Differential Price Pass-through between Downstream Markets after Common Upstream Price Changes

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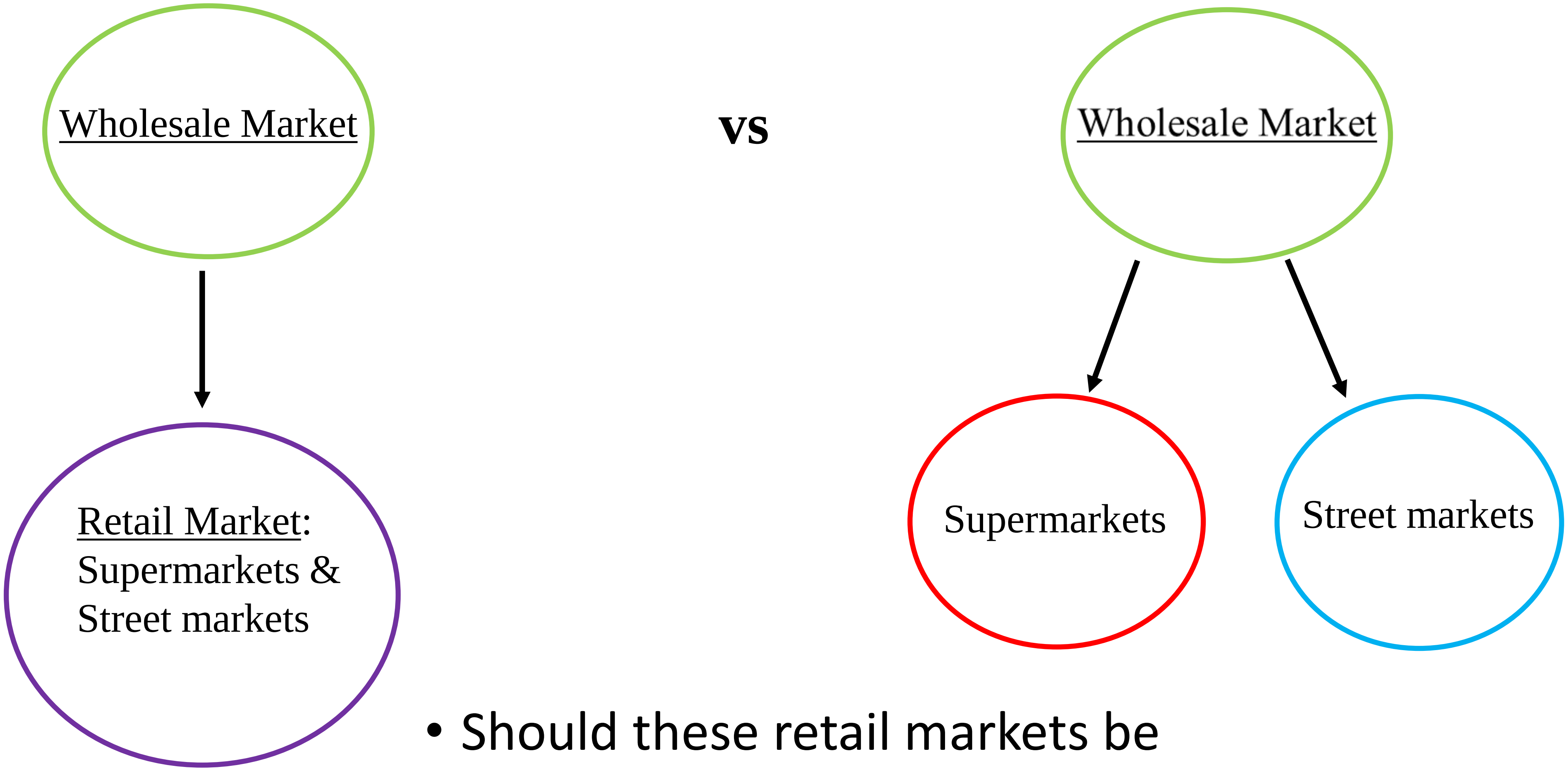
Introduction

- Social and political concerns about the extent and speed with which cost shocks are transmitted between different levels of the supply chain have triggered a plethora of economists to study price pass-through in different markets.
- The common belief among consumers that retail price increases are faster and of higher magnitude than decreases following a cost shock, was empirically confirmed for the US gasoline market by the early study of Bacon (1991), naming that situation as the broadly known “rockets and feathers”.
- As a consequence, firms may enjoy greater profits, while consumers may find it costly, since they gain less from price decreases than they lose when prices increase.
- Genakos and Pagliero (2022) and Bajo-Buenestado and Borrella-Mas (2022) go a step further by studying (tax) pass-through in different geographical markets (Greek islands and Spanish states, respectively).
- Yet, there is not enough empirical evidence to examine potential differences in pass-through between two distinct retail markets from a consumer-choice point of view.

Setting

- I concentrate on the fruit and vegetables (f&v) market in Athens, Greece.
- This market provides an ideal setting of an oligopolistic and vertically non-integrated market.
- The Greek market for f&v includes three levels: the production, the wholesale and the retail level.
- Wholesalers (Central Market) sell to supermarkets, street markets, grocery stores, and restaurants.
- Supermarkets typically buy from wholesalers and product unions, but nowadays they also buy directly from producers.
- At the same time, there are almost 195 street markets in Athens, where 10,000 sellers operate and 50 percent of them are producers themselves, whereas the remaining 50 percent are professional sellers (Genakos *et al*; 2018).
- The fact that consumers typically buy f&v from supermarkets and street markets, provides a unique setup to examine potential differences between these two markets considering that substitution effects may occur.

Setting & Research Question



- Should these retail markets be considered as a single market?

Data

- Several datasets are utilized for this paper. First, weekly store-level retail prices originate from the Ministry for Development and Competitiveness and cover the period from 8 February, 2010 to 8 August, 2013 for 24 supermarkets and 26 street markets.
- Second, wholesale median prices were obtained from the administration of the Central Market for the same period and concern a three times per week frequency.
- Prices were later averaged to have common frequencies.
- Fourteen products (apples, cucumber, eggplant, fresh onion, greens, lemon, lettuce, onion, orange, pepper, potato, spinach, tomato, and zucchini) were examined for this study.
- The selection of products is driven by two facts. First, to study products that are common in all markets and second, not to have products with missing observations during the sample period (since, missing observations discourages the implementation of the NARDL model).

Average Retail and Wholesale Prices

	Supermarkets				Street Markets				Wholesale			
Product	Mean	Min	Max	St. Dev.	Mean	Min	Max	St. Dev.	Mean	Min	Max	St. Dev.
Apple	1.48	1.18	2,00	0.15	1.35	0.97	2.13	0.21	0.86	0.70	1.11	0.12
Cucumber	0.45	0.24	0.84	0.14	0.46	0.26	0.77	0.08	0.25	0.11	0.51	0.08
Eggplant	1.74	0.75	3.55	0.76	1.64	0.66	3.45	0.64	0.84	0.30	2.18	0.35
Fresh onion	1.25	0.83	2.98	0.3	1.66	1.30	2.33	0.19	0.72	0.46	2.03	0.30
Greens	0.87	0.70	1.30	0.13	1.26	1.01	2.08	0.20	0.55	0.41	1.31	0.16
Lemon	1.20	0.73	2.07	0.36	1.23	0.81	2.29	0.40	0.74	0.40	1.58	0.28
Lettuce	0.46	0.29	0.73	0.10	0.52	0.43	0.63	0.04	0.33	0.20	0.58	0.07
Onion	0.53	0.32	0.95	0.15	0.71	0.52	1.09	0.13	0.39	0.22	0.72	0.13
Orange	0.71	0.46	1.35	0.15	0.69	0.42	1.05	0.15	0.46	0.30	0.85	0.12
Pepper	1.83	0.92	3.8	0.73	1.71	0.93	3.58	0.61	1.05	0.48	2.64	0.52
Potato	0.69	0.41	1.14	0.18	0.74	0.57	0.98	0.10	0.47	0.32	0.72	0.09
Spinach	1.08	0.53	1.85	0.22	1.34	0.90	2.18	0.27	0.62	0.40	1.30	0.13
Tomato	1.55	0.91	2.25	0.28	1.26	0.82	2.04	0.23	0.81	0.38	1.66	0.26
Zucchini	1.34	0.66	2.42	0.47	1.43	0.72	2.66	0.46	0.78	0.35	1.86	0.33

Empirical Methodology

- The Non-Linear Autoregressive Distributed Lags (NARDL) model, advanced by Shin *et al*. (2014), is adopted.
- This model allows for both long and short-run asymmetries among economic variables and it is the asymmetric expansion of the linear ARDL model proposed by Pesaran and Shin (1998) and Pesaran *et al*. (2001).
- The nonlinear ARDL (p, q) is of the form:
- $$\Delta r_t = \mu + \rho r_{t-1} + \theta^+ w_{t-1}^+ + \theta^- w_{t-1}^- + \sum_{i=1}^{p-1} a_i \Delta r_{t-i} + \sum_{i=0}^{q-1} \gamma_i^+ \Delta w_{t-i}^+ + \sum_{i=0}^{q-1} \gamma_i^- \Delta w_{t-i}^- + e_t, \quad (1)$$
- where, r_t is the logarithm of retail prices at time t, w_{t-1}^+ and w_{t-1}^- are lagged partial sum processes of positive and negative changes in the logarithm of wholesale prices w_t, such as:
- $w_{t-1}^+ = \sum_{i=1}^{t-1} \Delta w_i^+ = \sum_{i=1}^{t-1} max\,(\Delta w_i \,, 0)$ *and* $w_{t-1}^- = \sum_{i=1}^{t-1} \Delta w_i^- = \sum_{i=1}^{t-1} min\,(\Delta w_i \,, 0)$.

Empirical Methodology

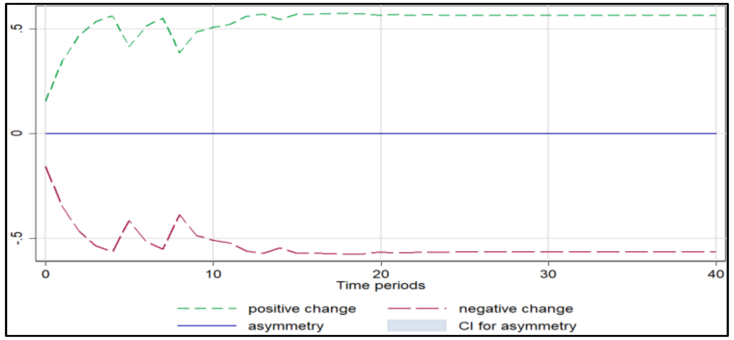
- After the estimation of (1), three steps follow.
- First, the model should be tested for the existence of a nonlinear cointegrating long-run relationship between the levels of r_t, w_t^+, and w_t^- in (1).
- This can be tested under two approaches.
- Under the Banerjee *et al*. (1998) approach, the null hypothesis of no cointegration ($\rho = 0$) against the alternative ($\rho < 0$) is tested using the t_{BDM} statistic.
- Under the Shin *et al*. (2014) approach, the joint null of no cointegration ($\rho = \theta^+ = \theta^- = 0$) is tested using the F_{PSS} statistic in (1) extending "bounds testing" approach, advanced by Pesaran *et al*. (2001).
- Second, model in equation (1) should be tested for long and short-run asymmetries. The long-run symmetry is tested by a Wald test, where the null is $\beta^+ = \beta^-$ (i.e. $-\theta^+/\rho = -\theta^-/\rho$).
- In case the null fails to be rejected, then the model should be reestimated taking the form:

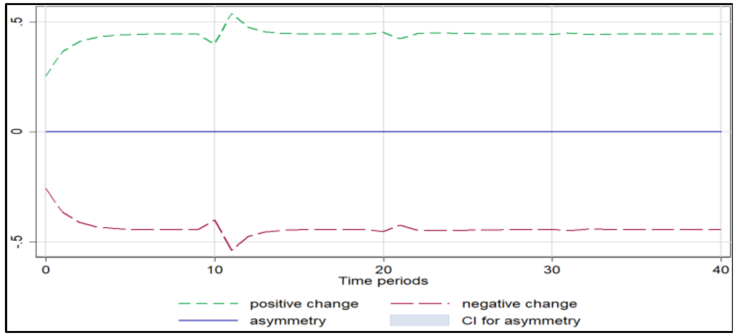
Empirical Methodology

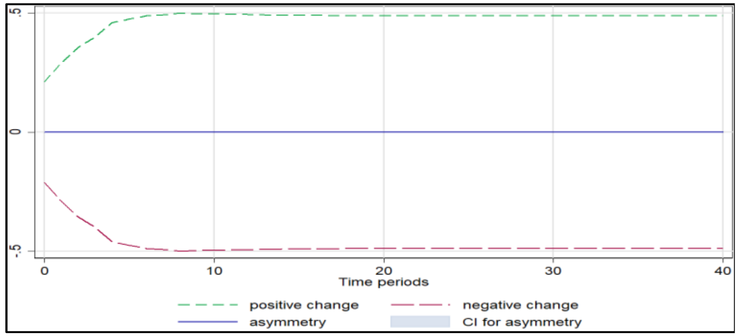
- $\Delta r_t = \mu + \rho r_{t-1} + \theta w_{t-1} + \sum_{i=1}^{p-1} a_i \Delta r_{t-i} + \sum_{i=0}^{q-1} \gamma_i^+ \Delta w_{t-i}^+ + \sum_{i=0}^{q-1} \gamma_i^- \Delta w_{t-i}^- + e_t,$ (2)
- The short-run symmetry is also tested by a Wald test and can be of two forms: either test $\gamma_i^+ = \gamma_i^-$ for all i = 0,…, q-1 (strong form), or test $\sum_{i=0}^{q-1} \gamma_i^+ = \sum_{i=0}^{q-1} \gamma_i^-$ (weak form). If no short-run asymmetry is detected the model becomes:
- $\Delta r_t = \mu + \rho r_{t-1} + \theta^+ w_{t-1}^+ + \theta^- w_{t-1}^- + \sum_{i=1}^{p-1} a_i \Delta r_{t-i} + \sum_{i=0}^{q-1} \gamma_i \Delta w_{t-i} + e_t,$ (3)
- If both long and short-run symmetries fail to be rejected, the model collapses to:
- $\Delta r_t = \mu + \rho r_{t-1} + \theta w_{t-1} + \sum_{i=1}^{p-1} a_i \Delta r_{t-i} + \sum_{i=0}^{q-1} \gamma_i \Delta w_{t-i} + e_t$. (4)
- Finally, the cumulative dynamic multipliers are derived, which measure the cumulative effect of wholesale price changes on retail prices. These are calculated as:
- $m_h^+ = \sum_{i=0}^{h} \frac{\partial r_{t+i}}{\partial w_t^+}$ and $m_h^- = \sum_{i=0}^{h} \frac{\partial r_{t+i}}{\partial w_t^-}$, for h = 0, 1, 2,…
- Note that, as h → ∞, $m_h^+ \rightarrow \beta^+$ and $m_h^- \rightarrow \beta^-$, where $\beta^+ = -\theta^+/\rho$ and $\beta^- = -\theta^-/\rho$

Empirical Results – (Spinach)

Supermarkets			Street Markets			Average Pass-through		
Symmetric ARDL			Symmetric ARDL			Symmetric ARDL		
Var.	Coeff.	S.E.	Var.	Coeff.	S.E.	Var.	Coeff.	S.E.
r_{t-1}	-0.467***	(0.061)	r_{t-1}	-0.583***	(0.071)	r_{t-1}	-0.392***	(0.067)
w_{t-1}	0.264***	(0.058)	w_{t-1}	0.259***	(0.054)	w_{t-1}	0.192***	(0.046)
Δr_{t-2}	0.117*	(0.065)	Δr_{t-10}	-0.175**	(0.067)	Δr_{t-1}	-0.141*	(0.075)
Δr_{t-6}	0.167**	(0.065)	Δw_{t}	0.256***	(0.069)	Δr_{t-4}	0.145**	(0.069)
Δw_{t}	0.157**	(0.076)	Δw_{t-11}	0.131**	(0.064)	Δw_{t}	0.212***	(0.058)
Δw_{t-5}	-0.158**	(0.073)						
Δw_{t-8}	-0.203***	(0.071)						
Const.	-0.009	(0.008)	Const.	-0.021***	(0.008)	Const.	-0.010*	(0.006)
L_W	0.565***	[0.000]	L_W	0.445***	[0.000]	L_W	0.490***	[0.000]
Adj. R^2	0.31		Adj. R^2	0.335		Adj. R^2	0.263	
X^2_{SC}	16.459	[0.171]	X^2_{SC}	11.842	[0.458]	X^2_{SC}	9.243	[0.682]
X^2_{HET}	0.016	[0.900]	X^2_{HET}	0.577	[0.448]	X^2_{HET}	1.845	[0.174]
t_{BDM}	-7.596	[0.000]	t_{BDM}	-8.193	[0.000]	t_{BDM}	-5.856	[0.000]
F_{PSS}	29.233	[0.000]	F_{PSS}	33.621	[0.000]	F_{PSS}	17.318	[0.000]

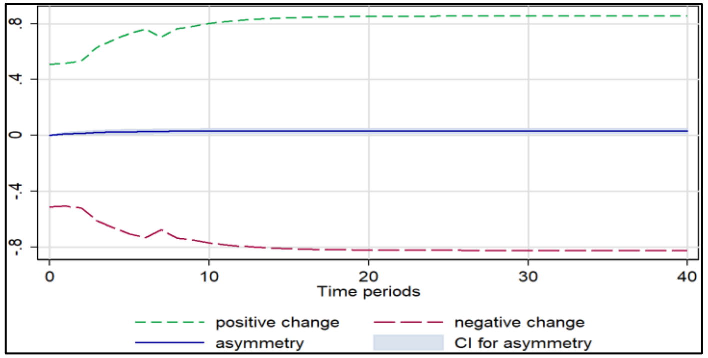


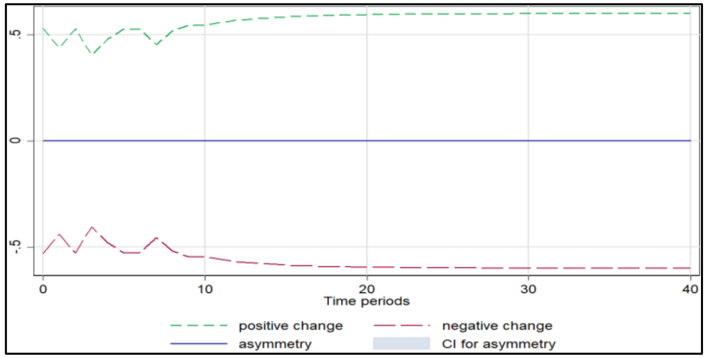


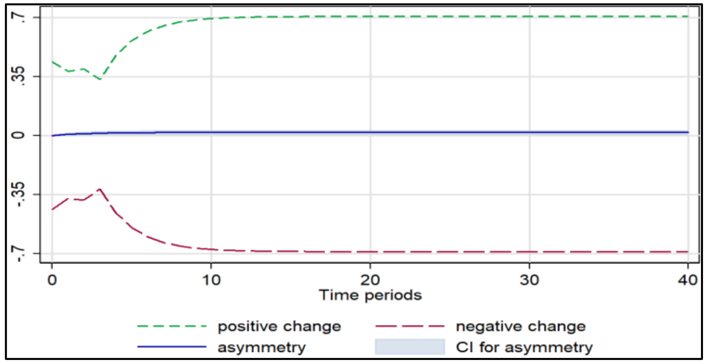


Lemon

Supermarkets			Street Markets			Average Pass-through		
NARDL with LR asymmetry			Symmetric ARDL			NARDL with LR asymmetry		
Var.	Coeff.	S.E.	Var.	Coeff.	S.E.	Var.	Coeff.	S.E.
r_{t-1}	-0.320***	(0.059)	r_{t-1}	-0.334***	(0.074)	r_{t-1}	-0.381***	(0.055)
w_{t-1}^{+}	0.273***	(0.059)	w_{t-1}	0.200***	(0.047)	w_{t-1}^{+}	0.270***	(0.049)
w_{t-1}^{-}	0.263***	(0.059)	Δr_{t-1}	-0.216***	(0.066)	w_{t-1}^{-}	0.262***	(0.049)
Δr_{t-1}	-0.204***	(0.062)	Δr_{t-2}	-0.201***	(0.073)	Δw_{t}	0.438***	(0.045)
Δw_{t-1}	0.510***	(0.053)	Δw_{t}	0.530***	(0.055)	Δw_{t-1}	-0.159***	(0.051)
Δw_{t-2}	-0.089*	(0.051)	Δw_{t-2}	0.122*	(0.066)	Δw_{t-2}	-0.111**	(0.048)
Δw_{t-7}	-0.081*	(0.048)	Δw_{t-3}	-0.146***	(0.053)	Δw_{t-3}	-0.182***	(0.046)
			Δw_{t-7}	-0.087*	(0.049)			
Const.	-0.030**	(0.014)	Const.	0.006	(0.005)	Const.	-0.017*	(0.010)
L_{W^+}	0.856***	[0.000]	L_{W}	0.599***	[0.000]	L_{W^+}	0.707**	[0.000]
L_{W^-}	0.822***	[0.000]				L_{W^-}	0.689***	[0.000]
Adj. R^2	0.490		Adj. R^2	0.587		Adj. R^2	0.550	
X_{SC}^{2}	8.549	[0.575]	X_{SC}^{2}	5.977	[0.817]	X_{SC}^{2}	5.790	[0.926]
X_{HET}^{2}	0.052	[0.820]	X_{HET}^{2}	2.248	[0.134]	X_{HET}^{2}	2.521	[0.112]
t_{BDM}	-5.412	[0.000]	t_{BDM}	-4.498	[0.000]	t_{BDM}	-6.864	[0.000]
F_{PSS}	10.913	[0.000]	F_{PSS}	12.276	[0.000]	F_{PSS}	16.376	[0.000]

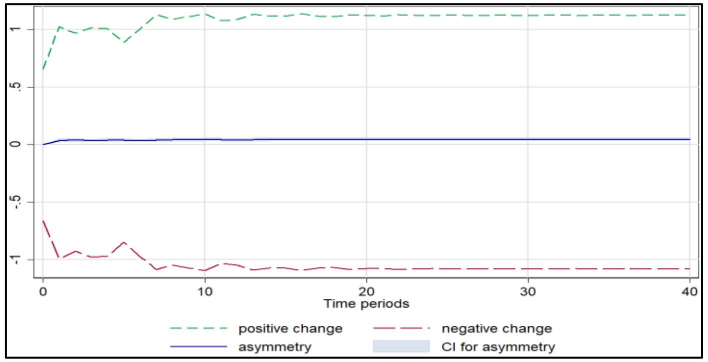


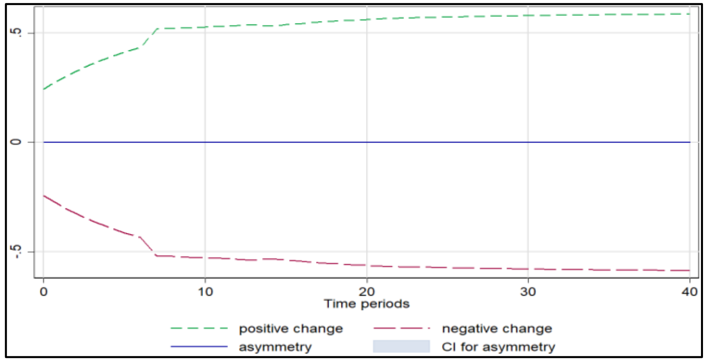


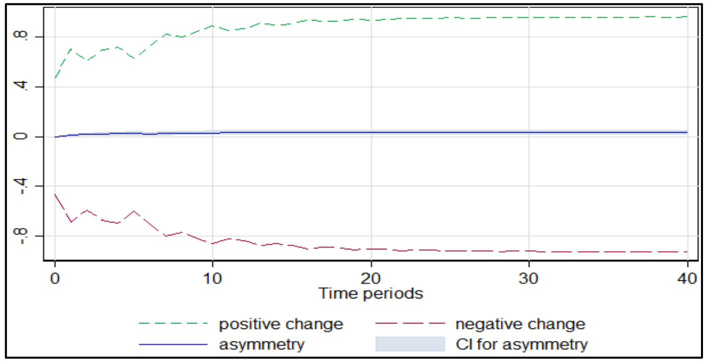


Potato

Supermarkets			Street Markets			Average Pass-through		
NARDL with LR asymmetry			Symmetric ARDL			NARDL with LR asymmetry		
Var.	Coeff.	S.E.	Var.	Coeff.	S.E.	Var.	Coeff.	S.E.
r_{t-1}	-0.786***	(0.129)	r_{t-1}	-0.125***	(0.038)	r_{t-1}	-0.373***	(0.117)
w^+_{t-1}	0.884***	(0.128)	w_{t-1}	0.074***	(0.028)	w^+_{t-1}	0.359***	(0.098)
w^-_{t-1}	0.849***	(0.124)	Δr_{t-7}	-0.154**	(0.073)	w^-_{t-1}	0.346***	(0.094)
Δr_{t-2}	-0.205**	(0.090)	Δw_t	0.243***	(0.044)	Δr_{t-1}	-0.247***	(0.106)
Δr_{t-4}	-0.158**	(0.072)	Δw_{t-7}	0.102**	(0.046)	Δr_{t-2}	-0.289***	(0.125)
Δr_{t-5}	-0.218***	(0.075)				Δr_{t-4}	-0.173***	(0.082)
Δw_t	0.660***	(0.106)				Δr_{t-5}	-0.239***	(0.083)
						Δw_t	0.466***	(0.077)
						Δw_{t-1}	0.168*	(0.093)
Const.	-0.066***	(0.012)	Const.	0.005	(0.003)	Const.	-0.010*	(0.006)
L_{W^+}	1.124***	[0.000]	L_W	0.589***	[0.000]	L_{W^+}	0.962***	[0.000]
L_{W^-}	1.080***	[0.000]				L_{W^-}	0.927***	[0.000]
Adj. R^2	0.595		Adj. R^2	0.201		Adj. R^2	0.499	
X^2_{SC}	17.951	[0.129]	X^2_{SC}	12.214	[0.429]	X^2_{SC}	17.573	[0.129]
X^2_{HET}			X^2_{HET}	0.272	[0.602]	X^2_{HET}		
t_{BDM}	-6.094	[0.000]	t_{BDM}	-3.337	[0.001]	t_{BDM}	-3.188	[0.002]
F_{PSS}	16.635	[0.000]	F_{PSS}	5.572	[0.005]	F_{PSS}	4.972	[0.003]

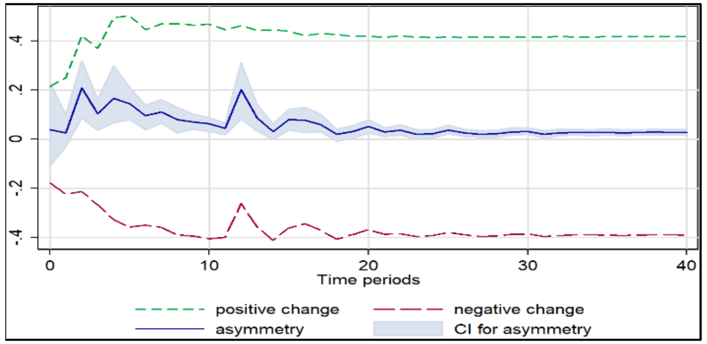


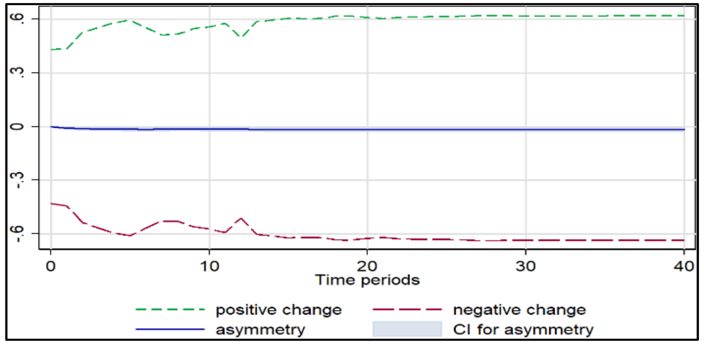


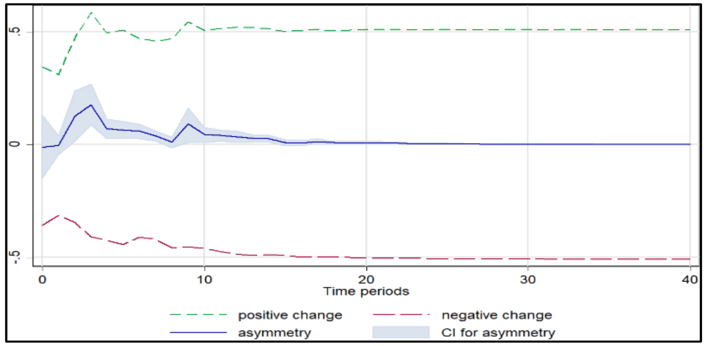


Greens

Supermarkets			Street Markets			Average Pass-through		
NARDL with LR and SR asymmetry			NARDL with LR asymmetry			NARDL with SR asymmetry		
Var.	Coeff.	S.E.	Var.	Coeff.	S.E.	Var.	Coeff.	S.E.
r_{t-1}	-0.398***	(0.063)	r_{t-1}	-0.501***	(0.074)	r_{t-1}	-0.399***	(0.061)
w_{t-1}^{+}	0.166***	(0.034)	w_{t-1}^{+}	0.310***	(0.046)	w_{t-1}	0.203***	(0.035)
w_{t-1}^{-}	0.155***	(0.033)	w_{t-1}^{-}	0.318***	(0.046)	Δr_{t-1}	-0.292***	(0.062)
Δr_{t-1}	-0.211***	(0.066)	Δr_{t-1}	-0.213***	(0.063)	Δr_{t-2}	-0.165***	(0.061)
Δr_{t-2}	-0.382***	(0.065)	Δr_{t-6}	-0.123**	(0.060)	Δr_{t-6}	-0.143**	(0.057)
Δr_{t-4}	0.110*	(0.065)	Δr_{t-7}	-0.190***	(0.064)	Δr_{t-7}	-0.120**	(0.058)
Δr_{t-5}	0.194***	(0.063)	Δr_{t-8}	-0.108*	(0.060)	Δw_{t}^{+}	0.345***	(0.054)
Δr_{t-10}	0.119*	(0.061)	Δw_{t}	0.430***	(0.051)	Δw_{t-2}^{+}	0.129**	(0.062)
Δw_{t}^{+}	0.215***	(0.064)	Δw_{t-12}	-0.099**	(0.049)	Δw_{t-3}^{+}	0.141**	(0.054)
Δw_{t-2}^{+}	0.195***	(0.072)				Δw_{t-9}^{+}	0.097*	(0.055)
Δw_{t-4}^{+}	0.136*	(0.069)				Δw_{t}^{-}	0.358***	(0.062)
Δw_{t}^{-}	0.178**	(0.078)						
Δw_{t-12}^{-}	-0.135**	(0.068)						
Const.	-0.073***	(0.014)	Const.	-0.074***	(0.014)	Const.	-0.064***	(0.010)
L_{W^+}	0.418***	[0.000]	L_{W^+}	0.619***	[0.000]	L_W	0.509***	[0.000]
L_{W^-}	0.390***	[0.000]	L_{W^-}	0.635***	[0.000]			
Adj. R^2	0.463		Adj. R^2	0.461		Adj. R^2	0.492	
X_{SC}^2	6.431	[0.893]	X_{SC}^2	8.153	[0.773]	X_{SC}^2	3.457	[0.991]
X_{HET}^2	0.842	[0.359]	X_{HET}^2	0.257	[0.612]	X_{HET}^2	0.041	[0.839]
t_{BDM}	-6.304	[0.000]	t_{BDM}	-6.781	[0.000]	t_{BDM}	-6.560	[0.000]
F_{PSS}	13.505	[0.000]	F_{PSS}	16.774	[0.000]	F_{PSS}	21.898	[0.000]

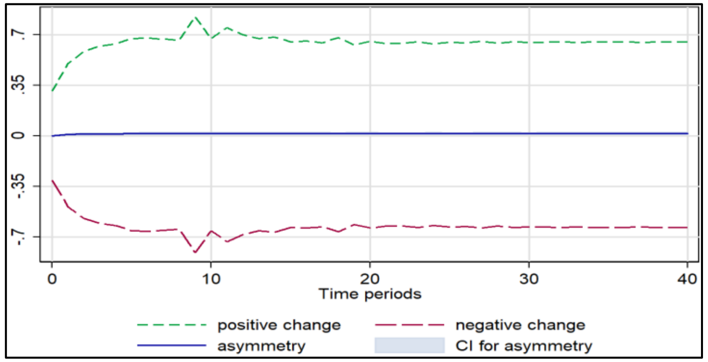


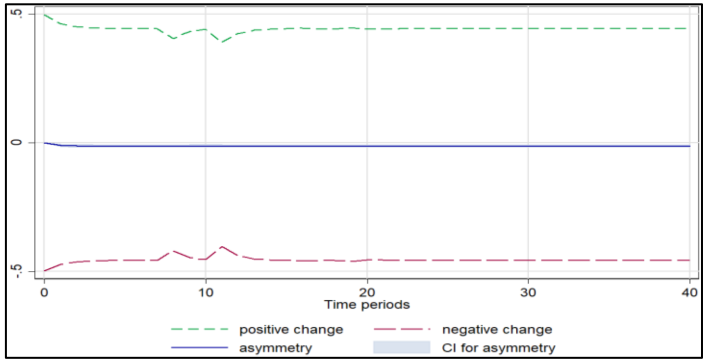


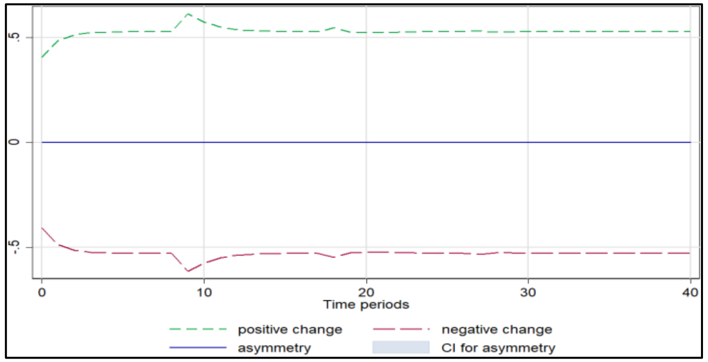


Zucchini

Supermarkets			Street Markets			Average Pass-through		
NARDL with LR asymmetry			NARDL with LR asymmetry			Symmetric ARDL		
Var.	Coeff.	S.E.	Var.	Coeff.	S.E.	Var.	Coeff.	S.E.
r_{t-1}	-0.564***	(0.060)	r_{t-1}	-0.647***	(0.072)	r_{t-1}	-0.653***	(0.065)
w^+_{t-1}	0.366***	(0.041)	w^+_{t-1}	0.288***	(0.047)	w_{t-1}	0.345***	(0.038)
w^-_{t-1}	0.358***	(0.040)	w^-_{t-1}	0.296***	(0.047)	Δr_{t-9}	0.209***	(0.043)
Δr_{t-5}	0.096*	(0.053)	Δr_{t-8}	-0.076*	(0.045)	Δw_t	0.407***	(0.028)
Δr_{t-9}	0.216***	(0.060)	Δw_t	0.499***	(0.036)			
Δw_t	0.308***	(0.039)	Δw_{t-11}	-0.053*	(0.031)			
Δw_{t-9}	0.102**	(0.041)						
Δw_{t-10}	-0.097**	(0.038)						
Δw_{t-11}	0.071*	(0.038)						
Const.	0.014	(0.016)	Const.	0.176***	(0.026)	Const.	0.110***	(0.013)
L_{W^+}	0.648***	[0.000]	L_{W^+}	0.444***	[0.000]	L_W	0.529***	[0.000]
L_{W^-}	0.634***	[0.000]	L_{W^-}	0.458***	[0.000]			
Adj. R^2	0.543		Adj. R^2	0.632		Adj. R^2	0.668	
X^2_{SC}	11.657	[0.474]	X^2_{SC}	10.283	[0.591]	X^2_{SC}	10.962	[0.532]
X^2_{HET}	14.368	[0.114]	X^2_{HET}	0.161	[0.688]	X^2_{HET}	6.254	[0.181]
t_{BDM}	-9.405	[0.000]	t_{BDM}	-8.998	[0.000]	t_{BDM}	-10.024	[0.000]
F_{PSS}	33.904	[0.000]	F_{PSS}	27.880	[0.000]	F_{PSS}	51.059	[0.000]







Summarizing Long-run Results

	Super Markets	Street Markets	"Average"		Super Markets	Street Markets	"Average"
Apple	LR +	LR +	LR +	F.Onion	sym	sym	sym
Spinach	sym	sym	sym	Eggplant	sym	LR -	sym
Lemon	LR +	sym	LR +	Greens	LR +	LR -	sym
Onion	LR +	sym	LR +	Lettuce	LR +	LR -	sym
Potato	LR +	sym	LR +	Orange	LR +	LR -	sym
Cucumber	LR +	sym	LR +	Pepper	LR +	LR -	sym
Tomato	LR +	sym	sym	Zucchini	LR +	LR -	sym

Discussion

- Overall, mixed evidence was found for the price transmission patterns between supermarkets and street markets, specifically:
- **Supermarkets: 11/ 14** ➡ LR + **vs street markets: 6/ 14** ➡ LR -
- More specifically, 4 products (apple, spinach, fresh onion, and eggplant) share almost the same path towards the new equilibrium in both supermarkets and street markets.
- Interestingly, 5 products (lemon, onion, potato, tomato, and cucumber) share another common pattern, they establish positive price asymmetries at supermarkets, whereas they exhibit symmetric price responses at street markets.
- More interestingly, for 5 products (greens, lettuce, orange, pepper, and zucchini) results indicate positive long-run asymmetries at supermarkets and negative ones at street markets.

Possible Explanations

- According to Ward (1982), product's perishability could explain the fact that wholesale price decreases are reflected more than wholesale price increases to retail prices in the f&v market. He points out that: "rising prices could reduce retail sales and increase the incidence of spoilage".
- The products he examined have differences according to their shelf-lives. They span from a few days (tomatoes, corn) to almost more than a month (carrots, potatoes).
- Going a step further, I tried to explain the non-identical phenomenon between supermarkets and street markets using differences in products' shelf-lives.
- To this end, products are classified to "short" (a few days), "medium" (some weeks) and "long" (over a month) categories. This classification fails to explain the findings, since a non-monotonic relation was found.
- The same holds for the cases that: products are classified according to which market they are priced higher and when they are classified as "high" vs "low" cost products.

Possible Explanations

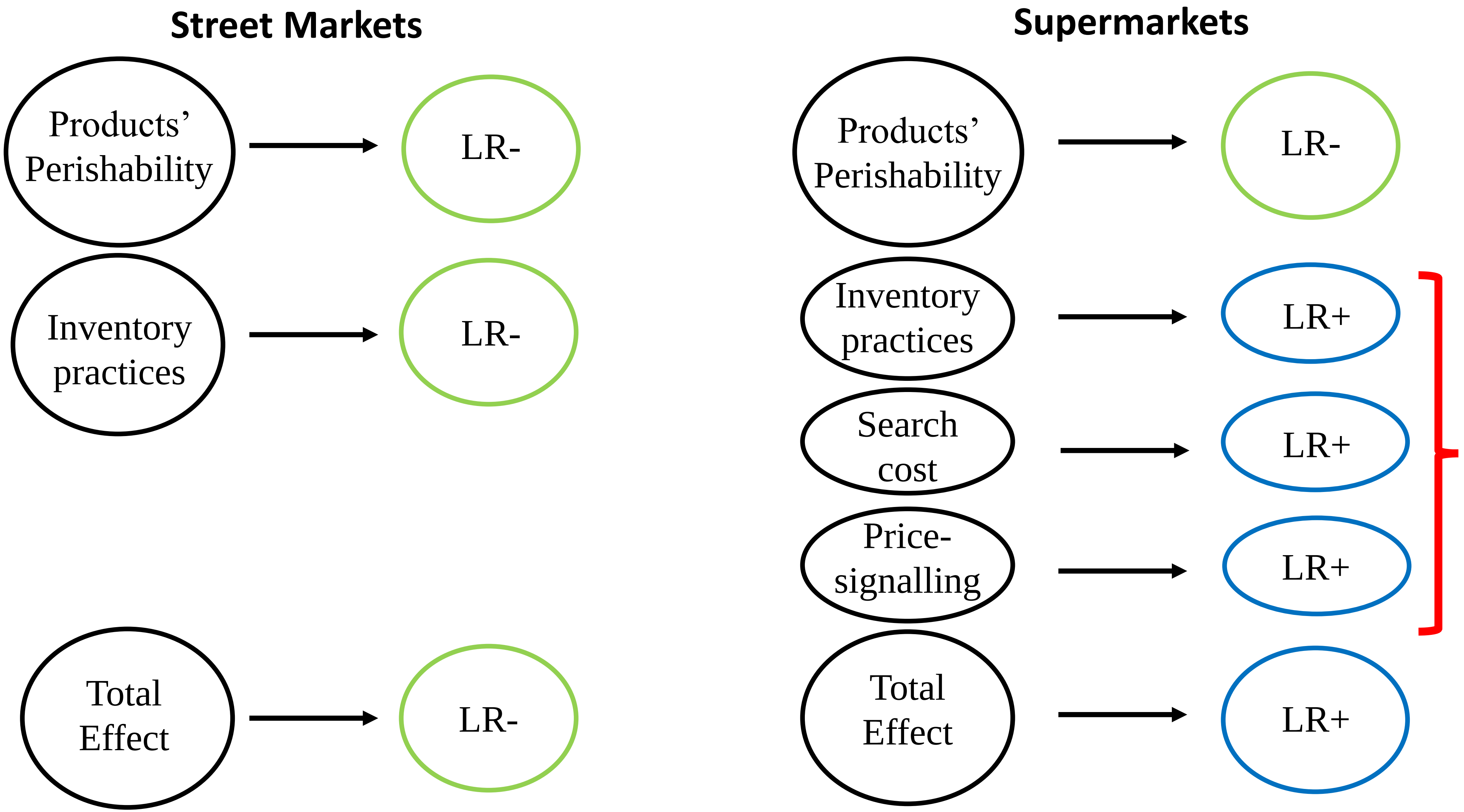
- Given f&v's perishability other reasoning could explain the opposite results between street markets and supermarkets.
- Inventory management techniques and search cost theory could offer such a reasoning.
- **Inventory management practices** at street markets reinforce f&v perishability effect. Sellers operating at street markets (producers and professional sellers), try to avoid transportation costs and re-storage costs of f&v excess supply. Hence, they increase prices mildly to avoid the possibility of being left with unsold products (while at the end of street markets operation they offer considerably high discounts).
- On the contrary, **inventory management techniques** have an opposite effect at supermarkets. Since about 10 percent of products quantity is discarded as spoilage, it seems that supermarkets care more about how to avoid stockouts than of being left with wasted products. To this end, they respond to a greater extent to wholesale price increases, than they do to decreases.

Possible Explanations

- Moreover, consumers typically visit supermarkets to buy a basket of products whilst, street markets offer just f&v. Hence, positive long-run asymmetries found at supermarkets may reflect savings on **search costs** for consumers. The consumers' unwillingness to search lowers the elasticity of demand that supermarket's chains face. This in turn may lead retailers to increase prices more quickly than they decrease them after wholesale price changes.

- Finally, collusive behaviour, through **price signalling**, among market players could explain the positive asymmetric price adjustment at supermarkets. Supermarket chains are obligated to report their prices at platforms such as e-prices. These platforms were designed to inform consumers about retail prices but, at the same time, every market player knows the price his competitor charges. This price signalling mechanism may result in sticky downward pricing. Especially, under imperfect monitoring by authorities (Borenstein *et al*; 1997).

Possible Explanations



Conclusion

- Overall, the results show that the examination of just the "average" case leads to misleading results. For 5 products (lemon, onion, potato, tomato, and cucumber), the positive long-run asymmetries, indicated by the "average" case, are driven by positive long-run asymmetries at supermarkets and are only partially mitigated by the symmetric price responses at street markets.

- Along the same line, for the 5 products (greens, lettuce, orange, pepper, and zucchini), the "average" case illustrates symmetric price responses, but these are the outcome of bipolar asymmetric responses between the two retail markets.

- Hence, care should be taken by competition authorities, when studying oligopolistic markets which can be separated to two distinct retail markets. While the "average" pass-through indicates symmetric price responses for some products, the results of the analysis for supermarkets and street markets indicate that this cannot be left without further investigation.

- Finally, this study informs market authorities, through indirect evidence, that while price comparison platforms/apps initially have been designed with the objective to inform consumers, they may have an adverse effect. They could act as a price-signalling mechanism to competitors and hence, in the presence of other factors may result in consumer harm.

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Appendix / Unit Root Tests

	Supermarkets				Street Markets				Wholesale			
Product	r_t	p-value	Δr_t	p-value	r_t	p-value	Δr_t	p-value	w_t	p-value	Δw_t	p-value
Apple	-2.214	[0.201]	-9.592***	[0.000]	-2.778*	[0.061]	-10.086***	[0.000]	-2.053	[0.264]	-9.758***	[0.000]
Cucumber	-4.306***	[0.000]	-13.180***	[0.000]	-4.904***	[0.000]	-11.953***	[0.000]	-4.197***	[0.001]	-10.853***	[0.000]
Eggplant	-6.794***	[0.000]	-13.361***	[0.000]	-6.361***	[0.000]	-12.655***	[0.000]	-6.120***	[0.000]	-11.453***	[0.000]
Fresh onion	-3.611***	[0.006]	-11.239***	[0.000]	-4.210***	[0.006]	-11.408***	[0.000]	-2.930**	[0.042]	-7.890***	[0.000]
Greens	-2.497	[0.116]	-7.383***	[0.000]	-2.794*	[0.060]	-8.794***	[0.000]	-3.417**	[0.010]	-10.606***	[0.000]
Lemon	-1.834	[0.364]	-7.180***	[0.000]	-2.825*	[0.055]	-7.560***	[0.000]	-2.627*	[0.088]	-6.893***	[0.000]
Lettuce	-4.787***	[0.000]	-10.721***	[0.000]	-4.401***	[0.000]	-12.952***	[0.000]	-4.471***	[0.000]	-8.983***	[0.000]
Onion	-2.107	[0.242]	-9.566***	[0.000]	-2.177	[0.215]	-8.688***	[0.000]	-2.256	[0.187]	-11.609***	[0.000]
Orange	-1.896	[0.334]	-9.492***	[0.000]	-1.613	[0.476]	-7.750***	[0.000]	-1.922	[0.322]	-8.998***	[0.000]
Pepper	-5.682***	[0.000]	-12.335***	[0.000]	-5.534***	[0.000]	-11.692***	[0.000]	-6.382***	[0.000]	-11.382***	[0.000]
Potato	-0.682	[0.851]	-5.555***	[0.000]	-1.617	[0.474]	-11.452***	[0.000]	-2.143	[0.228]	-11.538***	[0.000]
Spinach	-4.136***	[0.001]	-9.044***	[0.000]	-5.502***	[0.000]	-14.003***	[0.000]	-3.745***	[0.004]	-8.923***	[0.000]
Tomato	-4.679***	[0.000]	-11.771***	[0.000]	-4.454***	[0.000]	-10.967***	[0.000]	-5.230***	[0.000]	-11.641***	[0.000]
Zucchini	-6.357***	[0.000]	-11.577***	[0.000]	-5.978***	[0.000]	-12.908***	[0.000]	-4.092***	[0.001]	-8.820***	[0.000]

Appendix / Long-run and Short-run Symmetry Tests / Robustness

	Supermarkets								Street Markets							
	NARDL with LR and SR asymmetry				NARDL with LR asymmetry		NARDL with SR asymmetry		NARDL with LR and SR asymmetry				NARDL with LR asymmetry		NARDL with SR asymmetry	
Product	W_{LR}		W_{SR}		W_{LR}		W_{SR}		W_{LR}		W_{SR}		W_{LR}		W_{SR}	
Apple	4.820	[0.030]	0.097	[0.756]	5.643	[0.019]	0.232	[0.631]	7.315	[0.008]	1.119	[0.292]	5.932	[0.016]	0.307	[0.580]
Cucumber	13.890	[0.000]	4.308	[0.039]	15.070	[0.000]	4.530	[0.035]	1.646	[0.201]	8.028	[0.005]	1.973	[0.162]	8.432	[0.004]
Eggplant	1.569	[0.212]	0.777	[0.379]	2.352	[0.127]	0.908	[0.342]	5.644	[0.019]	1.325	[0.251]	3.160	[0.077]	0.648	[0.422]
Fresh onion	0.275	[0.601]	0.325	[0.569]	1.308	[0.254]	0.300	[0.585]	0.351	[0.554]	8.520	[0.004]	0.238	[0.627]	8.610	[0.004]
Greens	17.340	[0.000]	8.725	[0.004]	11.630	[0.001]	7.944	[0.005]	6.559	[0.011]	1.796	[0.182]	6.775	[0.010]	1.453	[0.230]
Lemon	7.309	[0.008]	2.081	[0.151]	10.730	[0.001]	2.177	[0.142]	1.669	[0.198]	0.074	[0.786]	1.621	[0.205]	0.018	[0.893]
Lettuce	7.286	[0.008]	0.273	[0.602]	7.574	[0.007]	0.080	[0.777]	29.310	[0.000]	15.150	[0.000]	20.180	[0.000]	15.890	[0.000]
Onion	11.080	[0.001]	0.216	[0.643]	10.060	[0.002]	0.008	[0.927]	0.699	[0.404]	0.445	[0.505]	0.379	[0.539]	0.373	[0.542]
Orange	4.930	[0.028]	0.802	[0.372]	3.936	[0.049]	0.760	[0.384]	5.540	[0.020]	0.943	[0.333]	5.863	[0.017]	1.150	[0.285]
Pepper	48.870	[0.000]	0.136	[0.712]	50.730	[0.000]	0.815	[0.776]	55.250	[0.000]	1.434	[0.233]	46.880	[0.000]	1.920	[0.168]
Potato	71.550	[0.000]	1.858	[0.175]	79.630	[0.000]	0.534	[0.466]	0.019	[0.891]	0.005	[0.941]	0.157	[0.692]	0.005	[0.947]
Spinach	1.297	[0.257]	0.709	[0.401]	0.178	[0.673]	0.608	[0.437]	0.911	[0.341]	0.869	[0.353]	0.525	[0.470]	0.235	[0.629]
Tomato	6.321	[0.013]	7.486	[0.007]	3.932	[0.049]	5.161	[0.024]	2.430	[0.121]	0.445	[0.506]	0.620	[0.422]	0.108	[0.743]
Zucchini	20.510	[0.000]	1.205	[0.274]	14.530	[0.000]	0.082	[0.775]	18.300	[0.000]	1.084	[0.299]	22.080	[0.000]	0.068	[0.794]

Appendix

- https://rutherford.tennessee.edu/wp-content/uploads/sites/200/2022/05/SP768-F-Storage-of-Fresh-Produce.pdf
- https://extension.sdstate.edu/storage-life-vegetables
- https://ucanr.edu/datastoreFiles/608-411.pdf
- and
- https://www.efsyn.gr/oikonomia/elliniki-oikonomia/422851_exairoyntai-apo-tin-apagoreysi-prosforon-ta-trofima-me-syntomi
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