israeli media's coverage of consumer-related topics 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. For instance, on April 7, 2016, the news site 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 information from `Pricez.co.il`, 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 items included in the basket varied across regions, ranging between 130 and 210.[23] On January 12, 2016, Channel 2 News, Israel's most popular news program, ran a 4.5-minute item on a new price competition among supermarket chains in the city of Modi'in.[24] In this case, too, the reporter used the Pricez mobile app to compare prices across supermarket chains. Another example of the role of the media relates to the merger between two large supermarket chains: Mega and Yeinot Bitan. The merger took place in June 2016, towards

[23] 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. Price comparisons are also highlighted in local media, in addition to national media: For instance, the local newspaper of Petach Tikva, the fifth largest city in Israel, used a price comparison platform to report on the supermarkets with the cheapest prices in Petach Tikva. See `https://goo.gl/YsVT9a`

[24] `www.mako.co.il/news-channel2/Channel-2-Newscast-q1_2016/Article-996f23598873251004.htm`.

the end of our data collection period. In this case, TheMarker, reported prices at the merged chains before versus after the merger, and compared them against the corresponding price differences at another supermarket chain that did not take part in the merger. TheMarker used price data from one of the price comparison platforms and repeated this exercise a few weeks after the merger and then again a few months after the merger.[25]

Does the media coverage of food prices affect prices themselves? We argue that supermarket chains that the media portrays as offering low prices will take advantage of this positive coverage and include it in their ad campaigns.[26] In particular, we expect that after the transparency regulation came into effect hard-discount chains are likely to have used ads referencing media reposts ("media-based advertising") to a greater extent compared with other supermarket chains. To examine this conjecture, we used advertising data by the five supermarket chains, and evaluated the expenditures of these chains on media-based before and after the transparency regulation. As can be see in Figure 7, after the transparency regulation the expenditures by Rami Levy, the hard discount chain, increased significantly whereas the expenditures on media-based ads by the other chains significantly dropped.[27]

We further argue that the use of media-based advertising in the post-transparency time period is likely to have resulted in fiercer price competition among supermarket chains. To capture this effect, we again estimated a treatment intensity version of Equation 2, replacing the transparency indicator in the original specification with a standardized measure of expenditures on media-based ads by Rami Levy in a given month. As before, we focused on the first control group (comprising products sold online) and considered two alternative samples of prices as the dependent variable: with and without prices of products sold at Rami Levy. By excluding prices of items at Rami Levy, we can better assess how an increase in media-based ads at Rami Levy affected prices at other supermarket chains. The results for these regressions, presented in columns 3 and 4 in Table 8, suggest that expenditures on media-based ads had a negative impact on retail prices. According to the estimates, an increase of one standard deviation in media-based ad expenditures by Rami Levy was associated with a decrease of 1.3% in retail prices. In line with our interpretation, when we excluded prices at Rami Levy, we observed a larger drop in prices, of 1.7%.

[25] See http://www.themarker.com/advertising/1.3006498 and http://www.themarker.com/advertising/1.3116830.

[26] In the pre-transparency period price surveys carried out by the media were limited in scope in terms of the number of products and stores surveyed. After prices became transparent these limitations largely disappeared, and therefore both the credibility of these surveys and their potential value for hard-discount chains increased.

[27] Regression results presented in column 1 of Table 9 in the Online Appendix confirm these patterns, showing that the expenditures on media-based ads by Rami Levy increased relative to the expenditures by other supermarket chains. As a falsification test, we show in column 2 in that table that the expenditures on promotional ads by Rami Levy did not increase relative to the other retailers after prices became transparent.

5.2.3 Comparing the two channels

Our next step was to compare the explanatory power of the two underlying mechanisms we propose, i.e., customers' usage of price comparison websites and supermarket chains' expenditures on media-based ads. Accordingly, we estimated a version of Equation 2 in which we added two interaction terms, one for each of the channels. We used the normalized measures of ad expenditures and usage so we can compare the coefficients obtained for the two channels. The results, shown in column 5 (with prices in Rami Levy) and 6 (without prices in Rami Levy) in Table 8 indicate that both channels are important and relevant in driving prices down. In both specifications, the coefficient for the price comparison websites channel is larger than the coefficient for the media-based ad channel. In particular, an increase of one standard deviation in the number of page views or in expenditure on media-based ads translate into price reductions of 1.7% and 0.8%, respectively. Moreover, the magnitude on the coefficients for the media-based ads is greater when we exclude from the sample the prices of the hard-discount chain. Relying on these estimates and the respective changes in the pages viewed and in the expenditures on media-based advertising before and after the transparency period, we observe that the price-comparison channel explains about 2/3 of the price reduction, and that the media-advertising channel explains about 1/3 of the price reduction (corresponding to price reductions of 3.4% and 1.7%, respectively, of 5.2%).

6 Discussion and concluding remarks

Since the beginning of 2017 alone, several large retail chains, including Macy's, JC Penney, Sears and Payless ShoeSource have announced the closing of hundreds of brick-and-mortar stores and the layoffs of many thousands of employees.[28] This dismal trend of the retail market is often attributed to the highly competitive digital age and the strength of online giants such as Amazon. One important traditional retail market which seems relatively immune to this trend is the grocery market, probably due to the unique characteristics of the products sold in grocery stores. How will, nevertheless, the rapid growth of the online market affect the traditional retail food market? Amazon decision's to purchase Whole Foods on June 2017 for $13.7 billion seems to suggest that blending the online channel and the traditional retail food world can offer substantial complementary benefits. For instance, it might result in traditional food stores voluntarily displaying their prices online. Alternatively, government policies may require food retailers to post their prices online. Will this information result in higher or lower food prices? Economic theory offers mixed predictions. On the one hand, the availability of price information is essential for the efficient functioning of markets. On the other hand, firms can use such information to better coordinate

[28] See https://goo.gl/R8pyTJ

their actions in a manner that will harm consumers.

In this paper, we investigate the impact of a transparency regulation on the price distribution of food products sold in traditional stores. Somewhat surprisingly, while the impact of mandatory disclosure of price information is at the core of IO, to our knowledge, hardly no studies have examined this issue empirically, and those that have are somewhat limited in scope: they focus on markets in which firms sell one product and do not examine how the effect of transparency varies with pre-regulation market conditions or across products. Our analysis addresses this gap, using a large set of price data from the Israeli supermarket industry in the period surrounding the implementation of a mandatory transparency regulation. We first show that, soon after the regulation went into effect, brick-and-mortar supermarket stores reduced the number of distinct prices that they set for each item offered. Second, we show that, several months later, price levels decreased. The decrease was particularly pronounced in stores affiliated with more pricey chains or stores that faced weaker competition in their local markets. We further highlight the important role of the media and media-based advertising in generating these price reductions. We show that hard discount chains extensively relied in their ad campaigns on price surveys conducted by the media as an objective and reliable source of information. These ad campaigns along with the usage of the price-comparison websites resulted in fiercer price competition among supermarket chains.

Our estimates further suggest that the magnitude of the effect of transparency on prices is not trivial. Relying on the 5% price reduction estimate, we can use back-of-the envelope calculations to assess consumer savings and firms' revenue losses from the increased transparency. In particular, we find that the average consumer saved about $27 per month and that chains lost about 46 million dollars in revenue each month. 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.

Information disclosure requirements have the potential to affect additional other decisions made by the firms. For instance, transparency can also potentially improve retailers‘ bargaining power vis-a-vis suppliers. In addition, transparency may affect the frequency at which retailers adjust their prices or their price promotion strategies. Retailers may also take transparency into account when making advertising decisions: For example, loss-leader campaigns may be a useful means of attracting consumers who do not have access to prices of other items in the store; they may be less effective, however, when prices are transparent. We leave these issues for future research.

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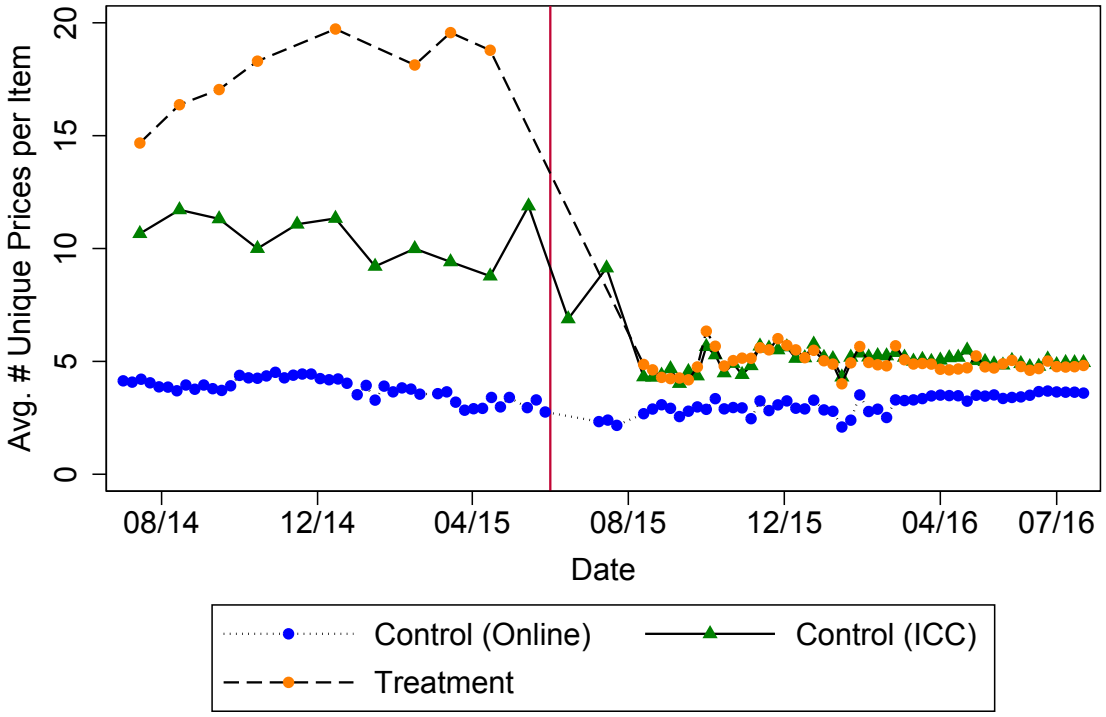
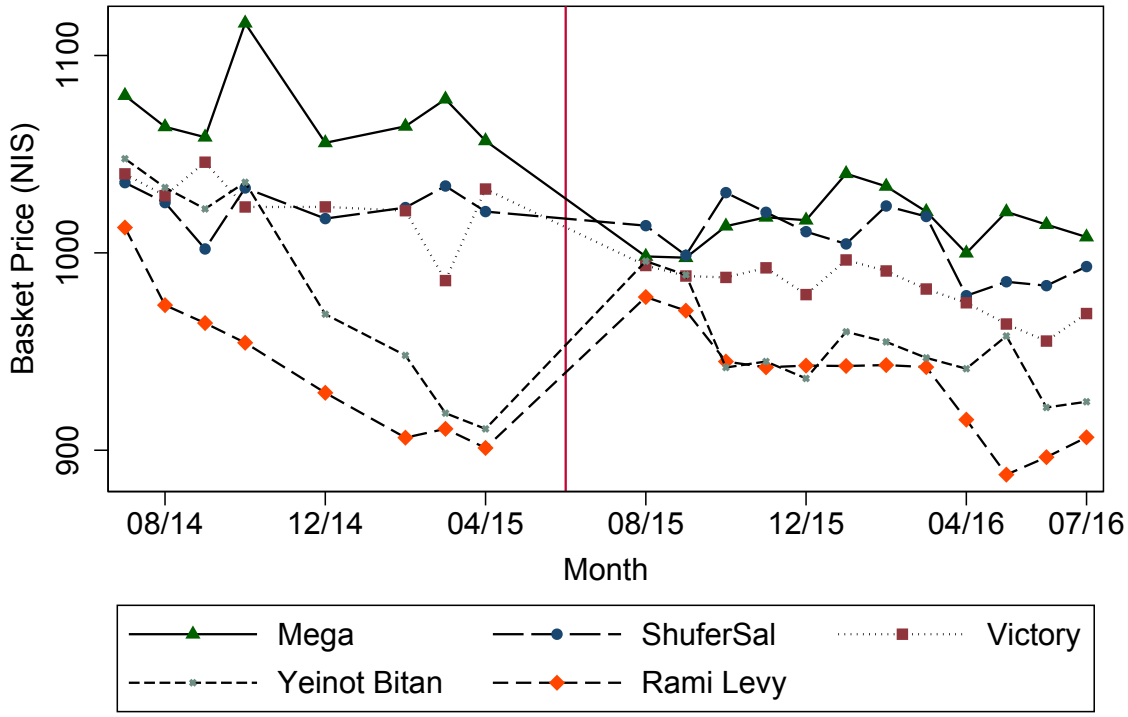
Figure 1: Number of Distinct Prices



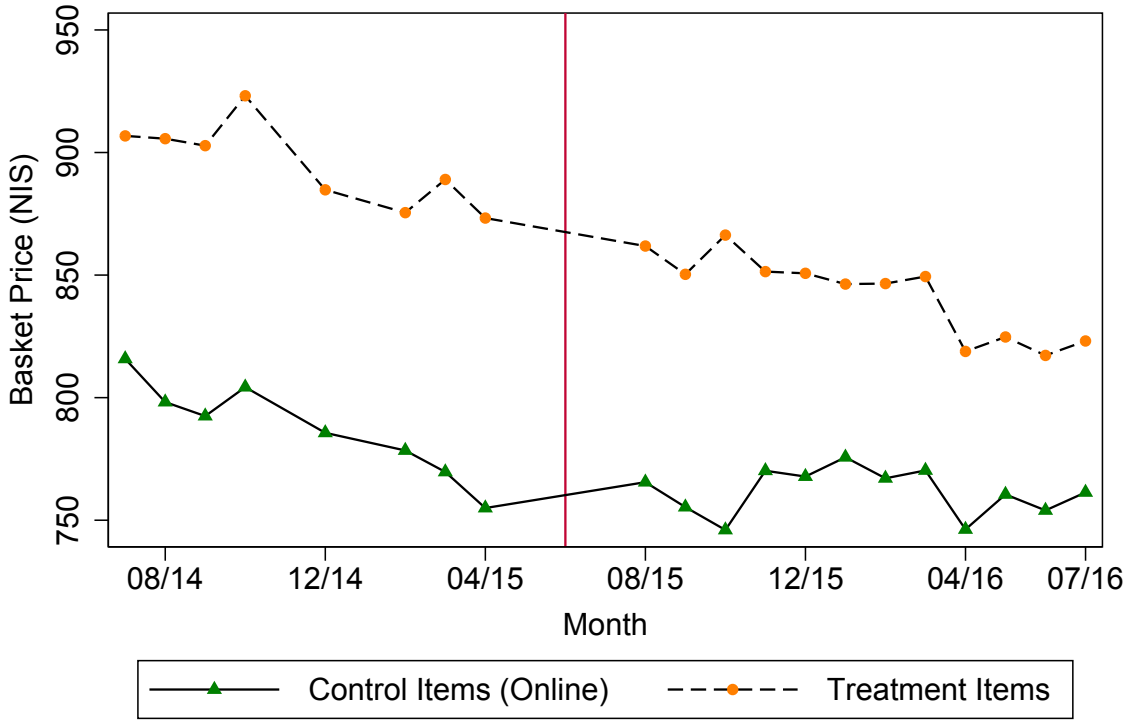
The figure shows a time series of the average number of distinct prices for the treatment group of items, the online control group and the ICC control group.

Figure 2: Retailer-Specific Basket Price



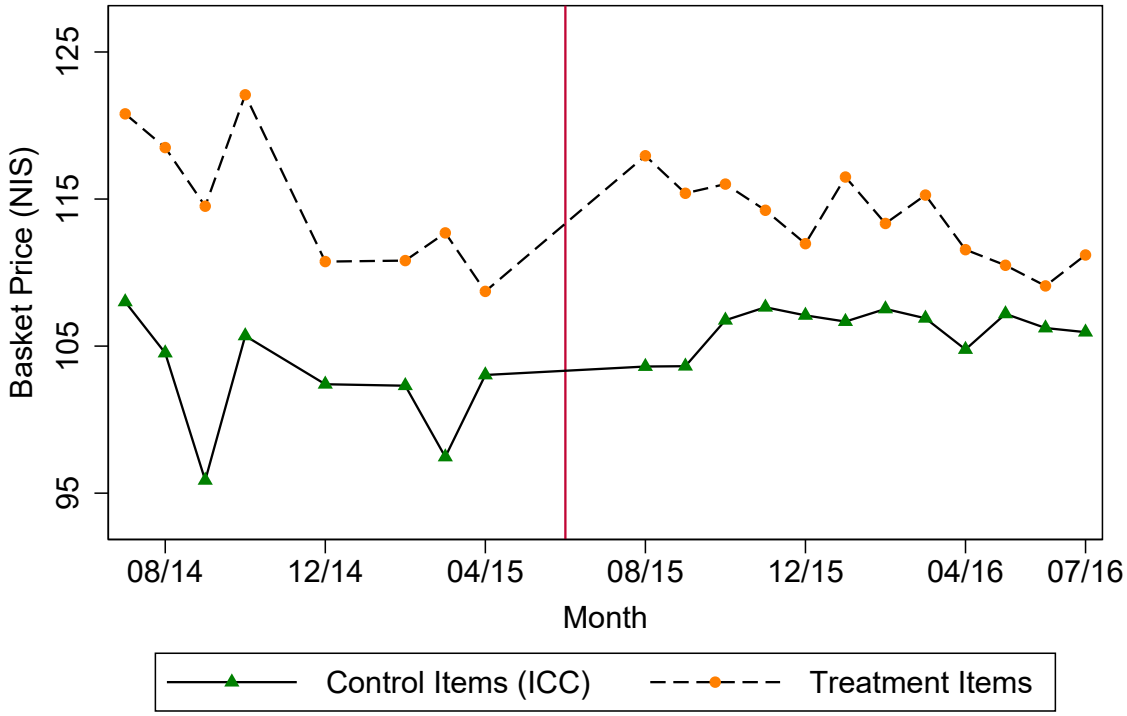
The figure shows a time series of the total basket price for each of the retailers. A basket consists of 58 items. Monthly basket price is the sum of items average price, where the average is taken over the retailers' stores. Missing price are imputed.

Figure 3: Basket Price in the Online Control and the Treatment Groups



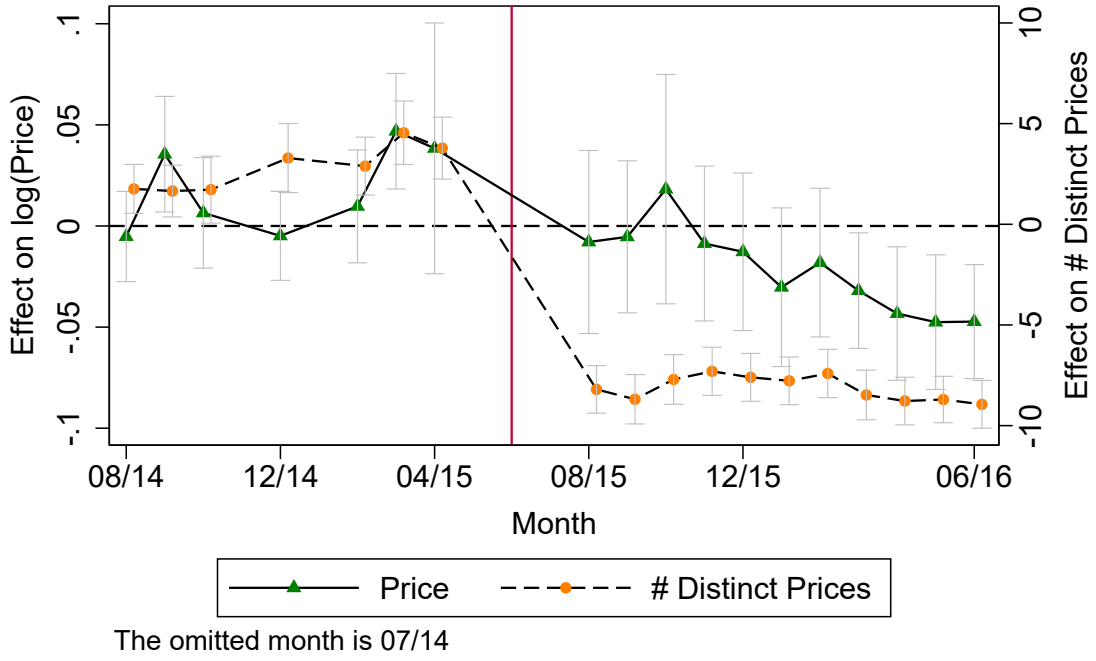
The figure shows a time series of the total basket price, divided into the online (control group) channel or traditional (treatment group) channel. In each channel, prices are averaged across stores and chains and missing prices are imputed. The figure shows that throughout the period the online basket is cheaper than the same basket purchased in the traditional channel. Yet, the difference between the two channels diminishes after the prices in traditional stores become transparent.

Figure 4: Comparable Basket Price



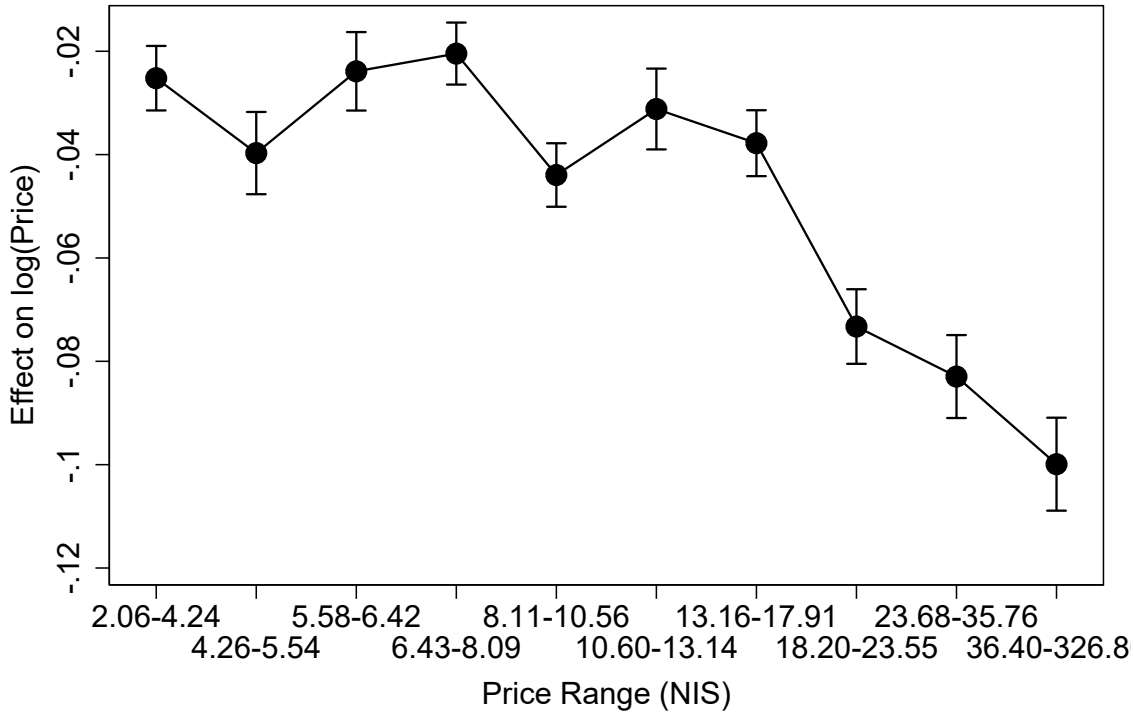
The figure shows a time series of the total basket price for two baskets. One basket consists of seven ICC control items (control group) and the other consists of seven comparable items from the treatment group. The figure demonstrates that the two baskets exhibited similar patterns before prices in the treatment group became transparent.

Figure 5: Monthly Effect on Price Level and Price Dispersion



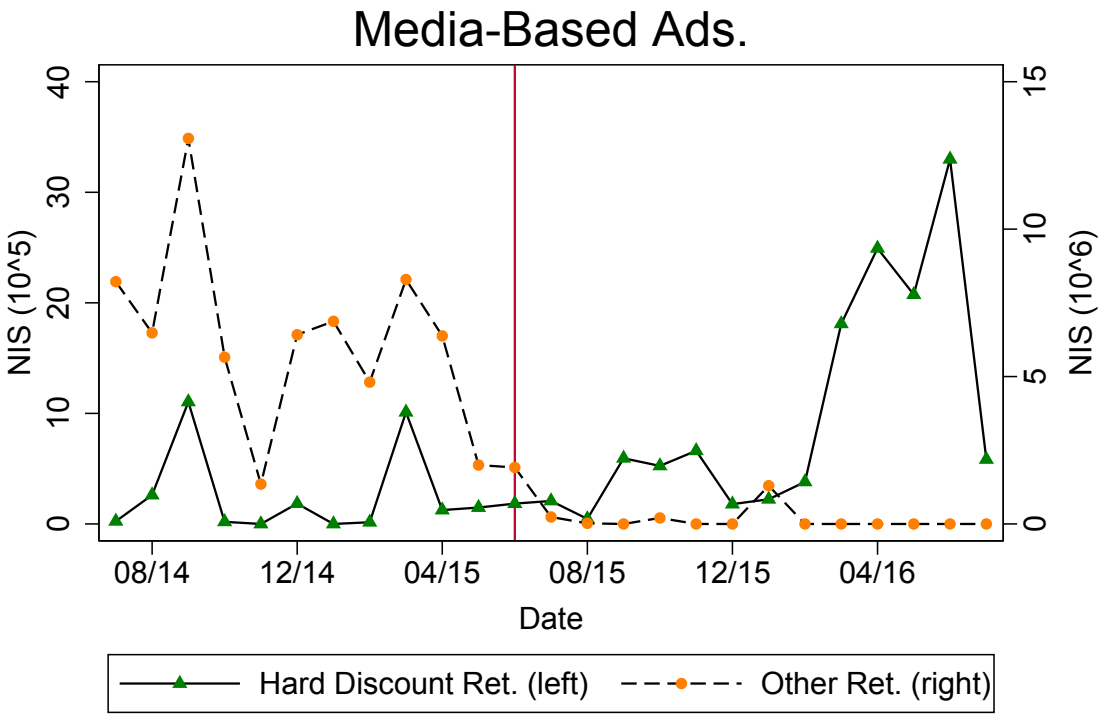
The figure shows the monthly F.E. from two variants of Equations 1 and 2 in which the effect is estimated for each and every month before and after the regulation went into effect. For each monthly estimate the 95% confidence interval is presented.

Figure 6: Post-transparency Analysis



The figure shows the relationship between the average price of a group of products and the reduction in prices of that group of products. In particular, we use the post-transparency price data and divide the products into 10 deciles based on mean price. Each dot in the figure corresponds to one decile and as shown there is a clear negative relationship between the average price and the price reduction.

Figure 7: Monthly Effect on Price Level and Price Comparison Website Page Views



The figure shows on the left vertical axis the monthly expenditures on media-based ads by Rami Levy, the largest hard discount chain in Israel and on the right vertical axis the monthly expenditures on media-based ads by the other supermarket chains. The vertical line correspond to the date in which the transparency regulation became effective. The Figure indicate that after the transparency regulation, expenditures on media-based ads increased for the hard discount chain and decrease for other chains.

Table 1: Descriptive Statistics

Data Source					
Supermarkets		# Stores	# Items	# Data Pulls	*N*
	Treatment group	61	69	58	159,214
	Online stores	5	69	99	30,865
	ICC	61	48	63	115,749
Drugstore		32	28	4	2,789

The table presents information on the number of stores, items and periods for which prices have been collected in the treatment and each of the control groups. For instance, the 115,749 prices of the 48 items in the ICC control group were collected in 61 stores at 63 different weeks.

Table 2: Mandatory Disclosure Effect on Price Dispersion

	# Unique Prices			Standard Deviation/Avg.			Percentage Range ($100 * \frac{P_{max}-P_{min}}{P_{max}}$)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
After*Treatment	-10.881**	-8.103**	-15.920**	-0.101**	-0.053**	-0.083**	-27.396**	-12.481**	-32.962**
	(0.549)	(0.812)	(1.700)	(0.011)	(0.012)	(0.024)	(1.679)	(2.436)	(6.300)
Week F.E.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Item F.E.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lin. Item Time Trend	✓	✓	✓	✓	✓	✓	✓	✓	✓
Control Group	Online	ICC	Super Pharm	Online	ICC	Super Pharm	Online	ICC	Super Pharm
Dep. Var. Average Value	16.265	17.317	19.097	0.211	0.211	0.209	55.006	55.642	57.742
R^2	0.785	0.804	0.833	0.392	0.627	0.471	0.488	0.736	0.635
N	9636	6176	1525	9345	6120	1510	9636	6176	1525

The unit of observation in columns 1, 3, 4, 6, 7 & 9 is item i in date t in treatment/control group

The unit of observation in columns 2, 5 & 8 is item i in date t

Time period covered 7/2014 - 6/2016

Errors are clustered by item

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

The Table presents the regression results of Equation 1 using three different measures of price dispersion as the dependent variable, and each of the three control groups (drugstores, online and ICC). To get a sense of the magnitude of the change in price dispersion following the transparency regulation, we also report in the table the average value of the corresponding dependent variable. For all the measures of price dispersion and for each of the control groups, we find a significant reduction in price dispersion.

Table 3: Mandatory Disclosure Effect on Price

	(1) log(Price)	(2) log(Price)	(3) log(Price)
After*Treatment	-0.051**	-0.052**	-0.040**
	(0.008)	(0.005)	(0.014)
Store F.E.	✓	✓	✓
Date F.E.	✓	✓	✓
Item F.E.	✓	✓	✓
Linear Item Specific Time Trend	✓	✓	✓
Control Group	Online	ICC	Super Pharm
R^2	0.937	0.961	0.909
N	186810	278228	58358

The unit of observation is item i in store j in time-period t

Time period covered 7/2014 - 6/2016

Errors are clustered by store

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

The table presents the regression results of Equation 2. Each column corresponds to a different control group. The results indicate that prices have declined by 4% - 5% after the prices in traditional stores become transparent.

Table 4: Mandatory Disclosure Retailer Type-Specific Effect on Price

	(1) log(Price)	(2) log(Price)	(3) log(Price)
Premium: After*Treatment	-0.061**	-0.058**	-0.045**
	(0.008)	(0.006)	(0.014)
Discount: After*Treatment	-0.015	-0.026**	0.011
	(0.009)	(0.007)	(0.015)
P-Val: Premium Retailers = Discount Retailers	0.000	0.000	0.000
Store F.E.	✓	✓	✓
Date F.E.	✓	✓	✓
Item F.E.	✓	✓	✓
Linear Item Specific Time Trend	✓	✓	✓
Control Group	Online	ICC	Super Pharm
R^2	0.937	0.961	0.909
N	186810	278228	58358

The unit of observation is item i in store j in date t

Time period covered 7/2014 - 6/2016

Errors are clustered by stores

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

The Table presents the regression results of a version of Equation 2 in which the post-transparency indicator is interacted with a supermarket type dummy (premium/discount). As shown in the table, the regression results (for each of the control groups) suggest that prices have significantly declined for the large, premium chains and have not changed for the discount chains.

Table 5: Mandatory Disclosure Effect on Price by Degree of Competition

	(1) log(Price)	(2) log(Price)
After*Treatment - Low Comp.	-0.059**	
	(0.006)	
After*Treatment - High Comp.:	-0.044**	
	(0.006)	
After*Treatment		-0.039**
		(0.007)
After*Treatment*Concentration		-0.040*
		(0.015)
Store F.E.	✓	✓
Date F.E.	✓	✓
Item F.E.	✓	✓
Linear Item Specific Time Trend	✓	✓
Control Group	ICC	ICC
P-Val: Low Comp = High Comp	.002	
R^2	0.962	0.962
N	259557	259557

Concentration ranges form 0 to 1, with 0 being perfect competition and 1 being monopoly

The $10^{th}, 50^{th}$ and 90^{th} percentiles of concentration are 0.13, 0.32 and 0.45, respectively

The unit of observation is item i in store j in date t

Time period covered 7/2014 - 6/2016

Errors are clustered by stores

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

In this table we present the regression results of a version of Equation 2 in which we interact the post-transparency indicator with a measure of the local competition faced by the supermarket store. In column 1, the local competition measure is a binary variable for high or low competition, and in column 2 we use a continuous measure of local competition. Because we want to compare price changes across stores that belong to the same chain but that face different local competition, we use only the ICC control group. The results suggest that prices in stores that faced weaker local competition have declined more than stores that faced stronger local competition.

Table 6: Mandatory Disclosure Effect on Price using Post Data - Heterogenuous Analysis

	Baseline Spec.	Popularity	Private Label	Mehadrin Kosher
	(1)	(2)	(3)	(4)
After*Treatment	-0.032**			
	(0.009)			
After*Treatment (property turned off)		-0.046**	-0.030**	-0.033**
		(0.009)	(0.010)	(0.009)
After*Treatment (property turned on)		-0.003	-0.010	0.047**
		(0.009)	(0.010)	(0.011)
P-Val: Property On = Property Off		0.000	0.000	0.000
Store F.E.	✓	✓	✓	✓
Date F.E.	✓	✓	✓	✓
Item F.E.	✓	✓	✓	✓
Linear Item Specific Time Trend	✓	✓	✓	✓
R^2	0.983	0.983	0.978	0.983
N	4981472	4981472	1005062	4981472

The unit of observation is item i in store j in date t

Time period covered 8/2015 - 6/2016

Data set is based on 355 items and 589 stores

Errors are clustered by stores

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

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 is the prices of 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 3. 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. In column 5 we examine changes in the prices of items that either follow the more stringent kosher (Mehadrin Kosher) requirements or items that offer standard kosher items including only categories with Mehadrin Kosher products.

Table 7: Mandatory Disclosure Effect on Price and price Dispersion using CBS Data

	(1) # Unique Price	(2) Standard Deviation/Avg.	(3) Percentage Range ($100 * \frac{P_{max}-P_{min}}{P_{max}}$)	(4) log(Price)
After*Treatment	-1.465**	-0.042**	-9.407**	-0.022**
	(0.288)	(0.004)	(0.726)	(0.007)
Date F.E.	✓	✓	✓	✓
Item F.E.	✓	✓	✓	✓
Linear Item Specific Time Trend	✓	✓	✓	✓
Control Group	Grocery Stores	Grocery Stores	Grocery Stores	Grocery Stores
Dep. Var. Average Value	9.856	0.164	38.853	
R^2	0.832	0.905	0.778	0.975
N	400	400	400	9472

The unit of observation in columns 1-3 is item i in month t

The unit of observation in column 4 is item i in store j in month t

Time period covered 7/2014 - 6/2016

Errors are clustered by month in columns 1-3 and by store in column 4

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

The table contains the regression results using price data obtained from the Israeli Central Bureau of Statistics as a control group. We repeat the analysis featured in Tables 2 and 3 using the three measures of price dispersion (columns 1 -3) and the price level (column 4). The results indicate that both price dispersion and price levels have significantly declined.

Table 8: Mandatory Disclosure Effect on log(Price) using Media-Based Ads. and Price Comparison Site Page Views as Channels

	(1) log(Price)	(2) log(Price)	(3) log(Price)	(4) log(Price)	(5) log(Price)	(6) log(Price)
Pricez Page Views	-0.024***	-0.027***			-0.017***	-0.018***
	(0.003)	(0.003)			(0.004)	(0.005)
Hard Discount Media-Based Ads. Exp.			-0.013***	-0.017***	-0.008*	-0.011***
			(0.004)	(0.003)	(0.005)	(0.004)
Include Hard Discount Retailer	✓	✗	✓	✗	✓	✗
R^2	0.937	0.936	0.937	0.936	0.937	0.936
N	186810	159147	186810	159147	186810	159147

The unit of observation is item i in store j in date t

Time period covered 7/2014 - 6/2016

Using online control

All specificaitons include date FE, item FE, store FE and item-specific linear time trend

Channel variables intensities are standardized

Errors are clustered by stores

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

The table contains regression results of a treatment intensity version of Equation 2. In this analysis, the control group is the prices of the same items sold through the online channel of each of the chains. Two "treatment intensities" are examined. The first intensity considered is the monthly number of pages viewed in the Pricez price comparison website. The second is the hard discount retailer (Rami Levy) monthly media-based ads expenditure.