Online Supplementary Appendix

Stuck at Zero: Price Rigidity in a Runaway Inflation*

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A.1. Israeli inflation 1978–1985

After 1973, the expenditures of the Israeli public sector rose to about 75% of the GDP, resulting in a deficit of about 15%. A large part of this deficit was monetized, leading to inflation. During January 1973 to June 1979, the annual inflation rate was about 40% on average. After June 1979, the annual inflation rate jumped to about 100%, on average. Sussman (1992) suggests that this was the outcome of the liberalization of the foreign currency market enacted in 1979. The reduced controls and the freer access to foreign currency resulted in lower demand for the local currency, resulting in accelerated inflation.

In October 1983, the inflation rate increased once again, this time reaching an annual rate of about 400%. Sargent and Zeira (2011) note these three stages in the Israeli inflationary process and interpret it in the context of the "unpleasant monetary arithmetic" (Sargent and Wallace 1981). The public anticipated that the government debt was likely to increase and predicted that the increase would be financed via an increase in the money supply. In July 1985, the government enacted a comprehensive stabilization program, and inflation came down to around 20% (Fischer, 1987).

The three stages of the Israeli inflation can be seen in Figure A1, which depicts the monthly inflation rate for the period of January 1978 – December 1986. In the first sub-period, up to mid-1979, the average monthly inflation rate was 3.9%. In the second sub-period, from mid-1979 until September 1983, the average monthly inflation rate was 7.1%. In the third sub-period, from October 1983 until August 1985, the average monthly inflation rate was 15.0%. In the final months of 1985, the average monthly inflation rate came down to about 1.5%.

A.2. Summary statistics for the 26 entry-level-items in the sample

The dataset used by Lach and Tsiddon (1992, 1996, and 2007) includes observations on 26 CPI-ELIs (CPI Entry-Level-Items). These are: Arak (anise), beef for soup, challah bread, champagne, chicken breast, chicken liver, cocoa powder, cocoa powder, codfish, drumsticks (chicken legs), fish fillet, fresh beef, fresh beef liver, frozen beef liver, frozen goulash, hock wine, liquor, grey mullet (known as "buri" fish in Israel), red wine, rice, rose wine, steak, sweet red wine, tea, turkey breast, vodka, and white vermouth.

Table A1 presents the summary statistics for the 26 ELIs. We report these statistics separately for each of the three sub-periods: January 1978–June 1979, January 198–December 1982, and January 1984–October 1984. The first column in each panel gives the average price. The second panel gives the average percentage of the consecutive right-most zeros in the prices. The third column gives the average proportion of prices that changed in a given month. The fourth column gives the number of observations.

A.3. Robustness checks

A.3.1. Non-consecutive price changes

In this section, we report the results of several robustness checks that we conducted. In the paper, we define a price change only if we have observations for both month t and $t + 1$. Here we relax this restriction and define a price change as any deviation in the price between two consecutive observations (even if they are separated by a missing data point) that exceed 0.5%.

We estimate separate linear probability model regressions for January 1978–June 1979, January 1981–December 1982, and for January 1984–October 1984. These three sub-periods correspond to the three stages of inflation.

The dependent variable in all regressions is a dummy for a price change. It equals 1 if the price has changed between two consecutive observations, even if they are separated by more than one month, and 0 otherwise. The independent variable is the share of consecutive right-most 0-endings, which we define as the share of consecutive right-most zeros in the price.[1] The estimation results are reported in Table A2. Columns (1)–(2) are for January 1978–June 1979, columns (3)–(4) for January 1981–December 1982, and columns (5)–(6) for the January 1984–October 1984 sub-period. The regression equations in columns (1), (3), and (5) include fixed effects for products in addition to the share of 0-endings.

We find that in all three periods, an increase in the share of 0-ending prices is associated with a decrease in the likelihood of a price change. The coefficients for the first, second, and third sub-periods are -0.27, -0.18, and -0.22, respectively. All three

[1] A price such as NIS 10.50 has 1 consecutive right-most zeros and a total of 4 digits. The share of consecutive right-most zeros, therefore, is ¼ = 0.25. The 4-digit price of NIS 10.00 has 3 consecutive right-most zeros, with a share of consecutive right-most zeros that equals ¾ = 0.75.

coefficients are statistically significant, the first and third coefficients at the 1% level, and the second at the 5% level.

In the regressions in columns (2), (4), and (6), we replace the fixed effects for products with fixed effects for products×stores, and for the observation month. The estimation results remain qualitatively unchanged. The coefficients of the share of 0-ending prices for the first, second, and third periods are $-0.21, -0.19,$ and -0.19, respectively. All three of them are statistically significant, the first and the third coefficients at the 1% level, and the second at the 5% level.

Thus, changing the definition of a price change does not alter our main result: In all three inflationary sub-periods, prices with a high share of right-most consecutive zeros change less often than other prices.

A.3.2. Expanding the final inflationary sub-period to January 1984–June 1985

In the paper, we define the third sub-period as January 1984–October 1984, although we have data until June 1985. The reason is that during the November 1984–June 1985 period, the Israeli government tried two stabilization programs, which included general price controls and might have affected the pattern of price changes. Ultimately, however, the inflation did not slow down until after the stabilization program of July 1985.

In this section, we re-estimate the regressions for the third sub-period, but this time we are using the data for the full sample period, January 1984–June 1985. The estimation results are summarized in Table A3.

We find that the coefficients of the share of 0-ending prices are negative and significant. The coefficient is −0.21 in the regression in column (1), which includes fixed effects for products, and −0.19 in the regression in column (2), which includes fixed effects for products×stores and for months.

A.3.3. Using the number of consecutive right-most zeros rather than their share

As a robustness test, we change the definition of the main independent variable. Instead of defining it as the *share* of the right-most consecutive zeros, we define it as the *number* of the right-most consecutive zeros. The estimation results are summarized in Table A4.

Columns (1)–(2) are for January 1978–June 1979, columns (3)–(4) are for January 1981–December 1982, and columns (5)–(6) are for the January 1984–October 1984 sub-period. The regressions in columns (1), (3), and (5) include fixed effects for products in addition to the number of the consecutive right-most 0-endings.

As the figures in columns (1), (3), and (5) show, we find that in all three sub-periods, an increase in the number of the consecutive right-most 0-endings is associated with a decrease in the likelihood of a price change. The coefficients for the first, second, and third periods are -0.08, -0.04, and -0.03, respectively. All three coefficients are statistically significant, the first and third at the 1% level, and the second at the 10% level.

In the regressions in columns (2), (4), and (6), we include fixed effects for products×stores and for months. We find that the coefficients are still negative, -0.07, -0.04, and -0.02, for the first, second and third sub-periods, respectively. All three of them are statistically significant, the first and the third at the 1% level, and the second at the 5% level.

A.3.4. Estimations using prices in Lira

In February 1980, the Israeli Lira was replaced by the Shekel as a legal tender, at the exchange rate of 10 Lira = 1 Shekel. In the paper, we perform all the calculations and estimations involving the shares of consecutive right-most zeros for the period after this transition, in Shekel denominated prices because the posted prices during that period were in Shekels. However, we do not know how shoppers perceived the prices. For example, it could be that some of them kept on calculating and/or assessing the prices in Liras.[2]

To explore this possibility, we add another right-most zero to every price and calculate the share of consecutive right-most zeros after this addition. We employ the resulting figures as an independent variable in the regressions similar to the ones we estimate in the paper. However, we estimate the regressions only for the post-1980 period, because the Shekel replaced the Lira as a legal tender in 1980. The estimation results are summarized in Table A5.

[2] Marques and Dehaene (2004) study how numerical intuition for prices develops after a switch from one currency to another, like during the adoption of the Euro by the EU member countries.

In columns (1)–(2), we report the estimation results for the January 1981–December 1982 sub-period, and in columns (3)–(4), for the January 1984–September 1984 sub-period. The regressions in columns (1) and (3) include fixed effects for products in addition to the share of consecutive right-most 0-endings.

We find that in both sub-periods, an increase in the share of zero-endings is associated with a decrease in the likelihood of a price change. The coefficients for the two sub-periods are -0.20 $(p < 0.05)$, and -0.20 $(p < 0.01)$, respectively.

In the regressions in columns (2) and (4), we include fixed effects for products×stores and for months. We find that the coefficients are still negative: -0.23, and -0.15, for the two sub-periods, respectively. Both coefficients are statistically significant. Thus, estimating the regressions in terms of Lira does not change the main results: 0-endings are associated with a lower probability of a price change.

A.3.5. Zero-endings and the size of price changes with the outliers included

In the paper, we estimate the correlation between 0-endings and the size of price changes after we remove outliers. Here we repeat the estimation, but we use all observations, including the outliers. The estimation results are summarized in Table A6.

In columns (1)–(2), we report the estimation results for the January 1979 – July 1979 sub-period, in columns (3)–(4), for the January 1981–December 1982 sub-period, and in columns (5)–(6), for the January 1984–September 1984 sub-period. The regressions in columns (1), (3), and (5) include fixed effects for products in addition to the share of consecutive right-most 0-endings. We find that the coefficients in all three periods are positive: 0.86, 3.48, and 9.06, respectively. They are, however, not statistically significant.

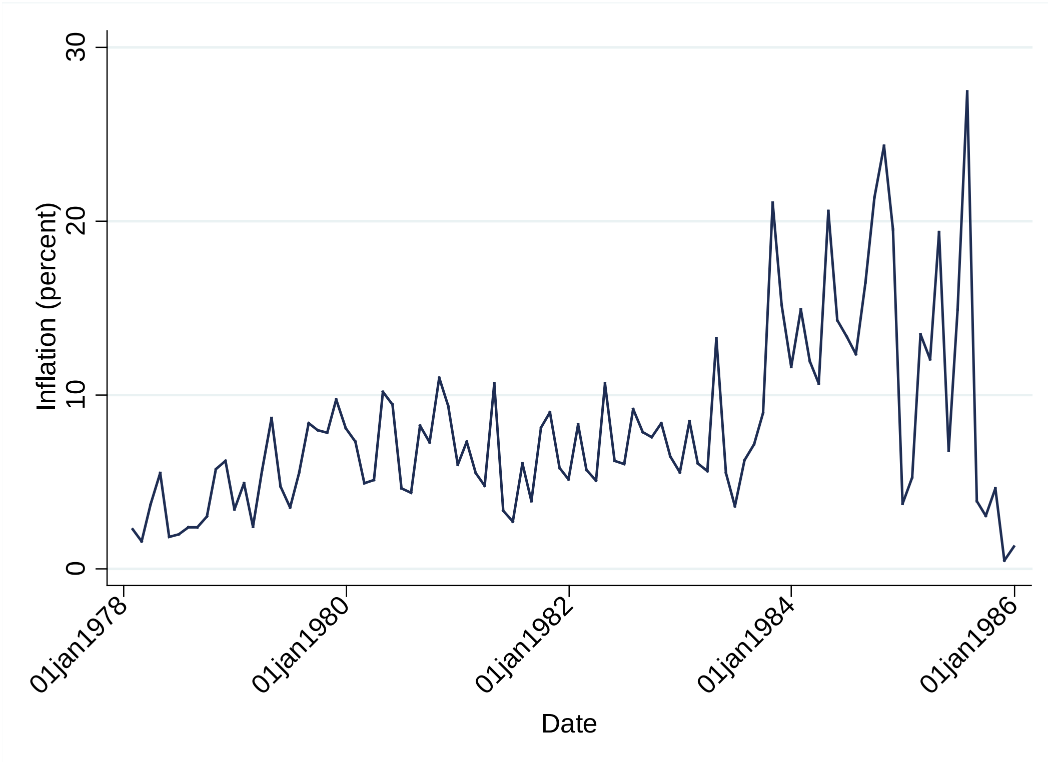
In the regressions in columns (2), (4) and (6), we include fixed effects for products×stores and for months. The coefficients remain positive: 1.24, 4.49 and 19.77 in the first, second and third periods, respectively. The second coefficient is significant at the 10% level. Thus, adding outliers does not change the direction of the effects – they remain positive. However, adding the outliers adds a lot of noise to the estimation, weakening the statistical significance of the coefficients.

A.4. Unit root tests

Our estimation is valid only if the time series data we are using is stationary. In this section, we show that for each period separately, Fischer type panel data unit-root test rejects the null hypothesis of a unit-root for our dependent and independent variables.

Table A7 reports the values of the test statistics for each sub-period. It can be seen from the table that for all sub-periods and for both variables, the null hypothesis of a unit root in all panels is strongly rejected.

Figure A1. Monthly inflation rate in Israel, January 1978–December 1985



Source: The Bank of Israel

Table A1. Summary statistics of the ELIs in the high inflation period data

	January 1978–June 1979				January 1981–December 1982				January 1984–October 1984			
ELI	**Average price**	**% 0-endings**	**% price changes**	***N***	**Average price**	**% 0-endings**	**% price changes**	***N***	**Average price**	**% 0-endings**	**% price changes**	***N***
Arak	31.157	28.176%	26.727%	333	35.047	39.264%	52.211%	475	368.462	50.131%	76.159%	151
	(7.579)	(17.119%)	(44.320%)		(18.038)	(17.763%)	(50.004%)		(194.504)	(16.377%)	(42.753%)	
Beef for soup	101.273	60.242%	47.059%	170	101.795	60.780%	64.567%	656	1292.395	67.420%	87.097%	217
	(18.929)	(15.562%)	(50.061%)		(48.046)	(13.029%)	(48.161%)		(67.421%)	(11.839%)	(33.601%)	
Challah bread	4.129	32.721	15.385%	247	8.285	35.398%	48.684%	304	118.379	45.533%	91.423%	105
	(0.908)	(21.894%)	(36.153%)		(4.367)	(22.312%)	(50.065%)		(55.379)	(18.706%)	(28.128%)	
Champagne	65.167	40.578%	23.500%	200	72.494	39.412%	48.035%	229	888.170	41.921%	75.510%	49
	(21.060)	(14.264%)	(42.506%)		(32.327)	(16.465%)	(50.071%)		(436.391)	(11.214%)	(43.448%)	
Chicken breast	74.023	52.855%	61.613%	620	87.908	53.134%	65.820%	787	1338.134	61.475%	94.444%	324
	(27.612)	(17.936%)	(48.672%)		(63.643)	(14.805%)	(47.462%)		(560.765)	(11.790%)	(22.942%)	
Chicken liver	92.703	59.466%	43.678%	522	108.816	55.258%	59.146%	820	1364.855	59.732%	85.231%	325
	(17.031)	(14.698%)	(49.646%)		(55.258)	(14.941%)	(49.186%)		(658.936)	(14.424%)	(35.534%)	
Cocoa powder	24.481	35.491%	44.552%	413	9.294	39.323%	48.908%	595	190.672	50.848%	79.167%	240
	(6.589)	(19.107%)	(49.763%)		(4.439)	(19.102%)	(50.030%)		(103.162)	(15.391%)	(40.697%)	
Codfish	37.462	49.561%	48.322%	298	47.406	55.328%	65.166%	422	674.598	63.685%	83.660%	153
	(10.443)	(17.119%)	(50.056%)		(23.714)	(14.080%)	(47.701%)		(307.470)	(17.155%)	(37.094%)	
Drumsticks	34.036	47.643%	59.637%	441	43.997	48.361%	67.868%	666	728.301	59.837%	95.038%	262
	(13.254)	(14.043%)	(49.182%)		(26.599)	(14.660%)	(46.733%)		(333.778)	(12.545%)	(21.757%)	
Fish fillet	31.535	49.482%	50.662%	302	35.877	53.217%	61.663%	433	512.158	64.507%	88.268%	179
	(8.0445)	(14.846%)	(50.079%)		(16.042)	(16.303%)	(48.677%)		(288.291)	(15.357%)	(32.270%)	
Fresh beef	92.724	52.348%	56.676%	704	120.358	58.065	64.685%	841	1580.099	65.769%	91.391%	302
	(24.299)	(18.709%)	(59.488%)		(59.634)	(15.148)	(47.823%)		(739.340)	(12.552%)	(28.097%)	
Fresh beef liver	83.779	60.900%	46.847%	444	103.873	63.752%	58.855%	559	1308.887	68.974%	81.951	205
	(21.613)	(17.480%)	(49.956%)		(47.607)	(12.994%)	(49.254%)		(663.853)	(13.774%)	(38.553%)	
Frozen beef liver	57.038	53.006%	56.561%	442	59.293	57.250%	60.137%	730	764.841	63.183%	88.525%	244
	(14.270)	(17.061%)	(49.624%)		(31.118)	(13.225%)	(48.995%)		(460.631)	(14.308%)	(31.938%)	
Frozen goulash	53.543	48.908%	39.148%	751	66.076	43.584%	56.277%	940	939.078	52.006%	90.959%	365
	(23.797)	(14.450%)	(48.841%)		(35.011)	(15.261%)	(49.631%)		(354.430)	(15.270%)	(28.716%)	
Hock wine	18.107	35.061%	23.649%	296	21.878	39.624%	46.640%	506	306.630	47.576%	75.373%	134
	(4.785)	(12.737%)	(42.564%)		(11.104)	(15.885%)	(49.936%)		(172.506)	(11.837%)	(43.245%)	
Liquor	34.968	40.038%	18.777%	229	53.310	37.893%	52.198%	182	804.859	46.099%	76.829%	82
	(13.760)	(13.189%)	(39.139%)		(34.216)	(16.683%)	(50.089%)		(492.770)	(14.432%)	(42.452%)	
Grey mullet	64.710	54.450%	58.159%	239	78.046	58.615%	73.723%	411	1189.726	67.048%	84.459%	148
	(15.876)	(18.323%)	(49.433%)		(40.713)	(14.976%)	(44.068%)		(731.540)	(16.319%)	(36.352%)	
Red wine	18.517	38.123%	23.453%	307	23.120	36.349%	48.471%	425	301.539	48.672%	69.811%	106
	(5.512)	(13.896%)	(42.440%)		(12.674)	(14.726%)	(50.036%)		(160.791)	(12.943%)	(46.126%)	
Rice	12.784	39.345%	30.295%	373	13.558	42.511%	55.984%	493	160.879	54.681%	80.676%	207
	(1.446)	(14.064%)	(46.015%)		(4.691)	(14.364%)	(49.691%)		(98.528)	(12.628%)	(39.579%)	
Rose wine	24.888	39.735%	21.933%	269	32.531	42.794%	51.456%	412	497.100	46.889%	78.495%	93
	(7.320)	(14.640%)	(41.456%)		(18.016)	(14.363%)	(50.040%)		(284.349)	(12.274%)	(41.309)	
Steak	102.459	56.149%	52.137%	468	136.518	60.497%	62.519%	659	1792.29	66.381%	86.381%	257
	(28.431)	(14.101%)	(50.001%)		(65.983)	(11.415%)	(48.444%)		(842.881)	(10.998%)	(34.366%)	
Sweet red wine	20.086	36.277%	21.294%	371	27.238	37.698%	47.790%	362	329.594	48.425%	66.667%	129
	(6.098)	(13.712%)	(40.994%)		(15.255)	(14.895%)	(50.020%)		(169.920)	(11.726%)	(47.324%)	
Tea	8.745	36.486%	23.505%	485	11.705	35.534%	49.157%	415	225.900	50.789%	75.309%	162
	(0.795)	(23.065%)	(42.447%)		(4.980)	(19.941%)	(50.053%)		(104.737)	(12.189%)	(43.255%)	
Turkey breast	89.700	53.276%	60.412%	437	103.884	55.460%	69.231%	520	1324.909	60.107%	90.110%	182
	(25.775)	(16.345%)	(48.960%)		(59.480)	(13.290%)	(46.198%)		(752.998)	(14.809%)	(29.935%)	
Vodka	34.654	35.317%	22.569%	288	38.354	38.118%	49.550%	333	430.561	50.456%	69.492%	118
	(9.965)	(15.477%)	(41.877%)		(21.742)	(15.683%)	(50.073%)		(247.200)	(15.397%)	(46.241%)	
White vermouth	30.363	39.831%	22.472	267	32.530	35.178%	46.957%	230	543.966	42.069%	78.082	73
	(7.342)	(14.811%)	(41.818%)		(15.018)	(15.355%)	(50.016%)		(294.294)	(6.900%)	(41.655	

Notes: The table reports the summary statistics for the 26 ELIs in the sample. The first panel covers the data for the period January 1978–June 1979. The second panel covers the data for the period January 1981–December 1982. The third panel covers the data for the period January 1984–October 1984. The first column in each panel reports the average price. The second column reports the average percentage of consecutive right-most zeros in the prices. The third column reports the average percentage of prices that changed in a given month. The fourth column gives the number of observations. In parentheses are the standard deviations. Prices in the first panel are in Lira. Prices in the second and third panels are in Shekel (10 Lira = 1 Shekel).

Table A2. Price rigidity in case of non-consecutive price changes

	January 1978–June 1979		**January 1981–December 1982**		**January 1984–October 1984**	
	(1)	(2)	(3)	(4)	(5)	(6)
Share of consecutive right-most 0-endings	−0.27*** (0.053)	−0.21** (0.048)	−0.18** (0.083)	−0.19** (0.088)	−0.22*** (0.036)	−0.19*** (0.031)
Fixed effect for products	Yes	No	Yes	No	Yes	No
Fixed effect for product-store	No	Yes	No	Yes	No	Yes
Fixed effect for month	No	Yes	No	Yes	No	Yes
R^2	0.0010	0.0010	0.0002	0.0002	0.0007	0.0007
N	9,916	9,916	13,904	13,904	5,224	5,224

Notes: The table presents the results of estimating regressions of the probability of a price change. The dependent variable in all regressions is a dummy that equals 1 if a price has changed between consecutive observations. Columns (1), (3), and (5) report the results of OLS regressions. Columns (2), (4), and (6) report the results of fixed effect regressions. The main independent variable is the share of right-most consecutive zeros in the price. The regressions in columns (1), (3), and (5) include fixed effects for products. The regressions in columns (2), (4), and (6) include fixed effects for products×stores and for months. The R^2's are the overall R^2. Robust standard errors, clustered at the product level, are reported in parentheses. ** $p < 5\%$, *** $p < 1\%$

Table A3. Expanding the final inflationary sub-period to January 1984–June 1985

	(1)	**(2)**
Share of consecutive right-most 0-endings	−0.21*** (0.037)	−0.19*** (0.048)
Fixed effects for products	Yes	No
Fixed effects for product-store	No	Yes
Fixed effects for month	No	Yes
R^2	0.0000	0.0000
N	9,916	9,916

Note: The table presents the results of estimating regressions of the probability of a price change. The dependent variable in both regressions is a dummy that equals 1 if a price has changed between month $t - 1$ and month t. The main independent variable is the share of right-most consecutive zeros in the price. The regression in column (1) includes fixed effects for products. The regression in column (2) includes fixed effects for products×stores and for months. The R^2's are the overall R^2. Robust standard errors, clustered at the product level, are reported in parentheses. *** $p < 1\%$

Table A4. Using the number of consecutive right-most zeros as the independent variable

	January 1978–June 1979		**January 1981–December 1982**		**January 1984–October 1984**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Number of consecutive right-most 0-endings	−0.08*** (0.013)	−0.07*** (0.012)	−0.04* (0.021)	−0.05** (0.021)	−0.03*** (0.007)	−0.02*** (0.006)
Fixed effects for products	Yes	No	Yes	No	Yes	No
Fixed effects for product-store	No	Yes	No	Yes	No	Yes
Fixed effects for month	No	Yes	No	Yes	No	Yes
R^2	0.0020	0.0020	0.0009	0.0009	0.0002	0.0002
N	9,916	9,916	13,405	13,405	4,812	4,812

Notes: The table reports the results of estimating regressions of the probability of a price change. The dependent variable in all regressions is a dummy that equals 1 if a price has changed between month $t-1$ and month t. Columns (1), (3), and (5) report the results of OLS regressions. Columns (2), (4), and (6) report the results of fixed effect regressions. The main independent variable is the number of right-most consecutive zeros in the price. The regressions in columns (1), (3), and (5) include fixed effects for products. The regressions in columns (2), (4), and (6) include fixed effects for products×stores and for months. The $R^{2'}$s are the overall R^2. Robust standard errors, clustered at the product level, are reported in parentheses. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table A5. Probability of a price change when prices are denoted in Israeli Liras instead of Shekels

	January 1981–December 1982		**January 1984–October 1984**	
	(1)	**(2)**	**(3)**	**(4)**
Share of consecutive right-most 0-endings	−0.20** (0.083)	−0.23** (0.087)	−0.20*** (0.038)	−0.15*** (0.037)
Fixed effect for products	Yes	No	Yes	No
Fixed effect for product-store	No	Yes	No	Yes
Fixed effect for month	No	Yes	No	Yes
R^2	0.0000	0.0001	0.0003	0.0003
N	13,405	13,405	4,812	4,812

Notes: The table reports the results of estimating regression equations for the probability of a price change. The dependent variable in all regressions is a dummy that equals 1 if a price has changed between month $t-1$ and month t. Columns (1), and (3) report the results of OLS regressions. Columns (2) and (4) report the results of fixed effect regressions. The main independent variable is the share of right-most consecutive zeros in the price. The regressions in columns (1) and (3) include fixed effects for products. The regressions in columns (2) and (4) include fixed effects for products×stores and for months. The $R^{2'}$s are the overall R^2. Robust standard errors, clustered at the product level, are reported in parentheses. ** $p < 5\%$, *** $p < 1\%$

Table A6. Absolute size of price changes, with the outliers included

	January 1978–June 1979		January 1981–December1982		January 1984–October 1984	
	(1)	(2)	(3)	(4)	(5)	(6)
Share of right-most zero endings	0.86 (1.035)	1.24 (1.784)	3.48 (2.129)	4.49* (2.323)	9.06 (6.43)	19.77 (16.656)
Fixed effect for products	Yes	No	Yes	No	Yes	No
Fixed effect for products×stores	No	Yes	No	Yes	No	Yes
Fixed effect for months	No	Yes	No	Yes	No	Yes
R^2	0.0006	0.0006	0.0000	0.0000	0.0001	0.0001
N	7,755	7,755	7802	7802	4,073	4,073

Notes: The table reports the results of OLS regressions of the absolute size of price changes. The dependent variable in all regressions is the absolute size of price changes between month $t-1$ and month t, in the case where the price has changed. The main independent variable is the share of consecutive right-most zero endings in the price. The regressions in columns (1), (3) and (5) include fixed effects for products. The regressions in columns (2), (4) and (6) include fixed effects for products×stores and for months. The R^{2}'s are the overall R^2. Robust standard errors, clustered at the product level, are reported in parentheses. * $p < 10\%$. ** $p < 5\%$

Table A7. Fischer type panel data unit root test

	January 1978–June 1979	**January 1981–December 1982**	**January 1984–October 1984**
Price-change	7,432.9	11,500.0	2,273.0
Share of consecutive right-most 0-endings	3,536.3	6,135.6	4,194.1

Notes: The table presents the results of Fischer type panel data unit-root tests for each of the three sub-periods. The test statistic follows the χ^2 distribution.

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