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End of 9-Endings and Price Perceptions

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End of 9-Endings and Price Perceptions

Abstract

We take advantage of a natural experiment to document an emergence of a new price ending that has the same effects as 9-endings. In January 2014, the Israeli parliament has passed a law prohibiting the use of non 0-ending prices. We find that one year after 9-ending prices have disappeared, 90-ending prices acquired the same status as 9-ending prices had before the law was passed. 90-ending prices became the new psychological price points. The retailers and the shoppers both reacted to the regulatory intervention optimally, which has eliminated the regulation's intended effect.

1. Introduction

9-ending prices are common, comprising about 70% of the retail prices. They are also more rigid than other prices (Kashyap 1995, Blinder et al 1998, Levy et al 2011, Knotek 2010, Anderson et al 2015, McShane et al 2015). Their ubiquity and rigidity are explained by 9-endings' positive effect on revenues (Anderson and Simester 2003), which is attributed to 9-endings being *psychological price points* (PPP), implying that they affect shoppers' price perceptions.[1] Two leading explanations for this effect are *level-effect* and *image-effect*.

According to the level-effect, consumers have bounded rationality and, therefore, they round prices down or process price information L-to-R, and sometimes ignore the rightmost digit (Schindler and Kirby, 1997, Stiving and Winer, 1997, Thomas and Morwitz, 2005). According to the image-effect, 9-endings signal low prices and, consequently, consumers are drawn to goods with 9-ending prices even when other goods have lower prices (Stiving, 2000). Snir et al (2015) show that, consistent with the image effect, 9-endings reduce the likelihood that consumers notice price changes.

We take advantage of a natural experiment to document an emergence of a new price ending that has the same effects as 9-endings. In January 2014, the Israeli government passed a law prohibiting the use of non 0-ending prices. We find that one year after 9-endings have disappeared, 90-ending prices acquired the same status as 9-ending prices had before the law was passed. Specifically, before passing the law, (1) the most common price-ending was 9, (2) the Israeli shoppers made larger errors when recalling 9-ending prices in comparison to other prices, and (3) the likelihood of noticing a price change was smaller for 9-ending prices than for other prices (Snir et al 2015). After passing the law, we find that (1) 90 is the most common price ending, (2) shoppers make larger errors when recalling 90-ending prices than other prices, and (3) the likelihood of noticing a price change is smaller for 90-ending prices in comparison to other prices. Thus, 90-ending prices have become the new PPPs. Our findings on the effect of 90-endings supports the image-effect hypothesis.

Next we discuss the regulatory change and the Israeli retailers' response. In section 3, we describe the data. In section 4, we discuss the estimation results. We conclude in section 5.

2. Outlawing non 0-ending prices: a natural experiment

The 0.01 New Israeli Shekel (1-agora) and the NIS 0.05 (5-agora) coins (1¢ and 5¢ "equivalents") were eliminated in 1991 and 2008, respectively. Although the 1-agora and 5-agora coins have not been in use since then, until January 2014 retailers were free to set any

[1] According to Landsburg (2012), dollar-store operators in the late 19th century began using 99¢ pricing to make it harder for cashiers to steal, and thus inadvertently discovered the benefits of 9-endings as PPP.

price ending.[2] In credit-card transactions, shoppers paid the exact amount. In cash transactions, however, the total bill was rounded to the nearest 10-agora. E.g., if the total bill was between NIS 4.45 and NIS 4.54, the actual amount paid was NIS 4.50.

Because shoppers were losing in cash transactions due to the asymmetric rounding, and because of a public demand to outlaw the "manipulative" 9-endings, the Minister of Economic Affairs announced in October 2013 the adoption of a regulation which requires that beginning January 1, 2014, all prices must end with zero.[3]

Figure 1 illustrates the effect of the law using monthly data collected by the Central Bureau of Statistics for compiling the CPI. The data from January 2013–July 2014 includes 68,053 observations on the prices of goods in 125 categories. According to the figure, the share of 9-ending prices varied around 75% until it dropped at the end of 2013, as retailers reacted to the law. At the same time, the share of 90-ending prices, which before the change comprised only 6% of the prices, rose to 55% by July 2014.

3. Data

We conducted two surveys, one in Oct–Dec 2013, and the second in Jan–March 2015. Shoppers exiting stores were shown a list of goods, and were asked to mark the goods they had purchased and indicate their prices. In the second survey, they were also asked whether the prices have increased, decreased or remained unchanged relative to the previous week.

The list included goods consumed on a regular basis, in 20 categories.[4] Summary statistics are given in Table 1. The table also gives the share of 9- and 90-ending prices the shoppers reported, and the average absolute % error they made in recalling the prices. The magnitude of errors in price recall are similar in the two surveys. The share of 9-ending prices in 2013 is only 12.5%, which is the result of retailers reducing the use of 9-ending prices by the end of the year in preparation of the regulatory change. Consistent with Figure 1, the share of 90-ending prices was low in survey 1, only 12%, but rose to 50% in survey 2.

4. Econometric model and estimation results

A. Before the law was changed

We use the data of survey 1 to assess the effect of 9-ending prices on the shoppers' price

[2] The coins were eliminated because of their increased cost of production. E.g., by 2008 the cost of minting a 5-agora coin was 16-agorot. Also, public was reluctant to accept them as a change, and vending machines, parking meters, and other coin-operated devices stopped accepting them. See: www.boi.org.il/en/NewsAndPublications/PressReleases/Pages/070716e.aspx. As of January 2014, only 0-edning prices (i.e., prices that end with .10, .20,…, .90) are allowed.

[3] See: www.jpost.com/National-News/Farewell-to-the-agora-and-the-phenomenon-of-prices-that-cant-be-paid-336741. See also Ater and Gerlitz (2016).

[4] The products included are: cottage cheese, soft cheese, semi-hard cheese, fresh milk, chocolate drinks, Coca-Cola, Diet Coke, mineral water, tomatoes, cucumbers, oranges, lemons, chocolate spread, dark chocolate, peanut flavor snack, pastrami, eggs, white sugar, margarine and sunflower oil.

recall ability. Thomas and Morwitz (2005) show that shoppers process price info L-to-R and often they are inattentive to the rightmost digits. Snir et al (2015) find that if shoppers use price endings as a signal for low prices, they are inattentive to the price itself. We thus expect that shoppers will be less precise in recalling 9-ending prices in comparison to other prices.

We estimate a random effect regression. The dependent variable is the % absolute error. Robust standard errors are clustered at the participant level. Column (1) in Table 2 reports the results when the only RHS variable is a 9-ending dummy (1 for 9-ending price, 0 otherwise).

For 9-ending prices, shoppers price recall error is 2% higher than for other prices. Next, we add control variables.[5] See column (2). The addition of the controls does not affect the coefficient of 9-endings.

The 9-ending effect could be due to level-effect or due to image-effect. If it is the former, then consumers should have made larger errors also when prices ended with other non-zero endings in comparison to the round ending. To test this hypothesis, we include a control for prices that end in cents other than 9. See column (3). The coefficient of 9-endings is not affected by the inclusion of the cents' dummy. The cents dummy is statistically insignificant. These results are consistent with the hypothesis that 9-endings influence the shoppers' price perceptions through image-effect.

We also test for the effect of 90-endings because below we test whether 90-endings have a negative effect on shoppers' price recall after the elimination of 9-endings. It could be that this effect was present before 9-endings were eliminated. We therefore add to the regression both a 90-ending dummy (1 for 90-ending price, 0 otherwise) and a 0-ending dummy (1 for 0-ending price but not 90-ending, 0 otherwise). See column (4).

The coefficient of 0-ending is negative and marginally significant, consistent with the argument that 0-ending numbers are cognitively more accessible (Dehaene 1997), and thus they are recalled better than non 0-ending prices (Schindler and Kirby, 1997). The coefficient of 90-endings is also negative, and its absolute value is greater than the absolute value of the coefficient of other 0-endings $(\chi^2 = 2.77, p < 0.1)$. Thus, 90-endings had no negative effect on price recall before 9-endings were abolished. We also do not find evidence that consumers made larger errors in recalling 90-ending prices in comparison to other 0-ending prices.

B. After the law was changed

[5] These include: the age, the goods' prices, household size, number of cars owned, number of supermarkets the shoppers frequent, the average amount spent per visit, and dummies for gender (1 if woman, 0 if man), marital status (1 if married, 0otherwise), academic degree (1 if an academic degree, 0 otherwise), ultra-religious (1 if the shopper identifies himself as ultra-religious, 0 otherwise) and for frequent buyer (1 if visits a supermarket more than once a week, 0 otherwise). Ultra-religious households usually have low incomes and large families. We also include dummies for the shop and for product categories (dairy, soft drinks, fruits and vegetables, sweets, and misc.). To save space, these coefficients are not reported.

Next we study survey 2. See Table 3. In column (1), we report the results of a regression in which the dependent variable is the % absolute error. The only independent variable is a 90-ending dummy (1 for 90-ending price, 0 otherwise). We use random effects with robust standard errors clustered at the shoppers' level. We find that the effect of 90-ending is positive and significant. Thus, one year after 9-endings were eliminated, shoppers made a larger error when recalling 90-ending prices than other prices.

For robustness, we add the controls listed in footnote 5. See column (2). The coefficient of 90-endings remains significant, although it decreases from 4% to 3%. Thus, shoppers' price recall mistakes are 3% larger for goods with 90-ending prices. Further, this point estimate is larger than the one we find for 9-endings before the law changed, 2%. Thus, the effect of 90-endings after the law was changed is at least as large as the effect that 9-endings had before the law was changed.

As an additional robustness check, we use data on sales. For 5 of the 7 shops surveyed, we have data on the goods that were on sale. We use these data to add a dummy variable for sales (1if the good was on sale, 0 otherwise). See column (3). The coefficient of the sales dummy is negative and significant, suggesting that shoppers make smaller errors in recalling the prices of goods on sale. We find, however, that the effect of 90-endings is larger when we control for sales than without it. Thus, sales assist shoppers in recalling the goods' prices, perhaps because sale prices are advertised/promoted, but 90-endings interfere with the price recall.

To assess whether the effect of 90-endings on price recall is because of the level-effect or the image-effect, we use data on shoppers' recall of price changes. If they make larger errors in recalling 90-ending prices because they round prices down, then 90-endings should have little effect on the shoppers recall of price changes. If they use 90-endings as a signal for low prices, however, then 90-endings should reduce the likelihood of noticing price changes.

Snir et al (2015) show that before 9-endings were abolished, consumers in Israel were indeed less likely to notice a price change when the new price was 9-ending than when the new price ended in a different digit. We test whether 90-endings have a similar effect after 9-endings were eliminated by estimating a random effect probit regression of the probability that consumers correctly recall price changes.

We use data from the 5 shops where shoppers were asked to indicate whether goods' prices have increased, decreased or remained unchanged. The dependent variable is a dummy variable that equals 1 if the consumer responded correctly and 0 otherwise. The shoppers recalled price changes correctly in 53% of the cases. See column (1) of Table 4.

We find that shoppers are less likely to notice a price change if the price ends with 90. If a price is not 90-ending, the probability of noticing a price change is 63%. If a price is 90-

ending, then the probability of noticing a price change is 41%.

For robustness we add the controls listed in footnote 5. See column (2). The effect of 90-endings remains negative and significant. If we set the continuous variables equal to their means and the dummies equal to zero, we find that the probability of a correct recall in case of a non 90-ending price is 76%. If the price is 90-ending, the probability is 67%.

We make two more robustness checks. First, we add a control for sales (column 3). The coefficient of 90-endings remains significant. Next we add the absolute % price change (column 4). The size and the significance of the coefficient of 90-endings remains the same.

5. Conclusion

Until January 2014, Israeli retailers could use 9-ending prices. Since January 1, 2014, the use of 9-endings are prohibited, bringing an end to 9-ending prices, and limiting the retailers' price-setting flexibility. We find that, as a result of this "integer constraint," 90-endings have become the new 9-endings. That is, 90-endings are the new PPPs. We find that 90-endings have acquired the new status through the image-effect, suggesting that 90-ending prices are popular in the new setting because 90-endings are used by shoppers as a signal for low prices.

These findings confirm once again that the market reacts to regulatory changes. The retailers' preferred price ending, 9, was eliminated by regulators. Their response was to find a new price ending, 90, which plays the same role. The shoppers benefited from the use of 9-endings as a signal for low prices until the law was changed. After the change, all prices end with 0, eliminating the value of 0-endings as a signal. Thus, rational shoppers responded by ignoring the 0-endings and treating the 90-ending prices as 9-ending. In other words, the marketplace has discovered that 90 can replace 9 as a PPP. Retailers and shoppers both reacted to the regulatory intervention optimally, which has eliminated the regulation's intended effect.

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Figure 1. The share of 9-ending and 90-ending prices in Israeli supermarkets, drugstores, and department stores, January 2013–July 2014

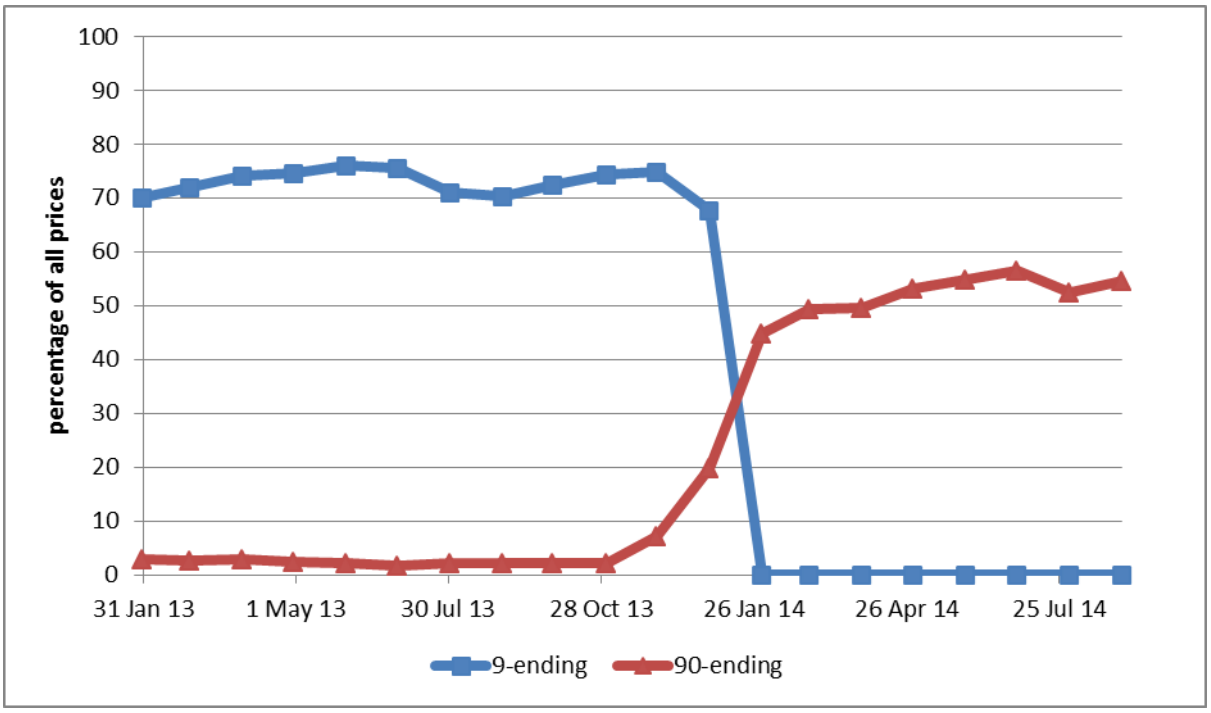

Table 1. Shoppers summary statistics – survey 1 and survey 2

	Survey 1 October-December 2013	Survey 2 January-March 2015
Age	39.16 (17.034)	44.26 (14.112)
Household size	2.73 (1.638)	3.79 (1.707)
% of Women	52%	56%
% of Academic	40%	39%
% of Married	58%	71%
% of Ultra-religious	2%	4%
No. of cars owned	1.20 (0.827)	1.41 (0.793)
No. of shops visited	1.53 (0.873)	1.92 (1.020)
Average amount spent per shopping trip	340.59 (223.404)	446.48 (222.681)
% of shopping more than once a week	37%	12%
Average recall error	8.94%	10.05%
% of 9 ending prices	18.64%	N/A
% of 90 ending prices	12.47%	47%
Responses per shopper	6.41	5.22
No. of shops	13	7
No. of shoppers	364	513

Table 2. Regression of the price recall error before the law was changed

Variable	(1)	(2)	(3)	(4)
9-ending	0.02***	0.02***	0.02**	
	(0.007)	(0.005)	(0.005)	
Good's price		-0.001***	-0.001***	-0.001***
		(0.0003)	(0.0003)	(0.0003)
Age		0.0001	0.0001	0.0001
		(0.0003)	(0.0003)	(0.0003)
Household size		0.004	0.004	0.004
		(0.003)	(0.003)	(0.003)
No. of cars		-0.005	-0.005	-0.004
		(0.004)	(0.004)	(0.004)
No. of supermarkets visited		-0.002	-0.002	-0.002
		(0.005)	(0.005)	(0.0005)
Average amount spent		0.00003	0.00003	0.00003
		(0.00002)	(0.00002)	(0.00002)
Woman		0.01	0.01	0.01
		(0.010)	(0.010)	(0.010)
Married		-0.02*	-0.02*	-0.02*
		(0.010)	(0.010)	(0.010)
Academic degree		0.001	0.001	0.001
		(0.008)	(0.007)	(0.007)
Ultra-religious		-0.02**	-0.03**	-0.03**
		(0.011)	(0.012)	(0.012)
Frequent-shopper		-0.005	-0.005	-0.005
		(0.008)	(0.008)	(0.008)
Cent ending			0.01	
			(0.007)	
90-ending				-0.02***
				(0.005)
0-ending				-0.01*
				(0.006)
Constant	0.08***	0.06***	0.005**	0.06***
	(0.004)	(0.020)	(0.021)	(0.020)
N	2,333	2,333	2,333	2,333
χ^2	15.97	1645.06	1930.80	2580.87

Notes:
1. In the table we report the results of a random effects regression. The dependent variable is a % absolute error in price recall.
2. We report robust standard errors, which are clustered at the participants' level.
3. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

Table 3. Regression of the price recall error after the law was changed

Variable	(1)	(2)	(3)
90-ending	0.04***	0.03**	0.06***
	(0.010)	(0.02)	(0.023)
Good's price		0.0008	0.0009
		(0.0008)	(0.001)
Age		-0.0003	-0.0006
		(0.0003)	(0.0005)
Household size		0.006	0.006
		(0.004)	(0.005)
No. of cars		0.02**	0.02**
		(0.008)	(0.009)
No. of supermarkets visited		0.0006	-0.00007
		(0.007)	(0.008)
Average amount spent		-0.00007*	-0.00007*
		(0.00004)	(0.00004)
Woman		0.004	0.004
		(0.004)	(0.01)
Married		-0.0009	-0.007
		(0.010)	(0.014)
Academic degree		-0.002)	-0.01
		(0.009)	(0.013)
Ultra-religious		0.009	0.02
		(0.027)	(0.03)
Frequent shopper		-0.02	-0.01)
		(0.014)	(0.02)
Sales			-0.03
			(0.012)
Constant	0.08***	-0.08**	-0.07*
	(0.008)	(0.035)	(0.044)
N	2,587	2,587	1,855
χ^2	15.67	293.90	215.68

Notes:

1. In the table, we report the results of a random effects regression. The dependent variable is a % absolute error in price recall.
2. We report robust standard errors, which are clustered at the participants' level.
3. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively

Table 4. Regression of the probability that shoppers notice a price change

Variable	(1)	(2)	(3)	(4)
90-ending	-0.56***	-0.25***	-0.32***	-0.37***
	(0.068)	(0.077)	(0.107)	(0.106)
Good's price		-0.01**	-0.01	-0.01
		(0.006)	(0.007)	(0.007)
Age		-0.005	-0.005	-0.002
		(0.003)	(0.004)	(0.004)
Household size		0.03	0.04	0.05
		(0.029)	(0.036)	(0.031)
No. of cars		0.08	-0.12	-0.08
		(0.062)	(0.078)	(0.068)
No. of supermarkets visited		-0.11**	-0.15**	-0.11*
		(0.055)	(0.068)	(0.067)
Average amount spent		0.0002	0.0003	0.0002
		(0.0002)	(0.0003)	(0.00003)
Woman		-0.09	-0.14	-0.11
		(0.079)	(0.101)	(0.088)
Married		-0.11	-0.29**	-0.28**
		(0.094)	(0.125)	(0.108)
Academic degree		-0.01	-0.002	0.08
		(0.085)	(0.111)	(0.095)
Ultra-religious		-0.28	-0.29	-0.29
		(0.196)	(0.22)	(0.195)
Frequent shopper		0.02	0.04	-0.06
		(0.0129)	(0.177)	(0.151)
Sales			-1.16***	-1.10***
			(0.171)	(0.173)
Size of price change				0.23
				(0.395)
Constant	0.34***	0.91***	1.00***	1.04***
	(0.065)	(0.253)	(0.328)	(0.286)
N	2,191	2,191	1,441	1,373
	67.62	386.64	272.34	227.58

Notes:

1. In the table, we report the results of a random effects probit regression. The dependent variable is a dummy variable that equals 1 if the consumer responded correctly (and 0 otherwise) whether the price has increased, decreased, or remained unchanged.
2. We report robust standard errors, which are clustered at the participants' level.
3. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively