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CHARACTERISTICS OF THE COMPETITION BETWEEN GAS STATIONS IN ISRAEL'S DIESEL FUEL MARKET

- Fuel prices are affected by the spatial features of gas stations, including the size of their control area, the number of other gas stations in the local area, the distribution of brands and the extent of their control—their centrality or distance from the main intersection.
- This analysis makes innovative use of data from Waze on travel duration between gas stations to calculate the features of the stations' control areas.
- The results support the assumption that adjacent same-brand stations collaborate, resulting in higher prices.
- Results show that if the major market brand is split up and its stations become independently owned gas stations, fuel prices will decline by almost 2.5 percent. This is a marked effect that indicates that increasing competition will have a significant effect on profitability, since in this specific market, fuel prices largely reflect fuel purchasing costs and taxes.
- A policy to encourage new stations that are not affiliated with the country's four major brands, together with tightened restrictions on opening new stations affiliated with the major brands, particularly in geographic proximity to same-brand stations, may lower diesel fuel pump prices.

1. Introduction

In 2017, the retail fuel market in Israel comprised some 1,200 gas stations, most of which were affiliated with four brands, and a small number of stations affiliated with small independent brands with uneven national distribution. According to estimates, in 2014, diesel and gasoline sales in this market totaled NIS 33 billion.[1]

The competition between gas stations has unique features: Although they sell homogeneous products and services, stations have unique spatial characteristics. The spatial characteristics of a gas station are defined with respect to its "local market"—a limited, well-defined area containing stations in competition. Spatial features include the distribution of the brands in the local market, the number of gas stations, and stations' dominance (centrality or proximity to a major intersection), and these may play an important role in determining transportation fuel prices.

The features of spatial competition have captured the interest of antitrust authorities because the authorities can significantly affect these features and through them, fuel prices. For example, antitrust authorities may impose restrictions on major brands with a large distribution of stations in a local market, define minimum distances between same-brand stations, encourage independent stations to enter the market, approve mergers of brands, and encourage or require brands to split up into independent stations.

This study estimates the effect of the local market features of a station on its pump prices, using data on gas stations in Israel and a formal model adjusted to this issue. The database contains station features and price data for 16 quarters, by station; The study focuses on diesel fuel prices, which represent an area in which competition is more pronounced. Simulations were also performed to explore how brand mergers or the split of a major brand into several independent stations might affect diesel fuel prices.

Written by Ran Sharabany.

[1] Central Bureau of Statistics (2017). Survey of Economic Sectors 2014.

The formal analysis presented in this study is based on an extension of a model developed by Firgo, et al. (2015).[2] The theoretical model includes a well-defined local market that contains a single central gas station (which is the station located closest to the main intersection) and several remote stations, which are either the same brand as the central station or stations of competing brands. The extension allows us to take into consideration that fact that multiple brands operate in the market.

Empirically, we determined that the local market of a station (the central station) includes all the gas stations within a 10-minute travel distance.[3] In this manner we determine the number of stations and brands operating in the local market. The size of the local market is based on the distances between stations in the local market.

Distances between stations were measured in travel time using the Google Maps (Waze) application. To the best of our knowledge, this is the first time Waze data were used to measure distances between gas stations. This measure adjusts traveling distance for effective average traffic congestion and is therefore more accurate than a measure based on speed limits. For this reason, the measure is a faithful representation of the substitutability of gas stations from the consumer's perspective.

To identify the parameters of the model, we use the fact that new stations were constructed in the estimation period—from 2010:Q1 to 2013:Q4. The identification assumption is that the opening of new gas stations, which is an action that changes the features of the local market, occurs independently of a local market's features or prices. That is, new station locations are determined exogenously and are, in effect, not directly dependent on demand but on expected demand. This assumption appears to be strong, yet is supported by a report published by the Antitrust Authority:[4] First, a long period elapses from the time a developer decides on the new station's location until the station becomes operable, and the features of the local market may change in this period. Second, a new station's location is largely determined by regulatory restrictions[5], and therefore is not completely an endogenous feature of the market. Therefore, it is not surprising to find that the local market features of new stations in a local market are similar to the features of the existing stations.[6]

In this study we analyze the pump price of diesel fuel and disregard gasoline prices because government regulation sets a cap on gasoline prices, with a small difference between actual prices and the maximum price. The empirical results are consistent with the predictions of the theoretical model: Station prices decline as the number of gas stations of competing brands in the local market increases, while an increase in same-brand stations drives fuel prices in the local market upward. Prices rise as the size of the local market increases[7], and as a station's distance to an intersection decreases. The quantitative estimates of the effects of local market features allow us to perform simulations to explore various market structure scenarios.

2 This is a variant of the theoretical spokes model (Riordan and Chen, 2007).

3 See Sharabany (2018).

4 Antitrust Authority (2017), Geographic competition of fueling stations. Draft for public comments. [Hebrew]

5 Ministry of the Interior, Planning Administration (2016). Guide for gas station developers.

6 For example, the features of the local market include the number of stations in the market, that is to say, the number of stations that are within a distance of 10 minutes travel time from the central station. We found that, given a district and a brand, the number of stations in the local market of old stations is similar to the number of stations of new stations in the local market.

7 The local market area is normalized by the number of stations in the local market.

The remainder of this paper is structured as follows: Section 2 introduces the theoretical model. Section 3 describes Israel's fuel market and explains the data and their limitations. Section 4 presents the findings and the simulations that explore how mergers or splits might affect prices. Section 5 concludes.

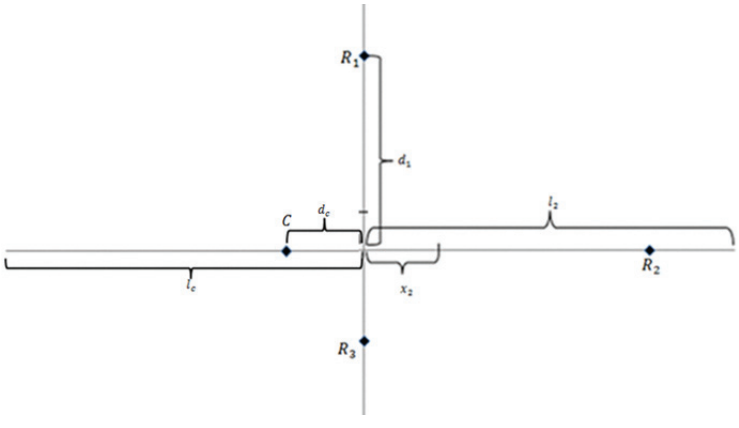
2. The theoretical model[8]

In the theoretical model, the local market is described as a system of spokes (roads) with a common core (the center of the market or the main intersection). Consumers are uniformly distributed in the spokes system, and all derive equal utility from consuming the product in question, which is a homogeneous product. Net utility equals the utility from consuming the product less the product's pump price and cost of travel to the gas station — these costs increase as a function of the travel distance to the station.[9]

The local market contains a single central gas station, *C*, which is the station closest to the main intersection, and several remote gas stations, *Ri*. Figure 1 illustrates the structure of the market where *li* is the length of the spoke of a remote station, *lc* is the length of the spoke of the central station[10], *di* is a remote station's distance from the intersection, and *dc* is the central station's distance from the intersection. The market contains a simple network: the market has four gas stations and four spokes (one central station, *C*, and three remote stations, R_1, R_2, and R_3).

We assume that consumers purchase fuel from the station closest to them, but take fuel prices into consideration. That is, consumers will chose the closest station as long as the price differential between the stations is smaller than the total (fuel and time) costs of traveling to a less expensive station. Otherwise, they will choose to travel to the less expensive, more distant station.

Figure 1



The gas stations are affiliated with brands, which are companies that own multiple stations. Brands maximize their total profit and not necessarily the profit of any single station.

8 This section includes a schematic description only. For a complete description, see Sharabany (2018).

9 Travel costs obviously include the costs of fuel.

10 Spokes may also be empty, that is, they may contain no gas stations.

According to the theoretical discussion, the price at the main gas station is affected by three types of features:

(a) the size of the local market, based on the length of the spokes emanating from the main intersection. The price increases as the size of the local market increases.

(b) the station's distance from the intersection: Prices rise as the station's distance from the intersection decreases.

(c) The total number and mix of brands in the local market.

(i) The addition of a station that is affiliated with the same brand as the central station will drive the price up, if other market features are unchanged, because same-brand stations may enter into local collaborations to prevent competition from eroding the price in the local market;

(ii) The price declines as the number of stations belonging to competing brands increases, if other market features remain unchanged.

3. Israel's gas station market

In this study, we examined 1,245 gas stations that operated between 2010 and 2013. Of these, 83 percent were affiliated with one of the four major brands (Dor Alon, Paz, Delek, and Sonol), and the remainder were affiliated with smaller brands. We obtained the list of stations from Fulltank and cleaned the data using data from the Survey of Israel[11] and Google Maps. The database includes data on gas station pump prices and geographic information including coordinates, which makes it possible to determine distances and travel times between the stations using Google Maps (Waze). Data on ownership of the gas stations (the contractual relationship between a station and its brand) were obtained from the Ministry of National Infrastructures.[12]

3.1 The data and their limitations

The information on diesel fuel prices in gas stations is based on observations reported by drivers to the Fulltank website.[13] As the observations are monthly and our analysis is quarterly, we used the average of the monthly observations in each quarter.

Recall that we are analyzing the price of diesel fuel only, as government regulation determines the maximum price of gasoline, and the difference between the maximum and effective pump prices of gasoline is small. Although the proportion of diesel-powered cars in Israel is relatively small (15 percent) compared to gasoline-powered cars, diesel-powered cars account for a much larger share (30 percent) of kilometers traveled.[14,15]

[11] We extend our thanks to Ralph Stone of Fulltank and to Yovav Sensers of the Survey of Israel.

[12] We extend our thanks to Nahom Yehoshua, Marina Murgman, and Chen Bar Yosef of the Ministry of Infrastructure.

[13] The information in the website helps drivers locate the most inexpensive gas station in the vicinity.

[14] Central Bureau of Statistics (2014), Motor vehicle 2013; Central Bureau of Statistics (2014) Distance traveled 2013; and calculations by the author.

[15] Not all diesel-powered vehicles, however, take part in the competition between gas stations. A considerable share of the buses and trucks do not use the public gas stations examined in this study because they belong to large fleets that have unique fueling arrangements.

The distance between stations is measured based on travel time, which is calculated using Google Maps (Waze). As noted, to the best of our knowledge, this is the first time that this method is used to measure distances between gas stations. This method has an advantage over methods based on speed limits, as it takes average traffic congestion into consideration, and is therefore a better reflection of the substitutability of gas stations from a consumer's perspective. Travel times between stations were calculated for typical day at 13:00.[16]

3.2 Features of the local market

Based on the theoretical model, we assume 1,245 local markets, corresponding to the number of stations. This assumption implies that each gas station fills two functions: In one market it functions as the central station, and in other markets it functions as a remote station.

The local market of a station includes all the stations within a travel time of 10 minutes of this station. In this estimation we include the number of stations in the market, and the number of local market stations affiliated with the central station brand, to examine whether same-brand stations have a different effect on fuel prices than do stations belonging to competing brands.

In addition to the variables above, the empirical estimation also includes the following control variables:

The proportion of independent stations (stations not affiliated with a major brand)—The number of stations that are not affiliated with one of the four major brands divided by the total number of stations in the local market. This is an important control variable for the gas stations' marginal costs, which are not available in the database. The marginal costs of stations not affiliated with one of the major brands may differ from stations affiliated with a major brand, because it is reasonable to assume that management costs are higher in major brands although major brands also benefit from economies of scale. This control variable may also indicate whether the independent brands tend to compete more aggressively in the market.

The Herfindahl-Hirschman Index (HHI) measure of market concentration—A higher value of this index reflects greater market concentration. As market concentration increases, we expected to see prices rise.

The definitions presented above were based on the definition of a local market as containing all the stations within 10 minutes travel time of the central station. Obviously local markets vary by the number of remote stations they contain. The following market features, in contrast, are not based on this market definition.

Centrality – The number of gas stations with which a station is affiliated.[17] This definition is based on Freeman (1979) and is used in the social networks literature. Recall that the formal model predicts that prices rise as station centrality increases.

To calculate centrality, we first identify the 14 closest stations for each gas station.[18] Station j's centrality

[16] We examined travel times at 13:00 rather than in the morning or the afternoon, because diesel-powered vehicles in Israel typically are used by professionals who spend many hours a day on the road and are not used by commuters who mainly use their vehicles in the morning and the afternoon.

[17] See Sharabany (2018).

[18] We selected 14 because this is the average number of remote stations located within the time range that defines the local market (within 10 minutes travel time; see Table 1).

equals the number of times station j appears in the lists of the 14 closest stations in all other local markets. For example, if station j appears in the lists of 16 local markets, its centrality index is 16.[19]

Control area (sum of the lengths of spokes in the formal model)—The sum of the distances between the central station and each of the closest same-branded stations, and the sum of the distances between the central station and each of closest stations belonging to competing brands.[20,21]

Market overlap—This is a control measure of the degree of connectivity between the central station and stations outside its local market.[22] When overlap is high, the central station is more exposed to competition and therefore prices are expected to decline.[23]

3.3 Gas station features and other control variables

We have no available data on the stations' marginal cost of fuel, but can approximately control for this variable using variables that affect the price that suppliers charge the stations: Ownership type—a categorical variable representing the contractual relationship between the station and the brand (a station may be owned by a brand or may own a franchise of the brand, etc.); district—a categorical variable representing the seven districts in Israel; tax-free zone—a dummy variable for Eilat, in which tax on fuel is low; brand—a categorical variable representing brand name; quarterly aggregate price of diesel fuel; and the share of independent stations in the local market.

Table 1.A
Definitions and descriptive statistics of the variables

Variable[a]	Mean	SD	Min.	Max.
The explained variable: pump price of diesel fuel (in NIS)	7.69	0.67	3.92	12.78
No. of stations in the local market: No of stations within 600 sec travel time of the central station.	14.4	7.57	0	54
No. of local market stations affiliated with the central station brand	2.25	2.29	0	13
Herfindahl-Hirschman Index of concentration	0.26	0.15	0	1
Share of independent stations in the local market	0.16	0.13	0	1
Centrality	14	6.04	0	37
Control area of the central station based on same-branded stations: Sum of the travel times from the central station to the closest same-branded stations (in secs)	1346	1541	0	18628
Control area of the central station based on stations belonging to competing brands: Sum of the travel times from the central station to the closest stations belonging to competing brands (in secs)	6089	4117	1609	42881
Market overlap (on a scale from 0 to 14)	10.24	3.33	0	14
Quarterly aggregate price of diesel fuel per liter	7.26	0.45	6.46	7.77

[a] From 2010:Q1 to 2013:Q4.
Source of diesel fuel prices: Fulltank database.

[19] We know that the mean centrality of all stations is 14; therefore the centrality of this station is greater than the mean.

[20] As noted, in the empirical analysis the closest group contains 14 stations.

[21] The two variables affect price in the same direction but at a different intensity.

[22] Market overlap is the number of times a central station is included in the group of the 14 closest stations of each of its 14 neighbors. See Sharabany (2018).

[23] For example, if the central station is not included in the group of the 14 closest stations in any of the 14 stations closest to the central station, market overlap equals zero. If it is included in the groups of the 14 closest stations in all these 14 stations, market overlap is maximal (14).

Table 1 presents the definitions and the statistical data for the variables. Data include 16 quarters and 1,245 stations. For the 8 percent of the stations that were opened in the course of the study period, data are available only for portions of the study period.

As shown in Table 1.C, in any given quarter, stations charge difference pump prices.

In the study period (2010:Q1–2013:Q4), 144 new stations were opened and 52 stations closed. Of the stations that closed, 46 stations were rebranded. Rebranding is treated as the closure of one station and the opening of another station.

Table 1.B
Definitions and descriptive statistics of the variables

Categorical variable for brand	Mean market share (percent)	Pump price of diesel fuel
Dor Alon	17	7.69
Paz	25	7.87
Delek	21	7.79
Sonol	20	7.80
Independent stations	17	7.25
Categorical variable for district	**Share of all stations (percent)**	
Jerusalem	6	
North	27	
Haifa	14	
Center	22	
Tel Aviv	11	
South	16	
Judea and Samaria	3	

Source of diesel fuel prices: Fulltank database.

Table 1.C
Pump price of diesel fuel given the quarter, district and brand category[a]

	Jerusalem	North	Haifa	Center	Tel Aviv	South	Judea and Samaria
	Stations affiliated with the four major brands						
Mean	7.55	7.77	7.80	7.74	7.75	7.51	8.08
SD[b]	0.55	0.56	0.53	0.55	0.71	0.64	0.84
	Independent stations						
Mean	7.17	7.21	7.19	7.11	7.12	7.13	-
SD[b]	0.25	0.26	0.30	0.22	0.17	0.31	-

[a] Means for independent stations differ between Table 1.A and Table 1.B, due to the manner of calculation. In Table 1.C we calculated the mean for each quarter separately and means were calculated weighting each quarter equally. As prices in the earlier quarters are lower, and as 25 percent of the independent stations were opened during the course of the study period, Table 1.C presents a simple mean (calculated on the basis of the total number of observations), giving smaller weight to earlier (lower) prices.
[b] SD was calculated separately for each quarter, district, and brand. The data presented in the table represent quarterly mean data.
Source of diesel fuel prices: Fulltank database.

Comparing station data by brand and district (see Table 2), we find that the features of the new stations and the existing stations do not differ significantly. This finding supports our assumption that the opening of a new station is not endogenous to the features of the local market and is, instead, a function of other exogenous considerations, such as the regulator's approval.

Table 2
Characteristics of stations that existed throughout the study period vs. stations that were closed or opened in this period[a,b]

	Stations that existed throughout the study period	Stations opened in the study period	Stations closed in the study period
	Stations affiliated with the four major brands		
No. of stations in the local market	14.10	13.16	15.07
	(8.52)	(9.14)	(9.18)
No. of local market stations affiliated with the central station brand	2.80	2.57	2.88
	(2.31)	(2.34)	(2.16)
Herfindahl-Hirschman Index of concentration	0.26	0.25	0.24
	(0.13)	(0.15)	(0.07)
Share of independent stations in the local market	0.14	0.16	0.16
	(0.11)	(0.12)	(0.1)
Centrality	14.25	13.22	14.69
	(5.87)	(5.69)	(5.49)
Control area of the central station based on same-branded stations (in secs)	1,500	1,509	1,729
	(1361)	(1680)	(2888)
Control area of the central station based on stations belonging to competing brands (in secs)	5,640	6,763	5,233
	(3655)	(5922)	(2696)
Market overlap	10.44	10.16	11.15
	(3.2)	(3.25)	(2.47)
	Independent stations		
No. of stations in the local market	13.06	13.42	13.07
	(8.17)	(10.16)	(9.19)
No. of local market stations affiliated with the central station brand	0.19	0.10	0.00
	(0.48)	(0.36)	(0)
Herfindahl-Hirschman Index of concentration	0.22	0.23	0.24
	(0.12)	(0.12)	(0.11)
Share of independent stations in the local market	0.27	0.28	0.36
	(0.15)	(0.16)	(0.29)
Centrality	13.93	13.57	13.81
	(6.02)	(5.67)	(5.52)
Control area of the central station based on same-branded stations (in secs)	70	34	52
	(200)	(126)	(196)
Control area of the central station based on stations belonging to competing brands (in secs)	6,982	7,559	7,241
	(3895)	(5239)	(2891)
Market overlap	10.35	10.55	9.99
	(3.23)	(3.29)	(3.14)

[a] The table presents means and standard deviations for the stations affiliated with the major brands and the independent stations. We calculated means and SD separately for each district and calculated weighted means and SD based on the relative weights of each district (the number of stations in each district).
[b] Data for Jerusalem and Judea and Samaria districts were omitted due to lack of observations.
Source of diesel fuel prices: Fulltank database.

4. The empirical model, estimation results, and simulations

4.1 The empirical model

We examine how quarterly diesel fuel pump prices are affected by the features of their local markets. The empirical specification of the model is obtained from a spatial error type model developed by Baltagi (2007). Estimation takes into consideration that the error term contains the spatial effect that the stations in the local market have on the central station:

$$(1)\ P_{m,t} = \boldsymbol{\gamma}\ \text{local market chracteristicst}_{m,t} + \boldsymbol{\beta}\ \text{control variables}_{m,t} + \text{u}_{m,t}$$

γ is the vector of the coefficients of the local market features derived from the formal model's equations, and β is the vector of the coefficients of the control variables that are not derived from the formal model—local market features and the aggregate diesel fuel prices. *t* and *m* are indices of time and of the number of stations, respectively. *P* is a vector of the prices of *m* stations (M = 1,245) and *t* quarters (T=16).

In the empirical estimation, we used multiple imputation to address two concerns—missing data on pump price of diesel fuel, and missing data for stations that did not exist throughout the entire study period (stations that closed or were opened in the study period). Multiple imputation is an accepted method of completing missing data and it was used in our estimations specifically to calculate the standard deviations of the estimates.[24]

4.2 Estimation results

All the estimates of the variable coefficients derived from the formal model were found to be significant and in the expected direction.

[24] See Sharabany (2018).

Table 3
Estimation results[a] (explained variable – pump price of diesel fuel)

Variable	Coefficient	SD	Significance level
Centrality	0.010	0.002	***
Control area of the central station based on stations belonging to competing brands	1.2E-5	3.3E-6	***
Control area of the central station based on same-branded stations	1.6E-5	5.1E-6	***
No. of local market stations affiliated with the central station brand	0.008	0.004	**
No. of stations in the local market	-0.005	0.001	***
Market overlap	-0.014	0.004	***
Herfindahl-Hirschman Index of concentration	0.192	0.079	***
Share of independent stations in the local market	-0.266	0.064	***
Stations in Eilat (dummy variable)	-1.139	0.087	***
Quarterly aggregate price of diesel fuel per liter	0.541	0.018	***
Categorical variable for district			
Haifa	0.116	0.021	***
Jerusalem	-0.018	0.032	
North	0.028	0.020	*
South	-0.033	0.020	*
Tel Aviv	0.002	0.020	
Judea and Samaria	0.074	0.059	
Categorical variable for brand (excluding independent stations)			
Dor Alon	0.296	0.020	***
Paz	0.412	0.019	***
Delek	0.385	0.025	***
Sonol	0.485	0.022	***
Categorical variable for ownership type	YES		
Constant	YES		
No. of observations	19920		
No. of stations	1245		
No. of imputations	90		

[a] The number of imputations is the number of times that the model was estimated, which is equal to the number of times in which missing data were produced. See Sharabany (2018).
*p < 10 percent, **p < 5 percent, *** p < 1 percent
Calculations were made using the SPREML procedure of SPLM R-package (Baltagi, 2007; Milo, 2014)
Source of diesel fuel prices: Fulltank database.

Local market features

Although the effects on pump price of diesel fuel (that the coefficients reflect) seem modest in terms of pump prices, we must recall that purchase costs and taxes account for 90 percent of the pump prices and therefore a station's margin, which includes the station's profit and other expenses such as rental expenses and salaries, is a mere 10 percent of the pump price, and equals NIS 0.77 per liter on average.[25]

Findings indicate that a station's centrality has an impact on the price that it charges. An increase of one standard deviation in centrality is associated with a price hike of close to NIS 0.06, which reflects a 0.79 percent increase in the mean of pump prices.

For control areas of central stations calculated for stations not affiliated (affiliated) with the central station's brand, a 10 percent increase in control area is associated with a 0.64 percent (0.31 percent) increase in pump prices.

Findings of how changes in the number of stations in the local market and the number of same-branded stations affect central station prices lend support to the argument that same-branded stations in a local market collaborate. An addition of one other-branded station to a local market decreases the pump prices by NIS 0.05 (0.07 percent). The addition of one same-branded station is associated with an increase of NIS 0.08 in price (0.11 percent).

Regarding the local market features that were not calculated from the theoretical model, the share of independent stations in a local market has a significant effect on local market prices. If a station affiliated with a major brand becomes an independent station (all else unchanged), prices will decline by close to NIS 0.035 (0.45 percent). A 10 percent increase in the Herfindahl-Hirschman Index drives pump prices up by NIS 0.005 (0.07 percent).

As expected, when market overlap increases—that is, when the density of stations in areas adjacent to the local market is high—pump prices decline. An increase of one standard deviation in market overlap drives prices down by 0.61 percent.

The coefficient of the dummy variable for tax-free zones (Eilat) is NIS 1.14, similarly to the reduction in taxes that we calculated for this area (NIS 1.09).

Regarding brands, stations affiliated with the four major national brands in Israel (Dor Alon, Delek, Paz, and Sonol) charge significantly higher prices than independent stations, and the differences range from 3.9 percent (Dor Alon) to 6.3 percent (Sonol).

4.3 Simulations

The empirical model allows us to perform simulations and explore how changes in market structure effect prices. In these simulations, we recalculate the prices in all stations and quarters: (a) assuming that the two largest brands merge into a single brand, and (b) assuming that the largest brand is split up and all its stations become independent. All else—the number of stations operating in each quarter and their locations—are unchanged.

[25] Assessment based on gasoline prices. Ministry of Energy, Price structure for January 2018, published December 31, 2017.

Table 4 presents the values of the model variables and their respective contributions to a change in price, relative to the benchmark model. In both simulations we calculated the mean pump price using the regression equation that appears in Table 3. As noted above, the effects are not insignificant in terms of the stations' margins, which constitute a mere 10 percent of the pump price (which equals NIS 0.77).

When the two largest brands are merged, mean pump prices increase by slightly more than 0.5 percent and when the largest brand is split up into independent stations, pump prices decline by close to 2.5 percent, or approximately one quarter of the margin.

Table 4
Simulations

Variable[a]	Benchmark	Simulation 1 – Merger of two largest brands		Simulation 2 – Split up of largest brand into independent stations	
	Mean	Mean	Contribution	Mean	Contribution
Explained variable: Diesel pump price	7.69	7.73	0.04	7.50	-0.19
No. of stations in the local market	14.40	14.40	0.00	14.40	0.00
No. of local market stations affiliated with the central station brand	2.25	3.82	0.01	1.43	-0.01
Herfindahl-Hirschman Index of concentration	0.26	0.37	0.02	0.21	-0.01
Share of independent stations in the local market	0.16	0.16	0.00	0.40	-0.07
Centrality	14.00	14.00	0.00	14.00	0.00
Control area of the central station based on same-branded stations	1346	2186	0.01	885	-0.01
Control area of the central station based on stations belonging to competing brands	6089	5249	-0.01	6550	0.01
Market overlap	10.24	10.24	0.00	10.24	0.00
Categorical variable for brand			0.00		0.00
Dor Alon	0.172	0.172	0.00	0.172	0.000
Paz	0.249	0.462	0.01	0.000	-0.007
Delek	0.214	0.000	0.00	0.214	0.000
Sonol	0.199	0.199	0.00	0.199	0.000
Independent stations	0.167	0.167	0.00	0.415	-0.096

[a] We omitted the dummy variable for Eilat and the categorical variables for district and ownership type.
Source of diesel fuel prices: Fulltank database.

5. Conclusion

We found that competitive conditions compel gas stations to relinquish a considerable share of their profits from transportation fuels, and that stations affiliated with the four major brands in Israel (Dor Alon, Delek, Paz, and Sonol) charge significantly higher pump prices than independent stations. Consequently, a policy to encourage the establishment of new stations that are not affiliated with the four major brands, alongside tightening the restrictions on new stations affiliated with the major brands, may reduce the pump prices of diesel fuel.

The results we obtained may point to implications of spatial competition in other industries. In the fuel sector, competition does not have a significant impact on pump prices because market margins account for a small share of the prices that consumers pay. The above analysis does, however, indicate that spatial competition has a considerable effect on marketing margins. Consequently, more intense competition might significantly reduce consumer prices in sectors in which marketing margins account for a larger share of the consumer price, such as the food and apparel sectors. Moreover, the above findings refer to competition in a geographic space but it is reasonable to assume that they also have implications for the effectiveness of increasing competition by expanding access to e-commerce or imports. It is nonetheless important to study these sectors separately as, in contrast to fuel stations, the products in those sectors are not homogeneous.

The above analysis does not lead to clear-cut conclusions regarding the strength of competition's effect on profits from the sale of non-diesel transportation fuels, as diesel consumers (such as taxis and commercial vehicles) have greater access to gas stations: These vehicles typically travel extensive distances during the day and are therefore better positioned to select less expensive gas stations, while gasoline customers are typically commuters whose travel routes are relatively limited as is their access to a selection of stations. For these reasons, reducing restrictions on gasoline pump prices may have a more limited effect on competition in that sector.

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THE CPI AND THE OWNER-OCCUPIED HOUSING SERVICES COMPONENT

- During the last decade, home prices have risen more rapidly than rents and therefore the question often arises as to how the CPI would have developed if the CBS had measured the owner-occupied housing services component using home prices rather than rents.
- Until 1998, the CBS measured the owner-occupied housing services component using an estimate of the alternative cost of home ownership—the price of a home multiplied by the alternative yield plus depreciation. From 1994 to 1998, the component essentially represented only the change in home prices due to the change in the method of measurement (use of a fixed yield and ignoring depreciation). Starting from 1999, the CBS began measuring the component using rent in new and renewed contracts.
- The current method of measurement, which uses rent, is consistent with international statistical standards and with the accepted practice in many OECD countries.
- The analysis below shows that changing the method of measurement affected the CPI to only a limited extent.

1. Introduction

During the last decade, home prices have risen faster than rents and therefore the question sometimes arises in public discourse as to how the CPI would have differed if the CBS had measured the owner-occupied housing services component by means of home prices rather than rents. In what follows, we will attempt to answer this question, while presenting the various methods of measuring the component and the methods that have actually been used in Israel and the rest of the OECD countries.

The CPI is published monthly and measures the monthly rate of change in the expenditure required to purchase a fixed basket of goods and services whose prices can be measured on a regular basis.[1] The CBS chooses a basket that represents household consumption, based on the findings of the CBS Survey of Households that is carried out annually among a representative sample of households. The CPI is composed of ten main components and a large number of sub-components. Each component has a weight that represents its share (in percent) of the expenditure on the products and services included in the average monthly household expenditure. Since consumption patterns change over time, the CBS updates the basket every two years and revises the weights accordingly.

Housing is one of the main components in the CPI and since the 1980s its weight has ranged between 16.5 and 25.2 percent. The housing component includes three sub-components: (a) owner-occupied housing services, which measures the change in the price of housing services consumed by households that own the home in which they reside (its weight in the total housing component is currently about 72 percent); (b) rent, which measures the change in the price of housing services consumed by households that live in a rented home (its weight in the housing component stands at about 23 percent); (c) other housing expenses, which include real estate agency fee, legal fees for signing a contract, and insurance (its weight within the housing component stands at about 5 percent). This analysis focuses on owner-occupied housing services.

Written by Daniel Levi and Yossi Yakhin.

[1] For further details, see the Statistical Abstract for Israel 2017, Chapter 10: "The CPI", pp. 133–134.

The CPI Manual[2] describes three approaches to measuring the value of these services: (a) the use approach, which estimates the market value of housing services by means of rent paid on a similar home or by means of cost of use, which is made up of the alternative cost of owning a home (loss of yield from holding other assets), depreciation and recurring expenses; (b) the payments approach, which measures the recurring payments as a result of owning a home; and (c) the net acquisitions approach, which is based on the costs of a home purchase less the cost of the land (the capital component). In each of the approaches, the housing component is measured in a different way although all of them seek to measure the cost of consuming housing services net of capital housing components.

Until 1998, the CPI measured the owner-occupied housing services using the estimated alternative cost of owning a home. From 1994–98, it multiplied home prices by a fixed alternative yield and therefore this component essentially represented the change in home prices. In 1999, following the recommendations of a committee of experts and the IMF, it was decided to change the method of measurement and to use the rents specified in new and renewed contacts in order to create an estimate of the price of housing services consumed by households living in their own home.

The rest of the analysis proceeds as follows: Section 2 reviews the methods for measuring the owner-occupied housing services component. Section 3 briefly reviews the measurement methods used in Israel in the past. Section 4 calculates alternative estimates for the owner-occupied housing services component based on the measurement method in place prior to 1999, before the transition to the use of rents, and presents the CPI derived from those estimates. Section 5 surveys the use of the various measurement methods in the OECD countries.

2. Methods of measuring the owner-occupied housing services component

According to international standards, the owner-occupied housing services component is meant to measure the value of the consumption of housing services net of capital expenditure. In this section, we will review the methods of measurement presented in the CPI Manual.[3]

2.1 The use approach

The use approach measures the value of housing services produced from residing in a home. This approach includes two measurement methods: user cost and rental equivalence. The two methods are based on the following asset pricing equation. It compares the cost of a home to a home purchaser (equity) in period t (left-hand side) to the present value of net receipts from ownership of the home for one period (rent for the period and the expected price of the home less recurring expenses, depreciation and mortgage payments; right-hand side):

$$(1) \qquad (1-\lambda)P_t = \frac{Rent_t - RC_t - D_t - (1+r_t^m)\lambda P_t + P_{t+1}^e}{1+i_t}$$

[2] A joint document of the World Bank, Eurostat, UNECE, the OECD, the IMF and the ILO.

[3] See Chapters 10 and 23 in ILO et al. (2004).

where λ represents the home purchaser's rate of leverage, P is the price of the home, *Rent* is rent, and P^e is the expected price of the home. *RC* and *D* represent, respectively, the recurring cost and the depreciation value of the home, r^m is the mortgage interest rate and i is the yield on alternative investment assets. The above specification assumes that all of the payments and the rental receipts during period t occur at the end of the period while the payment to purchase a home occurs at the beginning of the period.

After rearranging Equation (1), we get:

$$(2) \qquad \underbrace{Rent_t}_{Rental\ Eq.} = \underbrace{RC_t + i_t E_t + r_t^m M_t + D_t - (P_{t+1}^e - P_t)}_{User\ Cost}$$

where $M_t=\lambda P_t$ represents the balance of the mortgage loan and $E_t=(1-\lambda)P_t$ represents the household's equity. The two sides of Equation (2) represent the two methods for measuring the value of housing services in the use approach.

2.1.1 User cost

This method measures the costs incurred by homeowners as a result of living in their own home. According to this method, the user cost is composed of two main components: (a) recurring expenses which include, among others, repairs, maintenance and taxes; and (b) the alternative cost of the capital invested in the home instead of in another asset. This cost includes the yield that could have been earned on the equity, the interest payments on the mortgage and the depreciation of the home; the capital gains earned on the house are deducted from the cost. Due to the methodological complexity of this method of measurement, countries that use it usually do not take into account all of the expense types appearing in Equation (2) (see ILO et al., 2004).

2.1.2 Rental equivalence

This method is based on the market price of the housing services provided by the home, namely the level of rent that the homeowner would have paid in order to live in a similar home. Since under this method, the homeowner is considered to be a renter, it does not include costs that are generally imposed on the homeowner, such as insurance, taxes and maintenance. This method requires a broad rental market that includes housing that is similar to owner-occupied homes.

2.2 The payments approach

In this approach, the value of owner-occupied housing services is measured using the payments that are related to ownership and which affect the household's equity, namely the mortgage interest rate, real estate agency fee, insurance, fees, taxes and maintenance costs. Since this method of measurement is meant to identify the value of the household's consumption, it does not include payments that do not affect its equity. For example, the payments to purchase the home, whether they are financed by assets or by a mortgage, and payments to improve the asset are not included in the measurement, since they affect the household's composition of assets and liabilities but not its equity.

2.3 The net acquisitions approach

In this approach, the direct costs of purchasing the home and its improvement are measured, as well as accompanying costs, such as real estate agency fee, costs of maintenance and repairs, insurance and taxes. As mentioned, home prices include a capital component that should be deducted in the calculation of the CPI, and therefore in this approach the price of the home usually does not include the value of the land since it is a capital component; in contrast, the structure is "consumed" over time.

It should be mentioned that in this approach the weight of the owner-occupied housing services component is calculated differently than in the use approach and the payments approach, in which the weight of the component is calculated according to the average proportion (in percent) of the household's expenditure on housing services out of total consumption. In contrast, in the acquisitions approach the weight is calculated according to the proportion of net total expenditure on housing in the household sector out of total consumption expenditure. The net expenditure is equal to total expenditure less the value of purchases made by households from other households; in other words, the measurement includes purchases of new homes (from builders or from the government) and of secondhand homes from the business and government sectors.

3. How the owner-occupied housing services component has been calculated in Israel over the years

From 1964 to 1993, the CBS calculated the owner-occupied housing services component by imputing the alternative yield on the value of housing, plus depreciation on the structure. This calculation is essentially a partial implementation of the user cost method within the use approach (Section 2.1.1 above) since it focuses on the cost of use and does not relate to recurrent expenses, the expected capital gains from the house or leverage.

From 1994 to 1998, depreciation was removed and the housing services component was calculated according to a fixed return (4 percent) on the value of housing. This return represented the "normal ratio" between annual rent and the price of a dwelling during that period (Shiffer, 1995) and reflects the expected annual return on investment in a home. Although the calculation was based on the user cost method during that period, the reliance on a fixed return led to a situation in which the owner-occupied housing services component essentially captured the variation in home prices.

In 1999, the CBS adopted the rental equivalence method (Section 2.1.2). In this method, the change in rents specified in new and renewed contracts is estimated and therefore this index represents the changes in monthly rent that the owners would have paid for housing services provided by their homes if they had paid according to a rental contract.

The CBS divides the sample data they collect into homogenous categories,[4] measures the average rent in each category (in new and renewed contracts) and calculates the weighted average of rent in the various categories. The weights reflect the relative consumption of owner-occupied housing services in each category and are calculated based on data from the Households Survey.[5]

[4] The sample is divided into subpopulations on the basis of district and size of the home and the subpopulations are divided into categories using cluster analysis on the basis of average rent (see Borek (1999)).

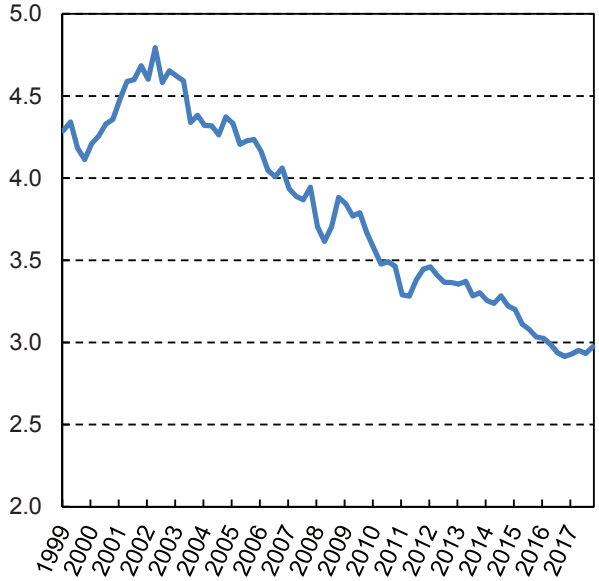
[5] For further details, see Borek (1999) and also the explanation of the methodology for calculating the housing component in the CPI that the CBS includes each month in the Statistical Bulletin on Prices.

4. Measurement of the CPI according to the method used in the past

In this section, we will examine what inflation would have been during the last two decades if the CBS had not changed its method of measurement for the owner-occupied housing services component. The weight of the component during this period ranged from 16.0 percent to 19.4 percent of the CPI and therefore the change in method of measurement had a significant potential to affect the CPI. In order to carry out this simulation, we will estimate the alternative cost of owning a home using the method employed before the change and will include this estimate in the CPI instead of the owner-occupied housing services component actually employed by the CBS (Appendix 1 describes in detail how we included the estimate in the CPI).[6]

Before the CBS changed the method of measurement of the owner-occupied housing services component, it measured the component according to the alternative cost of owning a home. This cost reflected the loss of yield on the capital invested in the home and therefore the rate of change in the component is based on the ratio $\frac{r_t \times P_t}{r_{t-1} \times P_{t-1}}$ where r represents the alternative yield and P is the price of a home. We will measure the owner-occupied housing component in two ways: (1) using a fixed yield as was the practice of the CBS before the change in the method of calculation; and (2) using a yield that varies according to the current ratio of rent to price, which changes over time. In this context, it should be noted that it is likely that the variation in the yield on a home would have led the CBS to update the yield on a regular basis, particularly in view of the criticism voiced in the mid-1990s of its use of a fixed yield (Shiffer, 1995). Therefore, we believe that the use of a variable yield produces a better estimate of the measurement that the CBS would have obtained if it had not changed the method of measurement. It should also be mentioned that the variable yields can also be estimated according to yields from the capital market, although an attempt to do so leads to large fluctuations in inflation, which would have made the adoption of the method unlikely. Appendix 2 presents the results obtained by using yields from the capital market as an estimate of the variable yield.

Figure 1
Alternative Yield of Residence in an Owner-Occupied Dwelling—Ratio of Annual Rent to Home Prices, 1999–2017 (quarterly data, percent)



SOURCE: Based on Central Bureau of Statistics.

For the price of a home, P, we used the CBS's hedonic index of home prices. In order to calculate the alternative variable yield, we used the data published by the CBS for average rents in the free

[6] The weights of the CPI component reflect the relative expenditure of a household on each component and therefore it is reasonable to posit that the change in the method of measurement of the owner-occupied housing component requires an adjustment in the weight of the component to the new method. A sensitivity analysis we carried out showed that the results are not sensitive to the adjusted weights that we calculated.

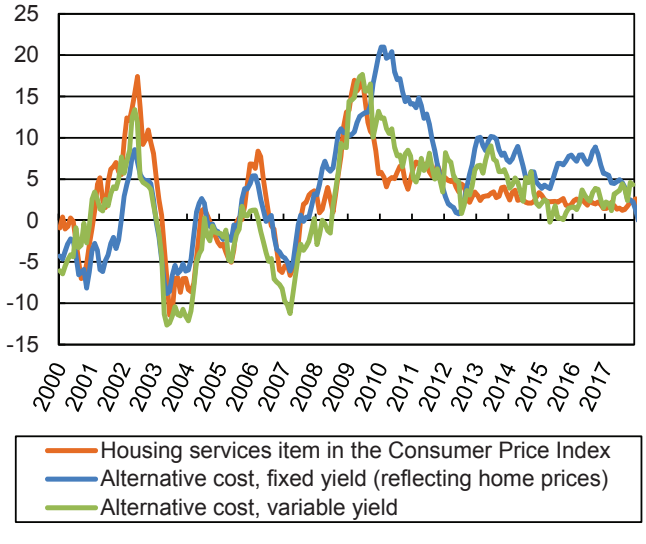
market and average prices of owner-occupied housing while focusing on apartments with 3.5-4 rooms, based on the assumption that they reflect the typical home in the economy. The data are available on a quarterly basis and are segmented according to size of apartment and region. In order to obtain the alternative yield, *r*, we calculated the average of the rent to price ratio in various regions. Figure 1 presents the resulting yield and it shows a downward trend starting from 2002. The decline in yields reduces the costs to households, both indirectly by way of reduced alternative costs and also directly by way of reduced interest payments on a mortgage. Therefore, we expect that the use of a variable yield will offset, at least partially, the rise in the price of housing services as a result of the increase in home prices.

Figure 2 presents the owner-occupied housing services component according to the CBS's measurement and according to estimates of the alternative cost. The rates of change in the estimate based on a fixed yield are identical to the rates of change in home prices and indeed the two indices deviate starting in mid-2009 when home prices started to rise faster than rents. In contrast, the estimate that uses variable yield is closer to the CBS measurement during this period, although differences between them can be seen.

Figure 3 presents the CPI published by the CBS and the two price indices in which the owner-occupied housing component is calculated according to the alternative cost of home ownership. It appears that the two alternative indices behave in a similar manner to the CBS index, and the index based on variable yield tracks it more closely. Clearly the differences in this Figure are smaller than those in Figure 2, as the owner-occupied housing services component receives only a partial weight (16.0 to 19.4 percent) in the CPI.

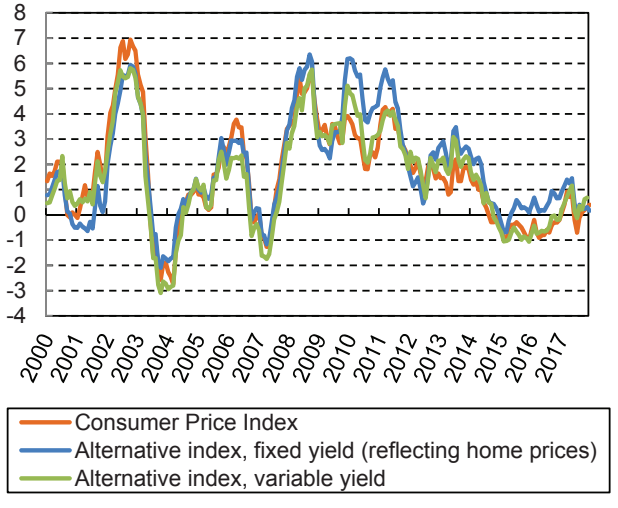
As can be seen, until 2008 the indices were quite similar although home prices started to climb sharply already at the beginning of that year. The indices deviated from one another only starting in the fourth

Figure 2
Owner-Occupied Housing Services Item and Estimated Alternative Cost of Owning a Dwelling by Fixed Yield and Variable Yield, January 2000 to December 2017 (annual rate of change)



SOURCE: Based on Central Bureau of Statistics.

Figure 3
The Consumer Price Index and Indices that Include Imputation of the Alternative Cost of Maintaining a Dwelling by Fixed Yield and Variable Yield Instead of Housing Services, January 2000 to December 2017 (annual rate of change)



SOURCE: Based on Central Bureau of Statistics.

quarter of 2009, since until then rent—the variable measured for the owner-occupied housing component—also rose sharply. Thus, from December 2007 until September 2009, rent rose by 11.4 percent annually and home prices rose by 13.7 percent annually. At the end of 2009, the rise in rents moderated while the rise in home prices accelerated and the alternative indices begin to show a higher rate of increase than that indicated by the CBS index. The rate of change in the index calculated according to variable yield returned to the vicinity of the CBS index already in June 2010, following a relatively sharp decline in the yield on housing (Figure 1) while in the case of the index calculated according to fixed yield the deviations continued for about two years. During those two years, home prices rose at an annual rate of about 16 percent, while rents rose at an annual rate of about 6 percent (Figure 2), a difference of about 10 percentage points in the measurement of the owner-occupied housing component which is manifested in a gap of about 1.7 percent in the measurement of the CPI (Figure 3). It can also be seen that from 2015 until mid-2017, the index calculated according to fixed yield again rises faster than the CBS index and the index based on variable yield.

When holding the yield fixed, we obtained higher inflation (by 0.7 percentage points on average per year) than that actually measured during the past decade. This is because home prices rose relative to rents. However, inflation still shows a downward trend starting from 2011, with inflation during the past three and a half years generally below the lower bound of the inflation target range and even negative during part of the period. When using a variable yield, we obtained an estimate whose value was very close to the actual inflation figure (average annual inflation was 0.1 percentage points higher than actual inflation) and in particular it is worth mentioning that we obtained negative inflation for recent years.

Since we believe that the index based on variable yield produces a better estimate for the owner-occupied housing services component measured using the old method, it is possible to conclude that the change in method of measurement did not significantly affect inflation as measured by the CPI, apart from a short period between 2009 and 2010. In particular, it is important to mention that the negative inflation in 2015–16 would have been obtained also without the change in the method of measurement.

5. Measurement of the owner-occupied housing services component in the OECD countries

Table 1 presents the methods of measuring the owner-occupied housing services component used in the OECD countries. The table is constructed on the basis of OECD and IMF publications. There remained doubts as to the method used by Ireland and New Zealand and in those cases we made use of publications of the local bureaus of statistics. The sources for the data are listed in the notes to the table.

The table shows that close to half of the countries (15 out of 35) do not include the owner-occupied housing services component in the CPI. In all of these countries, the CPI includes a housing component, but it represents the expenditure of renters rather than owners. Furthermore, most of the countries (15 out of 20) that include the owner-occupied housing services component in the CPI employ the use approach, and of those the majority (10 out of 15) use rental equivalence. Finally, only two countries use the payments approach and only three the acquisitions approach. Israel uses the rental equivalence method and therefore is counted among the majority of the OECD countries that has chosen to include the owner-occupied housing component in the CPI.

Table 1
The method of measuring the owner-occupied housing services component in the OECD countries

Country	Use					
	Rental equivalence	User Cost	Other	Payments	Net Acquisitions	Not included
Australia[1,2]					✓	
Austria[1,2]				✓		
Belgium[1]						✓
Canada[1,2]		✓				
Chile[1,2]						✓
Czech Republic[1,2]			✓			
Denmark[1,2]	✓					
Estonia[1,2]						✓
Finland[1,2]					✓	
France[1,2]						✓
Germany[1,2]	✓					
Greece[1,2]						✓
Holland[1,2]	✓					
Hungary[1,2]						✓
Iceland[1,2]		✓				
Ireland[1,2,3]				✓		
Israel[1,2]	✓					
Italy[1,2]						✓
Japan[1,2]	✓					
Korea[1,2]						✓
Latvia[1,2]						✓
Luxembourg[1,2]						✓
Mexico[1,2]	✓					
New Zealand[1,4]					✓	
Norway[1,2]	✓					
Poland[1,2]						✓
Portugal[1,2]						✓
Slovakia[1,2]			✓			
Slovenia[1]						✓
Spain[1,2]						✓
Sweden[1,2]		✓				
Switzerland[1,2]	✓					
Turkey[1,2]						✓
UK[1,2]	✓					
US[1,2]	✓					
Total	10	3	2	2	3	15

[1] Main Economic Indicators, Sources and Definitions, Consumer Price Index OECD (click on the information icon beside the name of the country).
[2] IMF, Dissemination Standards Bulletin Board.
[3] The Central Bureau of Statistics of Ireland, Consumer Price Index, Introduction of Updated Series, Section 7.3.
[4] The Central Bureau of Statistics of New Zealand, Home Ownership in the Consumer Price Index.

6. Conclusion

In view of the increase in home prices in Israel during the last decade, we examined the effect on the CPI if the CBS had measured the owner-occupied housing services component using home prices rather than rents.

The analysis we carried out showed that estimating the owner-occupied housing services component using home prices will result in an inflation rate over the past decade that is higher than was actually measured. However, a downward trend can still be seen starting from 2011, with inflation during the last three and a half years generally below the lower bound of the inflation target range and even negative during part of the period. When the component is estimated using home prices while assuming that yield varies over time, the estimate for inflation that is obtained is very close to the actual inflation figure, and in recent years negative inflation is generated. Since we believe that the index that uses variable yield produces a better estimate for the owner-occupied housing services component that was measured using the old method, there is a basis for concluding that the change in the method of measurement did not significantly affect the level of inflation as measured by the CPI. In particular, it is important to mention that the negative inflation during 2015–16 would have been obtained even without the change.

In addition to this analysis, we presented the methods for measuring the component according to international statistical standards and reviewed the practices in the OECD countries. We found that the practice in Israel meets international standards and is line with the practice in other countries that include the component in the CPI.

Appendix 1
The method of calculating the CPI that includes alternative components to the owner-occupied housing services component

In Section 4, we compared the CBS index to two indices that measure the owner-occupied housing services component differently. We calculated the alternative indices in two stages:

1. We calculated the CPI without the owner-occupied housing services component:

$$CPI_{ex.OOH} = \frac{CPI - CPI_{OOH} \times w_{OOH}}{1 - w_{OOH}}$$

where $CPI_{ex.OOH}$ is the index without the owner-occupied housing services component, CPI is the overall index published by the CBS, CPI_{OOH} is the owner-occupied housing services component published by the CBS and w_{OOH} is the weight given by the CBS to the owner-occupied housing services component.

2. We calculated the weighted average of the partial index and of the alternative component to the owner-occupied housing services component:

$$CPI_{alt} = CPI_{ex.OOH} \times (1 - w_{OOH}) + CPI_{OOH,alt} \times w_{OOH}$$

where CPI_{alt} is the alternative index and $CPI_{OOH,alt}$ is the alternative component to the owner-occupied housing services component (the hedonic index of the CBS for home prices multiplied by the alternative yield, whether fixed or variable).

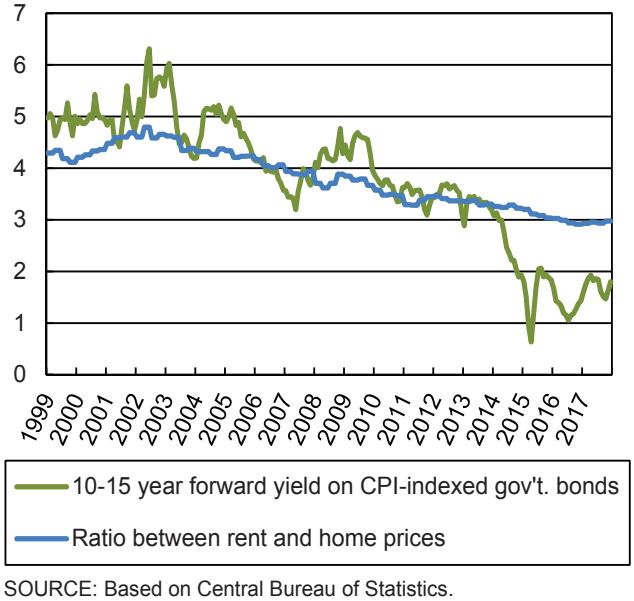
In the month previous to the date on which the CBS updates its weights (once every two years), the bases for all the indices were rescaled, as is the practice in the CBS. The updating of the bases prevents giving excessive weight to components that have grown faster than others.

Appendix 2
Use of yields from the capital market for estimating the alternative cost of owning a home

In Section 4, we used the ratio between rent and the price of homes as an estimator of variable yield, denoted by *r*. In this section, we will examine the sensitivity of the estimator of the CPI to the use of yield taken from the capital market. The relevant yield is the long-term real yield and we chose to use the forward yield for 10 to 15 years on CPI-indexed government bonds. Figure A.2.1 presents the yields over time. It should be mentioned that the ratio of rent to home prices is measured quarterly and therefore in the graph it is fixed within each quarter. It appears that the two yields are quite similar during most of the period and only at the end—when yields fell in the capital markets of advanced economies—do they diverge. Nonetheless, the forward yield is much more volatile and this is expected to also influence the estimators of the CPI. For example, the forward yield declined from about 3 percent in 2014 to 1 percent in 2015 and this will lead to a decline of about 67 percent in the owner-occupied housing services component and about 13 percent in the overall CPI.

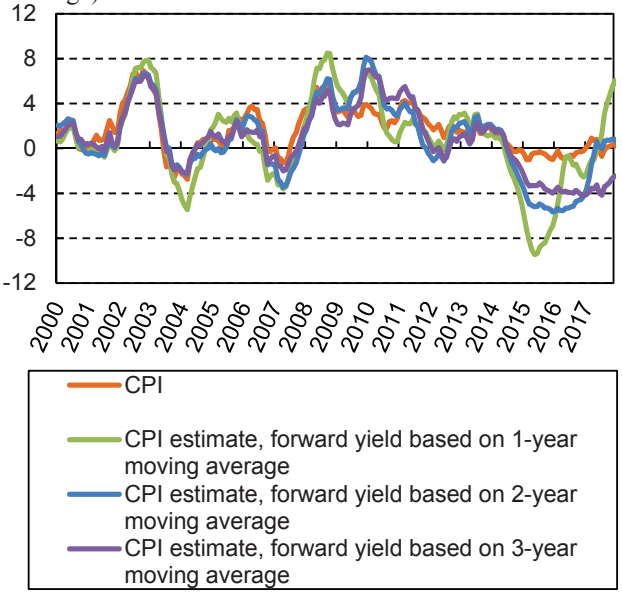
In order to smooth out the fluctuations, we chose to use moving averages of the forward yield for one, two and three years. Figure A.2.2 presents the estimates of the CPI. The graph shows that even after smoothing, there is significant volatility in the CPI, particularly after 2008. In our assessment, it is likely that the excess volatility would rule out the use of yields from the capital market in the calculation of the CPI.

Figure A.2.1
Alternative Yield of Residence in an Owner-Occupied Dwelling, Ratio of Annual Rent to Home Prices and Forward Yield to 10–15 Years of CPI-Indexed Government Bonds, January 1999 to December 2017 (percent)



SOURCE: Based on Central Bureau of Statistics.

Figure A.2.2
CPI and CPI including the alternative cost of owning a home calculated using the 10–15 year forward yield on CPI-indexed government bonds, January 2000 to December 2017 (annual rate of change)



SOURCE: Based on Central Bureau of Statistics.

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GETTING TO WORK BY PUBLIC TRANSPORTATION FROM VARIOUS LOCALITIES IN ISRAEL: RELATIVE ACCESSIBILITY INDEX[1]

- About 60 percent of workers in Israel are employed outside their home locality. Of those, two-thirds get to their job locality with a private car, about 20 percent by public transit, and about 10 percent via organized transport (hereafter: shuttles) provided by their employers.
- There are clear differences between the localities in Israel in terms of work opportunities that can be accessed by public transport relative to those accessible by private car. An analysis of this variance in relative accessibility can help in the sustainable development of infrastructure.
- The more distant home localities are from the metropolis, the less relative accessibility there is.
- In most peripheral localities, and particularly in Arab localities, relative accessibility is low due to the limited supply of public transit. In the small Jewish localities in the periphery, accessibility is low, but higher socioeconomic levels may indicate that, taking into account the level of public transit that can be provided to them, the low accessibility is due to residents' preference for using private cars. In ultra-Orthodox cities and localities, accessibility is relatively high.
- In most localities with a low socioeconomic level, particularly in the Arab sector, relative accessibility is low and is accompanied by the prevalence of employers' shuttles. This mode is efficient in the sense of distance covered in a given time. However, the absence of transport alternatives decreases employment opportunities available to the residents and makes them dependent on a few employers.

Introduction

Israel's economy suffers from overdependence on private cars due to infrastructure limitations and inefficient public transportation. This issue has been raised for discussion in many contexts in recent years, including increasing productivity in the business sector, expanding the housing supply (investment in a transportation infrastructure that will provide accessibility to inexpensive housing areas and create an alternative for the areas in high demand), a reduction in urban density and congestion on the roads, and a reduction in air pollution.[2]

Macro level analyses usually trace the relationship between the percentage of employees using public transport and the percentage using a private car. More detailed research focusing on the development of sustainable transport systems builds more sensitive accessibility indices with the help of high-resolution GIS data, by taking into account directions and time of travel, the characteristics of alternative routes, and spatial variation. These indices have been implemented in urban transport analyses (Benenson et al., 2010), in international comparisons (Kawabata and Shen, 2006), in monitoring changes in accessibility (Kwok & Yeh, 2004), in an analysis of geographical coefficients of differences in the accessibility of public transport and socioeconomic gaps (Vieira & Haddad, 2012), and in a discussion of the social aspect of existing

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[2] The Knesset Research and Information Center (2009), *Public Transport in Israel – The State of Affairs and Ways of Improving It; OECD Economic Survey 2014, page 31; OECD Economic Survey 2016 page 27;* Bank of Israel (2018), *Annual Report 2017,* Chapter 2.

accessibility differences between towns in the periphery from the viewpoint of populations with no access to a car (Currie, 2010).

In this study we calculate an index of the accessibility of workplaces by using public transport relative to the accessibility by a car, examine how this relative accessibility is distributed geographically, and characterize the prominent patterns of transportation use. We use the social surveys of 2014–16 conducted by the Central Bureau of Statistics which provide data on work-purposed trips, such as home and job localities and travel times.

Table 1 shows how employees in Israel are distributed according to their mode of transport and average travel times. It is based on the 2016 Social Survey.

Table 1
Modal split of employees in work-purposed trips and the average travel times

Transport mode	Share of employees using that mode(%)[1]			Travel time (minutes)[2]		
	Total	Inside the locality	Outside the locality	Total	Inside the locality	Outside the locality
Private car	60.7	21.7	39.00	26.4 [12.3]	13.9 [10.9]	33.3 [12.5]
Bus	17.5	7.8	9.8	41.7 [15.0]	27.6 [13.0]	53.1 [13.0]
Train	3.4	0.3	3.1	65.9 [13.0]	31.4 [12.5]	68.8 [12.9]
Shuttles arranged by the employer	7.8	1.7	6.0	36.2 [12.7]	15.9 [11.3]	41.8 [12.7]
Bicycle	1.7	1.3	0.3	13.5 [3.7]	11.8 [3.0]	20.1 [3.8]
Walking	7.6	7.2	0.4	11.2 [3.2]	10.8 [3.0]	18.5 [3.5]
Other	1.3	0.6	0.7	31.3 [13.6]	22.8 [9.6]	37.7 [14.6]

[1] Of all employees who reported their mode of travel to the workplace, excluding those who reported that they work from home.
[2] The average travel times are calculated on the basis of travel times within time frames in the survey questionnaire, on the assumption that the travel times in each range are uniformly distributed. In square brackets—standard deviations calculated using the bootstrap method.

Source: Based on the 2016 Social Survey and Google Maps.

In addition to Table 1, Table 2 provides estimated average distances between home and job localities traveled by the employees, based on Google Maps distances between the home and job locality recorded for each interviewee in the 2016 Social Survey. As Panel A shows, the employees travel a similar average distance—18 to 19 kilometers—whether they use a private car or public transport. However, for a given time frame (Panel B), say 30 minutes, greater distances are covered by car. The table also shows that on average, distances covered by shuttle are greater than those covered by car or public transport. Panel C shows that relatively long trips by shuttle are prevalent in localities that make intense use of this mode. The analysis that follows shows that such intensive use is common in peripheral localities with a low socioeconomic level and little public transport supply.

Table 2
The average distance (in kilometers)[1] traveled to work in Israel, by transport mode

Panel A: The average distance, total and by gender			
Transport mode t[2]	Total	Men	Women
Private car	17.7 [1.5]	18.4 [1.6]	16.9 [1.2]
Public transport (bus)	18.7 [1.6]	21.3 [1.7]	18.2 [1.5]
Shuttle	24.5 1.6	28.3 [1.7]	23.0 [1.3]
Panel B: The average distance in a given time frame			
Modes of transport	Up to 30 min.	Up to 60 min.	Up to 90 min.
Private car	11.3 [1.2]	18.7 [1.3]	21.7 [1.4]
Public transport (bus)	7.3 [1.1]	15.7 [1.3]	19.6 [1.4]
Shuttle	10.0 [1.2]	24.1 [1.5]	29.6 [1.6]
Panel C: The average distance traveled by shuttle, by intensity of shuttle use in a locality			
Percentage of shuttle users (of all those reporting in the locality)			
Up to 2%	[7.6]	19.3	
2%-14%	[6.3]	19.5	
14%-32%	[8.6]	24.7	
> 32%	[10.0]	37.0	

[1] In square brackets—the standard deviation of the average distances.
[2] Some of the interviewees replied that they go to work on foot, by bicycle, or in some other way. For these cases it is impossible to calculate average distances with Google Maps since there is no data on the origin and destination points in the locality.
Source: Based on the 2016 Social Survey and Google Maps.

Relative Accessibility Index

Accessibility in individual localities

Accessibility indices in the literature are based on travel distances or on travel times. We base our study on travel times (reported in the survey) because the data on distance, measured between localities` centers, may smooth differences in intra-locality accessibility[3], and the characteristics of the route (for example, walking pace, the time to exit the parking lot at home, and the time it takes to park at the destination) remain unknown. In contrast, reported travel times do reflect unobservable elements of the trip, such as the time to access the transport station or parking lot, the waiting time for mode of transport, the times of leaving for work, and the time lost in traffic jams. However, due to the limitations of the index data on this work, only the actual accessibility among employees is reflected and not the potential travel times of, for example, those who have passed up work in another locality due to low accessibility.
In order to quantify the relative accessibility in a given home locality, we calculated the ratio between (1)

[3] For example, individuals who choose to work in a neighboring locality may also live on the border between it and the home locality.

the number of job opportunities that can be reached from it within a reasonable time using public transport[4] and (2) the number of job opportunities that can be reached from it within a reasonable time by private car. The number of job opportunities for each home locality is evaluated basing on the distribution of work-trip destinations reached from this locality by car, bus, and train, as represented by the social survey sample, weighted by the time-dependent intensity of travel between each pair of home and job localities.[5] Details of the calculation may be found in the appendix. The lower the value of the index, the lower the number of workplaces that can be reached by public transportation relative to the number of places that can be reached by private car. For example, a relative accessibility of 0.1 in a certain locality means there are one-tenth of the number of workplaces that an employee can reach within a reasonable time by public transportation compared to with a car; a relative accessibility of 1 means equal access to workplaces by public transportation and by car.

The use of a relative as opposed to an absolute index allows us to control for the location of the locality: a resident of a remote locality apparently has few employment opportunities, but the relative investigation focuses on employment options that public transportation provides given the geographical location.

To characterize the accessibility of public transport at home locality i we use data on job localities actually being traveled to by public transport from it, the travel times, and the number of workplaces at each destination, as recorded by the 2014, 2015 and 2016 Social Surveys. We consider only localities from which at least five residents were sampled traveling to work by private car, public or shuttle transportation. Since the sample is limited in size, even when we combine the data from the three surveys, we are left with 350 out of 1,215 localities in Israel, but these account for 92 percent of the population. Nonetheless, an issue of under-represented trips in small localities remains and may lead to unreliable estimates. In what follows we therefore conduct our discussion on groups of localities, taking advantage of more robust results.[6] Our calculations show, among other things, that the intensity of travel between home and job localities is more sensitive to the travel time for public transport mode than for a car mode, and this also has an effect on the relative accessibility.

It should be noted that the index does not focus on the question of the time it takes to get to a particular workplace by public transportation relative to the time it takes to get to it by private car. It allows for higher relative accessibility to be expressed when the public transportation makes it possible to reach many workplaces, even if these are different from the workplaces customarily reached by private car.

Table 3 shows the distribution of employees in Israel by ranges of relative accessibility and reflects a significant difference between the localities. Figure 1 shows the geographical distribution on a map that emphasizes that localities characterized by low accessibility are concentrated in the periphery on the perimeter of the Gush Dan region.

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4 The localities the travel time to which was examined from each home locality and the travel times by all modes of transport were sampled based on the Social Survey data. Later and in Appendix 1, we explain how we calculated the extent to which the travel affected the probability of working in a certain locality.

5 See, for example, Simma & Axhausen K.W. (2003) and Levinson (1998). This method is based, for example, on an assessment of the probability that an individual (the employee) will travel from the home locality to the job locality and we use it to obtain a national picture. The method is not used by transportation planners in a specific area.
Cambridge Systemics (2008), Tel Aviv Activity Schedule Travel Demand System: A Tour-Based Approach, prepared for Israel Ministry of Transport.

6 The relative accessibility in the cluster was calculated by summing the total accessibility by public transport and the total accessibility by car over all localities entering the cluster and not by averaging the individual accessibility indices.

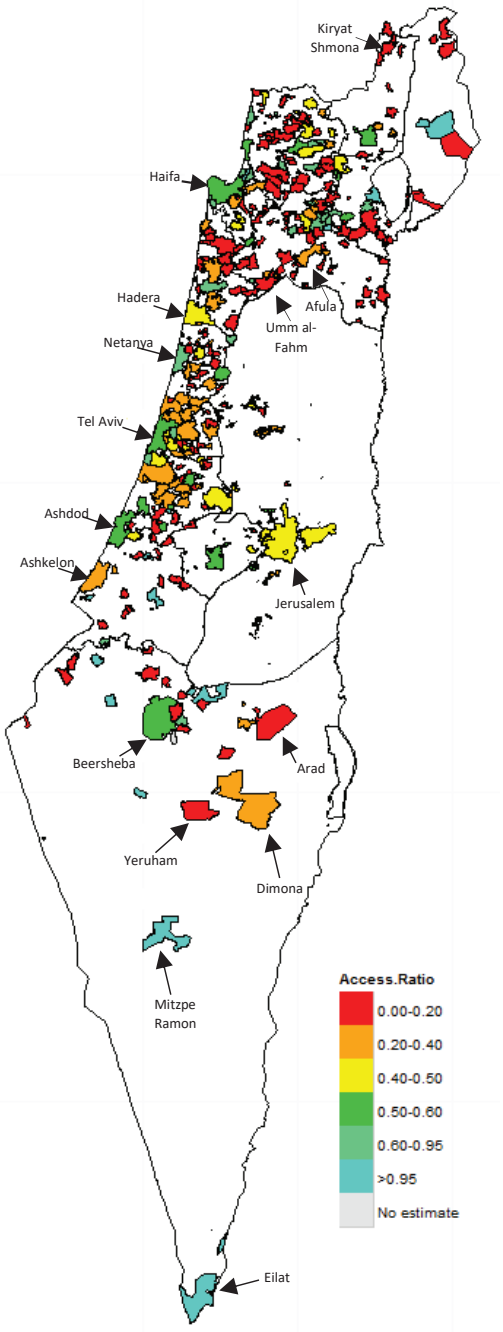
Table 3
Share of employees by the relative accessibility values[1]

Relative accessibility	Number of localities	(%) Share of employees
0.00-0.10	55	5.5
0.10-0.20	20	4.4
0.20-0.30	31	8.4
0.30-0.40	25	15.1
0.40-0.50	25	21.3
0.50-0.60	25	19.1
0.60-0.80	23	9.8
0.80-1.00	7	1.4
>1	18	3.0
Only private car	120	5.6
Not estimated	866	8.2

[1] As previously stated, we calculated the index only on the basis of home localities from which at least five residents were sampled who travel to work by public transport or by private car (excluding pedestrians and bicyclists). As a result of this filtering and also because many localities were not sampled in the survey, our assessments include only 350 of 1,215 localities in Israel, but these represent 92% of the entire population.
Source: Based on the 2014–16 Social Survey.

According to this calculation, the relative accessibility of public transport does not exceed 0.5 for 60.4 percent of employees in Israel. We note that according to the findings in the literature, the scale of accessibility indices is apparently sensitive to the detailed data; the accessibility differences increase as the geographical resolution and travel characteristics taken into account increase (for example, peak times and connections and transfers between the types of public transport; see Benenson et al., 2010).

Figure 1
The geographical distribution of the relative accessibility index



Source: The Social Survey conducted by the Central Bureau of Statistics for 2014-2016.

Accessibility in clusters of localities: notable patterns

The comparative analysis we have presented until now does not take account of shuttles provided by employers, but in some of the localities they are used more than public transport. In order to account for both transport modes and to identify notable use patterns, we divided the population of employees into three equal parts (weighted by population size of the localities) corresponding to the intervals of relative accessibility (0-0.296, 0.296-0.509 and greater than 0.509) and shares of shuttle users in the locality (0–2 percent, 2–7 percent, greater than 7 percent).

Consequently, five patterns are discerned (in parentheses—the percentage of employees belonging to each group):

None (19.7 percent) – Localities with a relative accessibility below 0.296 and the share of shuttle users below 2 percent. In this group, work trips are mainly conducted by private car outside the home locality.

Shuttle (11.2 percent) – Localities with a relative accessibility below 0.296 and the share of shuttle users above 7 percent. In this case we get an indication that employers who provide the shuttles have market power, and is the result of, among other things, inefficient public transport.

PT (9.2 percent) – Localities with a relative accessibility above 0.509 and the share of shuttle users of 2 percent and less.

Both (12 percent) – Localities with a relative accessibility above 0.509 and the share of shuttle users above 7 percent. This pattern indicates transport alternatives to the employers' shuttle.

Non-clustered (48 percent) – The remaining localities.

Figure 2 shows the five patterns according to regions. As is apparent, the *Shuttle* pattern is strongly represented in Arab localities (especially in the northern region) and the *None* pattern is strongly represented in small Jewish (non-ultra-religious) localities. Table 5 shows these phenomena quantitatively.

Figure 2
Relative accessibility patterns and the use of shuttle transportation, by region

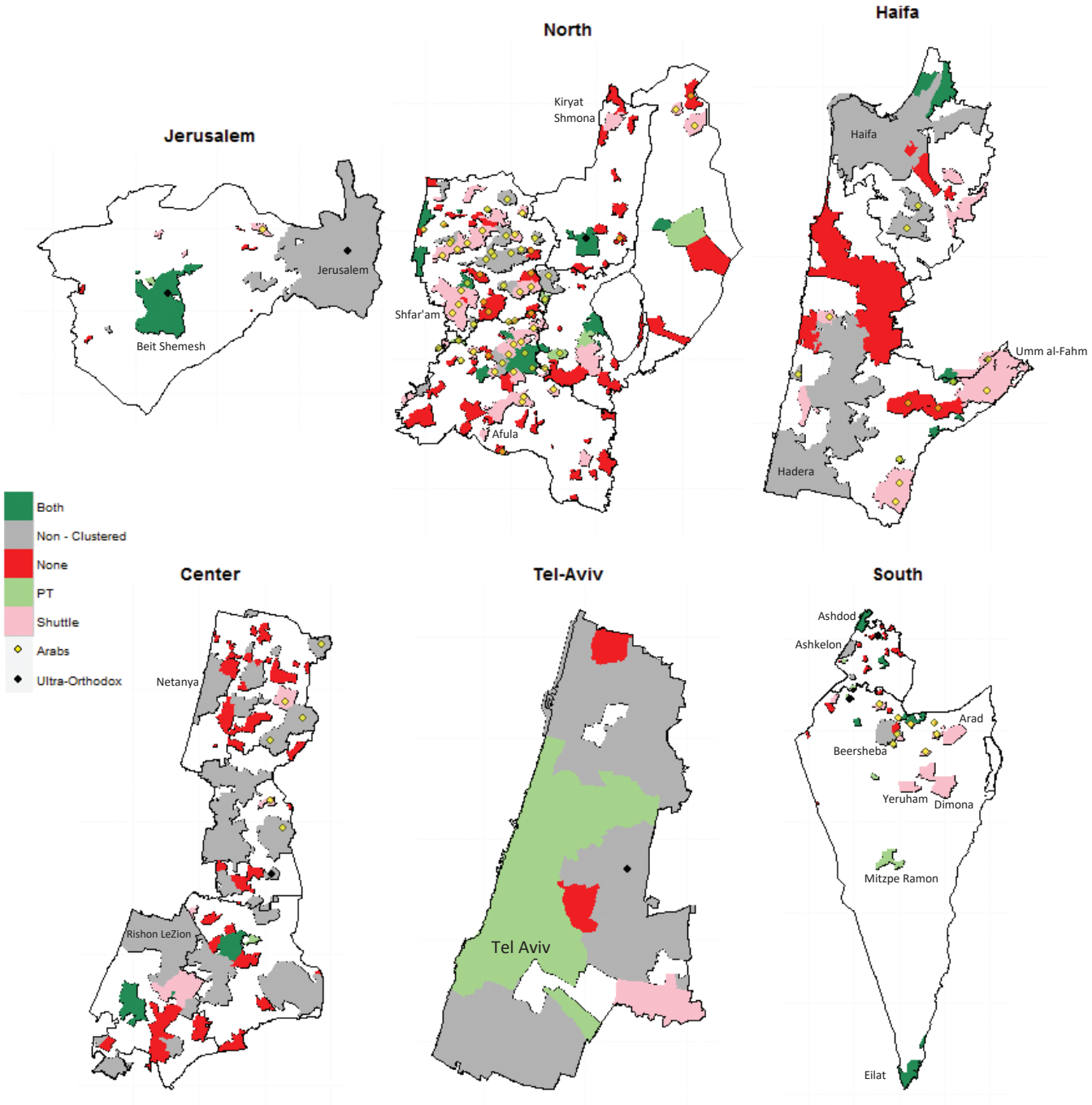


Table 4 presents additional characteristics of the patterns defined above, calculated with respect to all the residents in the localities (apart from the share of employees working in their home-locality). These provide indicators of the supply of transportation services (the number of bus stops for an area, bus and train access, satisfaction with public transport[7]), the standard of living, and the economic situation (the percentage of households with per capita income of more than NIS 4,000), and satisfaction with the region lived in.

Table 4
Patterns of transport use for work-trips, by travel profile, socioeconomic level[1], and the public transport service in the localities

Patterns of transport use	Share of employees in the age group 25–65	Percentage of employees working in the home-locality	The satisfaction[2] from: (% of all respondents in the (locality				Percentage of households with per capita income greater than NIS 4,000[1]	The number of bus stops[4] (normalized in the area of (the locality
			The efficiency of public transport in the locality	Residential area	Proximity to a railway station	Proximity to a bus stop		
None (19.7)	80.1	22.9	2.3	90.1	6.7	7.9	44.8	6.1
PT (9.2)	82.9	57.4	10.2	91.2	10.8	30.0	47.8	25.5
Shuttle (11.2)	63.9	33.8	7.4	78.2	3.8	13.3	20.1	8.5
Both (12)	70.4	53.7	7.7	77.5	7.1	21.1	22.7	11.2
Non-clustered (48)	78.7	39.7	9.4	84.6	9.0	24.0	38.7	11.1
Total	75.9	41.0	8.9	83.7	8.0	21.2	29.9	11.4

[1] The official socioeconomic index of the Central Bureau of Statistics is not available for some of the localities surveyed and therefore we use the percentage of households with per capita income greater than NIS 4,000—the highest income category in the survey questionnaire.
[2] Satisfaction with the efficiency of the transport in the locality and in proximity to where they live relates to all the interviewees (and not only to the employees) and is calculated on the basis of the percentage testifying to the highest grade out of 4.
[3] In parentheses—the percentage of employees living in localities with this pattern
[4] Calculated on the basis of the data provided by the Ministry of Transport on buses in the locality
Source: Based on the 2014–16 Social Survey.

Table 4 shows the groups *None* and *Shuttle* are characterized by high travel rates outside the locality (77 percent and 66 percent, respectively) and a relatively low level of public transport services (according to the number of bus stops per unit area, bus and rail access, and the efficiency index). However, these groups differ in their socioeconomic characteristics. The *None* group includes for the most part small Jewish (non-ultra-Orthodox) localities with a high socioeconomic level[8] (according to the satisfaction with the region and the percentage of households with per capita income of more than NIS 4,000), and the low use of public transport may reflect consumers' preferences. In contrast, the low accessibility indices in the *Shuttle* group presumably reflect limited public transport. So it is reasonable to assume that the shuttles replace it—in other words, the employers take upon themselves the responsibility to provide transportation for their workers.

7 The interviewees were asked to grade to what extent they agreed with the sentence "It is possible to reach the destination point from where I live in a reasonable time by public transport" on a scale with values between 1 and 4. We examined which percentage of them gave the highest grade.

8 Table 5 shows in detail that the group also includes Arab localities (14.4 percent of the population of the localities in the group). These are characterized by a low socioeconomic level and 12 of them are in the northern district.

The localities in the *PT* group are characterized by a higher socioeconomic level and above-average transport supply. Table 4 also shows a higher percentage of employees working inside these localities. In the *Both* group the socioeconomic indicators are lower and there is overrepresentation of ultra-Orthodox employees (10.5 percent, while the average is 7.5 percent; these figures are not represented in the table). Table 5 presents geographical distribution of defined patterns. Panels A and B show that the metropolitan cities have greater relative accessibility (0.4–0.8) than the satellites[9] (0.3–0.5), a well-known phenomenon from studies in transport geography. Notice also intensive shuttle use recorded for Haifa and Jerusalem satellites (11.1 percent and 7.4 percent, respectively).

Table 5
Patterns of getting to work according to regions

Locality groupings	Average relative accessibility index	Characteristic travel patterns	Representation of travel patterns[1] in the locality groupings
Panel A: Metropolises and large cities			
Jerusalem Haifa Tel Aviv Beersheba	0.50 0.59 0.54 0.50	*PT*	Irrelevant
Rishon LeTzion Petah Tikva Ashdod Netanya	0.39 0.36 0.59 0.76	*Both*	Irrelevant
Panel B: Satellite towns[2]			
Tel Aviv area	0.39	*Shuttle* *None*	4.1% 6.7%
Jerusalem area	0.28	*Both* *None* *Shuttle*	31.6% 22.2% 9.1%
Haifa area	0.49	*Both* *Shuttle* *None*	26.9% 9.0% 4.9%
Panel C: Periphery towns			
Jewish localities in the periphery with 20,000–100,000 residents and less than 10% ultra-Orthodox	0.36	*Both* *Shuttle* *None*	19.90% 16.20% 2.90%
Arab localities	0.25	*Shuttle* *None* *PT* *Both*	48.8% 14.0% 4.5% 2.6%
Small, non-ultra-Orthodox Jewish localities (up to 20,000 residents with less than 10% ultra-Orthodox)	0.21	*None* *PT* *Shuttle* *Both*	66.6% 8.5% 7.7% 2.6%
Panel D: Ultra-Orthodox towns and localities			
9 towns and localities with more than 25% ultra-Orthodox	0.60	*Both* *PT* *None*	48.7% 8.2% 1.2%

[1] In terms of the percentage of employees living in the localities grouping; the *Non-clustered* pattern is not represented and brings the grouping up to 100%.
[2] According to the Central Bureau of Statistics definition of "satellite towns" in the "metropolises in Israel" group.
Source: Based on the 2014–16 Social Survey.

9 According to Central Bureau of Statistics definitions.

Relative accessibility across the periphery is low. In the northern district it reaches an average of 0.26; about half of the localities are Arab communities (61 of 128) and their relative accessibility index averages only 0.23. On the other hand, the percentage of use of employers' shuttles in the area is particularly high: 16.7 percent on average and 18.2 percent in Arab localities. The Wadi Ara localities (these are Arab localities in the Hadera sub-district, and include (among others) Umm Al-Fahm, Ma'ale Iron, Baqa Al-Gharbiyye, Kafar Qara, Basma, Jatt and Ar'ara) are prominent in the Haifa district: the relative accessibility there is lower and accompanied by intensive use of shuttles to the workplace. The *Shuttle* pattern is also particularly common in the Negev area.

Panel C shows that the relative accessibility in Arab localities is low (0.25 percent) and around half of them (48.8 percent) are characterized by a travel pattern dominated by employers' shuttles. Figures 1 and 2 demonstrate that the localities of this sector suffer from low relative accessibility in all the districts.

Panel D shows very low relative accessibility (0.21 on average) in small Jewish (non-ultra-Orthodox) localities characterized by a *None* pattern (the prevalent pattern in localities populated by 67 percent of the residents in localities such as these). As Table 4 shows, most of these localities are small community villages with a high standard of living and great satisfaction with the area lived in. It can be assessed that the little use of public transport may stem from consumers' preferences or in other words, given the size of these localities and their locations, the level of service that can be provided to them at a reasonable cost is considerably lower than the level that will cause residents with a high income to use it to a considerable extent.

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The findings show that in the geographical periphery, mainly in the northern and southern districts, there is marked dependence on shuttles provided by the large employers. The development of efficient public transport in these localities would expand employment opportunities and help reduce dependence on the large employers in their proximity. However, it should be noted that employers' shuttles have an advantage due to their efficiency in the sense of distance coverage, travel times, and cost to users. An additional advantage is that the authorities can cooperate with the employers in order to manage the demand for public transport, as is done in various metropolises worldwide.[10]

The finding that there is a comprehensive shuttle system in the Arab localities weakens the argument that it is difficult to provide them with effective public transport due to urban planning and the topographical structure characteristic of them. There is room to deepen our acquaintance with the shuttle system since it can help in the planning of effective public transport for the Arab localities while striking a balance between current employment needs and the desire to expand employment opportunities.

[10] For example, in Washington State in the United States, a law was enacted in 1991 on the management of the demand for transportation, and Section 13 in it sets out various requirements of employers.
http://lawfilesext.leg.wa.gov/biennium/1991-92/Pdf/Bills/Session%20Laws/House/1671-S2.SL.pdf?cite=1991%20c%20202%20%C2%A7%2010

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Appendix: Explanation of the calculation of the relative accessibility index

Equation 1 shows how we calculated the accessibility level of a given mode of transport in locality i (the mode parameter in the following formula can represent public transport $A_i^{(PT)}$ or a private car $A_i^{(car)}$):

$$A_i^{(\mathrm{mod}\,e)} = \sum_{j \in D^{(\mathrm{mod}\,e)}} L_j f^{(\mathrm{mod}\,e)}(t_{ij}) \qquad (1)$$

Where:

$A_i^{(\mathrm{mod}e)}$ – accessibility of public transport (mode=PT) or private car (mode=car) in locality i;
L_j – the number of work opportunities in destination j (in terms of employment size).
$D^{(\mathrm{mode})}$ – destinations accessible from home-locality i;
$f(t_{ij})$ – weights that follow an impendence function f(t) negatively depending on travel time between localities i and j.
The impendence function $f(t) = \exp(\alpha t)$ expresses the intensity of work-trips between localities i and j,

while the parameter $\alpha < 0$ can be evaluated through the gravity equation:

$$\ln(M_{ij}) = c + \ln(Pop_i) + \ln(Pop_j) + \alpha \ln(\bar{t}_{ij}) + \varepsilon_{ij} \qquad (2)$$

For the sake of simplicity the mode parameter (public transport or private car) is omitted from (2), which was estimated for each mode separately.[11]
The notations in (2) are as follows:
M_{ij} – the number of travelers from locality i to locality j (according to the survey);
Pop_i, Pop_j – the population sizes of the home and job localities (according to Central Bureau of Statistics data);
$\bar{t}_{ij}$ – average travel time (weighted according to the survey sample) from locality i to locality j;
c, α – parameters for statistical evaluation;
ε_{ij} – a random term

[11] This parameter can also be assigned by calibration, as was done in a study of the transport systems in Sao Paulo (Vieira& Haddad, 2012). In that study it was assigned $\alpha = -0.01154$ in order to ensure that travel times of 0 minutes and two hours receive weightings of 1 and 0.25, respectively.

Statistically significant parameters are obtained from the gravity equations: $\alpha = -0.0176$ for public transport and $\alpha = -0.0162$ for a private car.

Finally, we calculated the relative accessibility of public transport in locality i thus:

$$G_i = A_i^{(PT)} / A_i^{(car)} \qquad (3)$$

RISK SALIENCE AND MUTUAL FUND FLOWS: THE CASE OF THE EXCLAMATION MARK[1]

- In 2010, the Israel Securities Authority required that an exclamation mark in parentheses "(!)" be added to the names of some mutual funds, to highlight their inherent risk. Following this slight visual modification, the inflows to the marked funds dropped significantly, both in statistical and economic terms, relative to other mutual funds.
- This study shows that investor behavior may be affected, at least in the short term, by regulation focusing on information presentation, even if no restrictions or increased disclosure requirements are imposed on funds. The findings of this study are relevant to various regulatory reforms in Israel and beyond, specifically reforms that focus on marking with the aim of increasing public awareness of the risks that financial products represent.

Behavioral finance literature shows that changes in the presentation of information, and particularly an increase in the salience of specific information, play a significant role in investor decision making, due to behavioral biases and well known limitations such as limited attention. Evidence is, however, based mostly on laboratory studies, and it is not clear whether these effects reflect investors' real-life behaviors. Recent studies have been conducted to address this lacuna. This paper joins these efforts in examining how increased salience of a specific (rather than general) risk affected investors in the real world.

This research focuses on an Israeli regulatory reform that increased the salience of a specific risk related to mutual funds in Israel by requiring fund managers to add an exclamation mark ("!") to the names of mutual funds that hold a high share of low-rated and unrated bonds. Our research examines how this slight visual change affects the inflow of investments to these funds—that is, we examine the effect of the change in risk presentation on investor behavior. This regulatory change creates a unique opportunity to isolate the effect of presentation because modifications in information presentation usually accompany actual investment policy changes, or at least changes in the information available to investors, which was not the case in our setting. Moreover, whereas regulatory reforms typically affect an entire universe of investment vehicles, in the examined reform an exclamation mark was affixed only to the names of specific mutual funds. Comparable funds to which no exclamation point was added provide a unique control group.

Various studies on mutual fund decision-making found, among other things, that because search costs are high, investors tend to invest in highly salient funds, where saliency is due to the funds' association with a large management company or to extensive media coverage (Sirri and Tufano, 1998). Mutual funds understand the impact of such factors and respond strategically by increasing their marketing efforts (Kaniel and Parham, 2017). The literature also shows that mutual funds managed to attract investments by changing their names to reflect popular investment trends (Cooper, Gulen, and Rau, 2005). In contrast to studies that examine whether visibility-enhancing strategies help funds attract investments, we examine if investors are affected by a regulatory mandated change (rather than a change initiated by the funds)—the addition of a minor mark to the names of several funds in order to highlight a specific risk.

Financial regulation designed to protect consumers poses challenges in various countries (Campbell, 2016), including Israel (Mugerman, Sade, and Shayo, 2014; Tzur-Ilan, 2017; Sade and Haran Rosen, 2017).

[1] This paper was written by Nadav Steinberg based on a study in progress conducted by Zvi Weiner, Yevgeny Mugerman, and Nadav Steinberg.

In recent years, regulators around the world have taken considerable steps to simplify the disclosure of financial information, improve its accessibility, and facilitate investors' ability to compare financial products. Within these efforts, and in response to the growing awareness of the significance of information presentation, attention is increasingly directed to the presentation of financial information, and specifically to risk-related information. In several cases, exclamation points and other marks have been used to signify specific risks in investment products. A noteworthy case is the new European Key Investor Information Disclosure (KIID) regulations, which use a numerical indicator of risk and add an exclamation point to mark specific risks that the ordinary risk measurement methodology is unable to fully reflect. These regulations were examined in a survey-based study (IFF Research and YouGov, 2009) and provoked a public debate over the merits and limitations of the use of an exclamation point to mark specific risks. Our research on the addition of an exclamation point to specific mutual funds in Israel may provide important insights for regulators and financial product vendors worldwide.

The remainder of the paper proceeds as follows: We describe the regulatory reform, the data, and the methodology. We then evaluate the effect of the exclamation point addition on mutual fund inflows, and finally examine how the initial announcement of the reform affected investors and funds, with the aim of examining alternative explanations for the findings we present. In the concluding section, we summarize the findings and discuss their implications.

The Exclamation Point Reform

Like their global counterparts, mutual funds in Israel are an important investment vehicle, and they are used primarily by the general public. In late 2017, 1,437 mutual funds managed NIS 243 billion, representing 6.6 percent of the total financial assets of the public.

Mutual funds in Israel are regulated by the Israel Securities Authority (ISA). On March 1, 2010, the ISA issued a new directive to be implemented by the end of that month, which required mutual funds to add an exclamation mark to their names if their investment policy permitted them to hold non-investment grade bonds (unrated bonds, or bonds with a local credit rating below BBB) in excess of their maximum exposure to equity investments.[1] The new directive replaced a previous rule that required a monthly (ex-post) disclosure of holdings of high-yield bonds in excess of the maximum possible equity exposure on at least one day of the month. To the best of our knowledge, the ISA did not issue a campaign to accompany the new directive, although the reform was announced in a press release and was covered in several media, which possibly increased its visibility and directed investors' attention to the change in mutual funds' names.

[1] This directive supplemented the directives on the classification of funds and the presentation of their exposure to equities and to foreign currency that were already in place prior to March 2010, which add a number and Latin letter to the names of all the funds in Israel, to signify their maximum permitted exposure to equity instruments and foreign currency, respectively. Similarly to the exclamation point, these marks do not represent the overall risk of a fund but function as indicators of specific risks. The exclamation point differs from these markets in that the criterion for its addition is based on a relative rather than constant maximum exposure to high-yield bonds—relative to the fund's exposure to equity instruments. Therefore, two funds may have the same maximum exposure to high-yield bonds but only one of them is required to add an exclamation point to its name, due to the differences in the funds' maximum exposure to equity instruments.

The reform was reported in the announcement systems of the ISA and the Tel Aviv Stock Exchange (TASE) and in letters addressed to fund investors, but was not published in the press, which is a step that is required in other cases of changes to mutual fund names. By the end of March 2010, an exclamation point had been added to the names of 110 mutual funds. A unique feature of this reform is that it affected the presentation of the information only, that is, it did not add information that was not previously available to investors. There was no change in either the scope or quality of information available to the public relative to the pre-reform period, since:

(1) The mutual funds' investment policies had already been available to the public.

(2) The mutual funds' names had already included a number indicating the funds' maximum exposure to equities (and a letter marking the funds' maximum foreign currency exposure).

(3) The mutual funds' actual end-of-month holdings of each asset class had already been reported by all fund managers.

(4) Most importantly, the mutual fund managers were required to report to the public if their holdings in non-investment-grade bonds was in excess of their maximum stock exposure. Such reports made available, in concentrated form, the information that can be derived independently from (1) and (3) (investment policy and scope of holdings) or (2) and (3) (maximum exposure to shares and scope of holdings).

Moreover, according to indications that we obtained, the reform did not lead to a systematic change in the internal ratings that the banks awarded mutual funds.[2] Moreover, the proportion of mutual funds that added an exclamation point to their names and whose rating was downgraded in March 2010 did not exceed the proportion of mutual funds without an added exclamation point whose rating was downgraded. It therefore appears that the information that was used by financial advisors to direct customers to mutual funds was not affected by the addition of the exclamation point.

Data and method

We use proprietary daily inflow and outflow data for mutual funds for March 2010 (the month of in which the reform was implemented) and September 2009 (the month in which the draft reform was first introduced). Our March 2010 (September 2009) data consist of 25,278 (18,472) fund-day observations pertaining to 1,222 (1,115) actively managed mutual funds managed by 29 (33) management firms. We exclude extremely small funds and extreme observations (1 percent of each side of the distribution of the scaled net inflows).

To estimate the effect of the addition of an exclamation point to the names of specific mutual funds on their flows, we used the differences-in-differences methodology. The first difference is between funds that received the exclamation mark and those that did not receive the mark, and the second difference is between the days prior to and following the adoption of the exclamation mark. The estimation equation is:

$$(1)\ Flow_{n,t} = \alpha + \beta_0 * \text{excl\_mark}_{n,t} + \lambda_t + \varphi_n + \mathcal{E}_{n,t}$$

[2] We obtained data on mutual funds' ratings from a major bank whose financial advisory function is responsible for a large share of financial consulting in Israel.

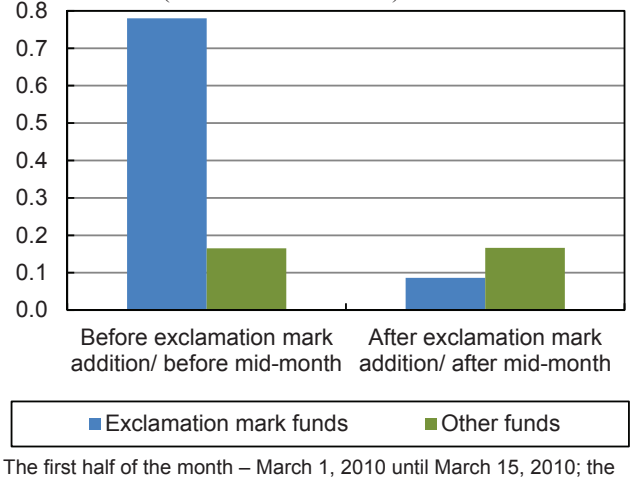
where $Flow_{n,t}$ represents inflows less outflows in fund n on day t, divided by total fund assets at the end of February 2010; $excl\_mark_{n,t}$ is a dummy variable whose value is 1 if the name of fund n on day t included an exclamation mark and 0 otherwise; λ_t is a dummy variable for day t that captures the day fixed effect; φ_n is a dummy variable for fund n that captures the constant fund effects. We cluster standard errors at the management firm level. We focus on the estimation of b, the coefficient that captures the DID effect of the exclamation point on fund flows, above and beyond fund heterogeneity and time trends. As our data are daily, and as investment management firms added the exclamation point on different days of the month, we control for the exact date the exclamation point was added to each fund by including in the control group not only funds to which no exclamation point was added, but also funds that added an exclamation point to their names on a later date.

In March 2010, an exclamation point was added to the names of 110 funds, the majority of which specialized in bonds, and of these 71 percent specialized in corporate bonds. Therefore, in addition to examining all funds, we also examine two sub-groups of mutual funds: fixed income funds and corporate bond funds. Furthermore we repeat the estimation for only those funds to whose names an exclamation point was added, distinguishing between the period before and after the addition of the exclamation point.

The effect of the exclamation point reform

Before we proceed to the econometric estimation, we present a preliminary outline of the effect of the exclamation point addition: We focus on the funds to whose name an exclamation point was added in March 2010 and compare the mean rate of net inflows to total assets on days preceding the addition, to the mean rate on the days following the addition. For the sake of comparison we also examine the remaining funds and compare the mean rates of net inflows to assets in the first and second halves of the month (see Figure 1). Figure 1 shows that while there is no difference in the nominal inflows between the beginning or end of the month in the remaining funds (the difference is not statistically significant according to a t-test), the funds to whose names an exclamation point was added show a sharp drop in net inflows (which is statistically significant at the 1% level).

Figure 1
Mutual Fund Net Inflows Before and After the Exclamation Mark Addition, First and Second Halves of the Month[a] (share of fund's assets[b])



[a] The first half of the month – March 1, 2010 until March 15, 2010; the second half – March 16, 2010 until March 31, 2010.
[b] Fund's assets at the end of February 2010.
SOURCE: Bank of Israel.

To examine the effect the added exclamation point in a more formal manner, we observe the results of the estimation of equation (1) with respect to results for all funds (Column 1) and treated funds (Column 2), for partial samples that include fixed income funds (Column 3) and treated fixed income funds (Column 4), and for further restricted partial samples that include corporate bond funds (Column 5) and treated corporate bond funds (Column 6) (see Table 1). It is evident that adding an exclamation point led to a statistically significant decline in flows. The decline is also significant in economic terms: adding an exclamation point

reduced the rate of daily net inflows to fund assets by 0.85 percentage points relative to the estimation of the counterfactual outcomes using the data on all funds—Table 1, column 1). This decline is approximately five times greater than the mean of daily fund inflows (the unconditional mean of daily inflows of all funds in the March 2010 sample was 0.17 percent of the assets at the end of February).

Table 1
The effect of the exclamation mark addition on mutual funds' daily net inflows

	(1)	(2)	(3)	(4)	(5)	(6)
excl_mark	-0.85***	-0.50***	-0.87***	-0.51***	-0.95***	-0.66***
	(0.16)	(0.13)	(0.16)	(0.13)	(0.14)	(0.13)
Trading Day in March Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Mutual Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	22,370	1,840	15,368	1,819	6,797	1,392
R^2	2.42%	19.48%	3.26%	19.76%	8.27%	26.78%

Standard errors, clustered at the management firm level, appear in parentheses below the coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. Columns 1 and 2 represent estimation results for all funds and for treated funds, respectively. Columns 3 and 4 represent estimation results for the partial samples that include fixed income funds and treated fixed income funds, respectively. Columns 5 and 6 represent estimation results for the further restricted partial samples that include corporate bond funds and treated corporate bond funds, respectively.

The results presented in Table 1 show that the addition of an exclamation mark had a strong impact on net inflows to mutual funds. The question arises as to whether this effect stems from the inflows, the outflows, or both. Barber and Odean (2008) show that retail investors tend to purchase attention-grabbing stocks and sell the stocks they already own (although theoretically they also have the option of selling other stocks, too, through short sales). The addition of an exclamation point presumably attracted the attention of existing investors, which may have led them to sell their holdings in funds. It is more difficult to develop a hypothesis with respect to inflows: The exclamation point is an indication of increased risk and while it therefore may deter potential investors, it also attracts attention and therefore may lead to purchases.[1] Another perspective is suggested by experiments conducted by Barron, Leider, and Stack (2008), who demonstrated that people tend to take more risky decisions after experiencing a sequence of safe outcomes. Therefore the exclamation point may affect existing investors less than potential investors, as the latter have not yet gained positive experience with these funds.

To test these hypotheses, we repeat our analysis, this time distinguishing between outflows and inflows. The results show that both inflows into and outflows from treated mutual funds were affected by the addition of the exclamation mark; Inflows into treated funds were lower than expected without the exclamation point, and outflows were higher relative to the expected outflows. However, the relative economic magnitude of the effect is greater for inflows: In the sample period, the daily increase in outflows accounts for less than half of the average daily fund redemptions, while the daily reduction in inflows is greater than average daily fund inflows. This difference may be attributable to the high yields that investors in treated mutual

[1] Hirshleifer, Myers, Myers, and Teoh (2002) and Lee (1992) found that investors make net purchases in response to both positive and negative surprises in companies' profit statements.

funds gained by holding these funds in the period prior to the reform. This positive experience may have made current investors in the treated mutual funds less sensitive to the increased risk salience than potential investors who did not enjoy these high yields.

Impact of the exclamation point reform announcement

The exclamation mark reform was first introduced to the public in a draft directive published by the ISA on September 9, 2009. On this date, the ISA announced its intention to add an exclamation point in the future to the names of funds with a relatively high exposure to non-investment-grade bonds. Therefore an examination of the following is warranted: (a) investors' reaction to the forthcoming regulation; and (b) mutual funds' reaction to the forthcoming regulation in the period preceding its implementation (the run-up period),[1] in order, among other things, to examine alternative explanations to the results obtained.

(a) The public's response to the announcement

We have seen that investors responded strongly when an exclamation point was added to the names of several mutual funds in March 2010. The question arises of whether this response stems solely from the heightened salience of the risk of holdings low-grade bonds, or whether their response was also affected by altered perceptions of this risk. Specifically, investors may have interpreted the new regulation as an indication that the regulator—the ISA—believes that investments in low-grade corporate bonds represent a heightened risk. This is, however, unlikely, since even prior to March 2010, funds were required to report if their non-investment-grade bond holdings exceed their maximum exposure to equities. Nonetheless this possibility should be addressed directly.

To disentangle the potential impact of the information embedded in the ISA new requirement from the impact of the enhanced risk salience, we examine investors' responses to the first draft of the directive, which was published in September 2009, and was not accompanied by any actual change to fund names. We use DID estimation to examine the impact of the new regulatory draft on net inflows into funds that were expected to receive an exclamation mark (based on their September 2009 disclosure of holdings in high-yield bonds in excess of their maximum equity exposure) versus funds that were not expected to add an exclamation mark. As demonstrated in Table 2, the release of the draft had only a slight impact on net mutual fund inflows, in contrast to the strong effect of the actual addition of an exclamation mark.

[1] The funds' response to the implementation of the reform is a separate issue. Specifically, it is possible that mutual fund management firms anticipated the negative impact of the added exclamation point to the names of several funds under their management and therefore diverted their marketing efforts from those funds to other funds under their management. Such a diversion might create a self-fulfilling prophecy: Diverting marketing efforts might lead to the diversion of investments from the treated funds to other funds, and add to the effect of the exclamation sign itself. However, when we study all the advertisements by mutual funds that appeared in March 2010 in Israel's three major financial newspapers, we find that the changes in advertisements do not explain the main results presented here.

Table 2
The effect of the exclamation mark addition on mutual funds' daily net inflows in September 2009

	(1)	(2)	(3)	(4)	(5)	(6)
expected_excl_mark	-0.05*	0.01	-0.05	0.01	-0.06	0.21***
	(0.03)	(0.05)	(0.03)	(0.05)	(0.05)	(0.07)
Trading Day in September Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Mutual Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	16,915	4,464	11,484	4,445	5,098	2,366
R^2	1.83%	4.74%	2.32%	4.71%	8.78%	10.89%

Standard errors, clustered at the management firm level, appear in parentheses below the coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. Columns 1 and 2 represent estimation results for all funds and for funds that were expected to add an exclamation mark to their names, respectively. Columns 3 and 4 represent estimation results for the partial sample that includes fixed income funds and fixed income funds that were expected to add an exclamation mark to their names, respectively. Columns 5 and 6 represent estimation results for the further restricted partial samples that include corporate bond funds and corporate bond funds that were expected to add an exclamation mark to their names, respectively.

(b) Fund responses to the announcement

The exclamation points are presumably exogenous from the funds' perspective, yet a self-selection mechanism may have operated if funds took action to evade the new requirement in the run-up period between the initial announcement of the reform and its implementation. To address this possibility, we focus on the six months prior to March 2010, and examine the funds' filings on their holdings of non-investment-grade bonds in excess of their maximum stock exposure. On the basis of these data we identify "suspect funds," which are funds that could be expected to add an exclamation point to their names according to their filings between September 2009 and February 2010[2] yet ultimately did not do so. Fund managers who wished to avoid adding an exclamation point to their funds' names had two alternatives, which were not mutually exclusive: (a) they could adjust the fund's investment policy and increase the fund's maximum permitted equity holdings, or (b) they could reduce their holdings of non-investment-grade bonds until these holdings were beneath the threshold of the fund's maximum equity exposure.

The first method requires a decision by the fund's board and notification to the public, and consequently entails costs and might attract even more attention than the exclamation point. In fact, after reviewing all the mutual fund reports of changes in their investment policies in the six months between the first announcement of the reform and its implementation, we found only 29 reports of a change in investment policy in the relevant direction, of which 27 appear to be authentic, that is they do not appear to be motivated by a desire to evade the exclamation point regulation. The remaining two policy modifications pertain to a single management firm, and the nature of the modifications suggests that they may have been made to circumvent the exclamation regulation. Omitting these two funds does not affect the main results of this study.

[2] A fund is considered suspect if it reported that the share of its holdings in high-yield bonds is greater than its maximum exposure to equity instruments in one or more days in the months preceding the reform. The results of this analysis are similar even if we focus on the funds' reports in the month in which the reform was first announced (September 2009) or their reports in the month preceding the implementation of the reform (February 2010).

The second method—sale of non-investment-grade bonds—entails lower costs and therefore it is not surprising that it was more common: 290 funds employed this method in the run-up period, possibly in order to evade the forthcoming reform. As these suspect funds belonged to the control group in the main estimation (Table 1), we repeat the estimation for (1) the complete sample, (2) the bond funds, and (3) the corporate bond funds, each time excluding the suspect funds. The results are presented in columns 1–3 in Table 3, and essentially are similar to the results presented in Table 1. In other words, even when we omit suspect funds from the control group, the addition of an exclamation point significantly reduced net inflows to the funds in the treated group relative to the inflows to the other funds.[1]

Our final examination addresses the econometric concern that the suspect funds introduce bias into the control group. It is, however, conceivable to argue that they actually comprise a superior control group because they are ex-ante similar to the funds to which an exclamation mark was added with respect to the specific risk targeted by the reform. We therefore repeat the main estimations for all the funds, the fixed income funds, and the corporate bond funds (Table 3, columns 4-6, respectively) but this time we use only the partial sample that includes the funds which added an exclamation mark to their names and the suspect funds. Results show that even relative to funds that are ex-ante similar with respect to the relevant risk, the funds whose risk became more salient as a result of the added exclamation point suffered from a decline in daily inflows.

Table 3
The effect of the exclamation mark addition on mutual funds' daily net flows after excluding suspect funds or when suspect funds serve as the control group

	(1)	(2)	(3)	(4)	(5)	(6)
excl_mark	-0.05*	0.01	-0.05	0.01	-0.06	0.21***
	(0.03)	(0.05)	(0.03)	(0.05)	(0.05)	(0.07)
Trading Day in March Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Mutual Fund Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	16,296	9,378	3,798	6,437	6,353	3,328
R^2	1.38%	1.83%	6.00%	6.90%	7.02%	13.92%

Standard errors, clustered at the management firm level, appear in parentheses below the coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. Columns 1-3 respectively represent estimation results for all funds, fixed income funds, and corporate bond funds, after omitting suspect funds. Columns 4-6 respectively represent estimation results for all funds, fixed income funds, and corporate bond funds, after eliminating all funds other than the treated funds and the suspect funds.

[1] To address the possibility that some management firms systematically evaded the requirement to add an exclamation point to the names of the funds under their management, we repeat the analysis excluding the quartile of firms that managed the highest share of suspect funds. The results remain unchanged from the main results.

Conclusion

We used proprietary data on daily inflows and outflows of mutual funds in Israel and employed the differences-in-differences methodology to demonstrate that a minor change in the names of certain funds—the addition of an exclamation mark—caused changes to the investments in these finds. The addition of an exclamation mark significantly reduced—both statistically and economically—investments in the treated funds in the wake of this change, despite the fact that the modification merely heighted the salience of the risk they represent. That is, the added exclamation point was not accompanied by any fundamental change in the funds' features or in the information available to investors. The reform affected fund inflows and fund outflows, although the economic impact was reflected mainly in a reduction in new purchases.

The analysis presented herein demonstrates that regulation focusing on information presentation may affect investors' risk perceptions and their behavior, at least in the short term, even if the regulatory change does not impose restrictions on the investments of regulated entities or increase their disclosure requirements to investors. The question of whether a change in the manner of information presentation may have a more long-term effect on investors' behaviors (months or even years) remains for a future study. It is not simple to address this question empirically,[2] and the answer may depend on the nature of the reform and the public attention that it attracts.[3]

The findings from the exclamation point reform are relevant for regulators in and outside Israel who consider reforms, specifically reforms that focus on marks to protect households from the risks embedded in financial products. For the sake of illustration, the findings may contribute to the debate on the potential impact of KIID regulations, and specifically their use of exclamation points to highlight specific risks. The results are also relevant for similar reforms in other areas, such as the use of colored stickers to mark food products to reflect their effect on consumers' health.

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[2] The current findings are based on daily data over a single month. An examination that extends over a longer period creates the risk that factors that are unrelated to the reform, yet over time have a differential effect on various mutual funds, will eclipse the effects of the reform. Furthermore, implementation of the reform was staggered and therefore the control group for daily data included funds that added the exclamation mark after the estimation date in the control group. However if we use monthly data, the control group will include only those funds to whose names no exclamation point was added and therefore these are expected to be more different from the treated group. Finally, the mix of investors in mutual funds may change over time and therefore data on fund holders may be necessary for an in-depth analysis of the reform's long-term effects.

[3] However, an analysis of the current mutual fund market suggests that the reform did not cause long-term harm to the funds that added an exclamation point to their names. Specifically, we compared the funds with an exclamation mark in late 2017 to funds with an exclamation mark in March 2010 and found that in March 2010 these funds accounted for 9 percent of all mutual funds while in late 2017, they accounted for 12 percent. Moreover, the funds with an exclamation mark managed less than 12 percent of all mutual fund assets in March 2010 and 15 percent in 2017. These findings do not support the hypothesis that the added exclamation point deterred a significant portion of the investors for an extended period.

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