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Undergraduate Thesis
Testing for Collusion in the Egg Industry

The law of demand states that an increase in demand leads to an increase in prices, all else being equal.

However, all else is seldom equal, and sometimes increases in demand can lead to a decrease in prices. Under certain conditions, this behavior is economically rational and is empirically demonstrable.

In this paper, I am testing a theory proposed by Rotermberg and Saloner (1986), which analyzes countercyclical price behavior in an oligopolistic market. Examining data on retail and wholesale egg prices over two years, I conclude that (a) egg prices fall during periods of peak demand and (b) that retail margins also fall during seasonal demand peaks-- results that are inconsistent with the law of demand, but are vindicated by Rotermberg and Saloner's model.

It is first necessary to explain the economic theory behind Rotermberg and Saloner's model. Then, I will summarize the data I use and analyze it using a fixed-effects econometric model. Finally, I will conclude.

The Theory

When consumers demand more of something (ex. eggs), they're willing to pay more for it. But there is a rebound effect on the supply side. In response to consumer behavior, firms will increase their prices in order to capture more revenue. That price change resonates throughout the economy.

For consumers, an increase in prices will change the *quantity* demanded. The theory of consumers' responsiveness to prices- *the price elasticity of demand*- states that, in periods of peak demand, increasing the price will increase revenue, despite a decrease in the quantity demanded.

For suppliers, a price increase is a signal for competitors to enter the market with new innovations that return prices to their equilibrium level.

However, if only a few firms dominate a market (an *oligopoly*), then those firms can conspire to fix the price in periods of peak demand (*collusion*).

This theory is called *counter-cyclical pricing,* because prices behave counter to the laws of supply and demand.

Unfortunately, things aren't rosy for long. The unintended consequence of collusion is that there exists an incentive for a single firm to lower its prices and capture a larger share of the market (*defection*). Theoretically, defection occurs when the gains from defecting (lower prices and an increase in market share) exceed the benefits of colluding.

The proverbial flake of snow becomes an avalanche. Once other firms are aware of the unscrupulous, defecting firm, they break their collusive agreement and prices drop to their competitive level (a *price war*). (At this new equilibrium, however, there is an incentive to collude and the game can be replayed ad infinitum.)

The variant on the theory of defection proposed by Rotemberg and Saloner (1986) splits the defection choice into two time periods: prior to demand spikes and during demand spikes.

Prior to demand spikes, firms will collude to increase prices (and margins) during periods of expected demand.

Then, when the clock strikes midnight and demand peaks, prices and margins will drop in a price war.

The Data

The econometric analysis in this paper tests for the possibility of colluding firms (and subsequent defection) in the egg industry. The first dataset provides pooled weekly egg sales in urban and suburban supermarkets outside of Chicago from June 3rd, 1991 to May 24th, 1993. The panel also provides the store number (a total of 9), retail price (per dozen), quantity sold, the vendor (15 total), and the UPC (48 total). The large number of UPCs suggests that this is a highly representative sample. A second panel dataset provides the wholesale price per dozen, an indicator of marginal cost. From this second dataset I was able to measure the retail profit margins, equal to the retail price minus the wholesale price. I also included two additional datasets with prices for inputs into egg production: commodity corn from the Commodity Research Bureau in Chicago and energy (gasoline) from the Energy Information Association.

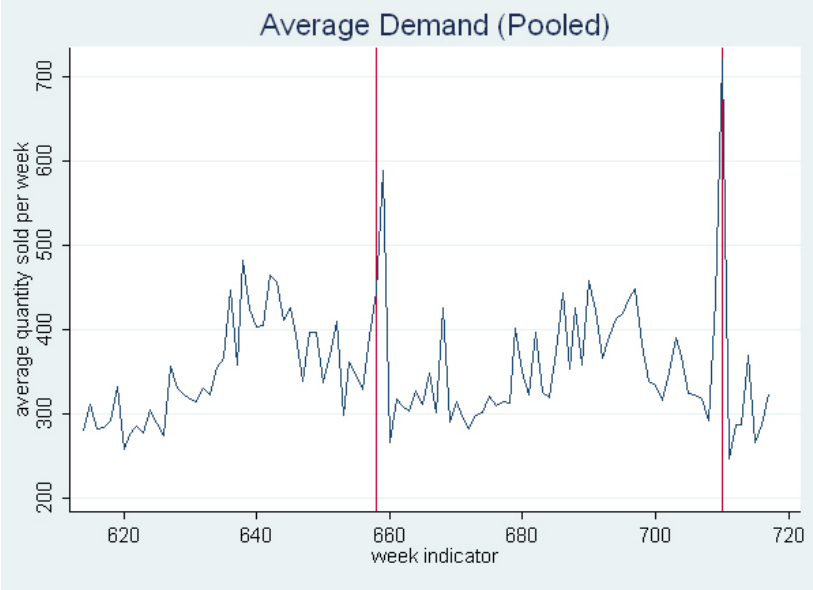
Corn prices were weekly and gasoline prices are given monthly from June 1991 until June 1992 and weekly from May 1992 until May 1993. A fifth dataset provides weekly temperature data in Chicago, a crude measurement of seasonality.

Table 1: Descriptive Statistics (6097 obs)

Variable	Min	Max	Avg	St Dev
Retail price of eggs ($ per 1 dozen), *P*	0.19	2.13	1.038	0.4001
Wholesale price of eggs ($ per 1 dozen), *PW*	0.486	0.718	0.589	0.053
Quantity purchased (per UPC, weekly), *Units*	1	9925	352.24	640.53
Week for 2 years, *Week*	614	717		
summer temperature (Fahrenheit), *summer_temp*	0	75.7	18.7	31.1
average weekly temperature (Fahrenheit), *averageTemp*	24.4	75.7	49.3	16.75
wholesale gas price (cents/gal), *gasprice*	100.3	114.5	107.31	3.986
whole corn price (dollars/bushel), *cornprice*	1.94	2.63	2.37	.207

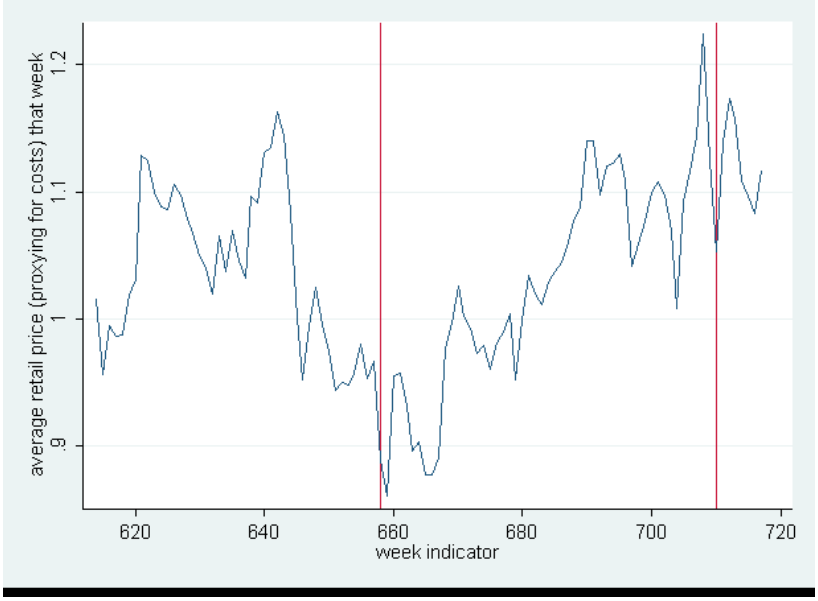
Analysis

The first logical question to ask is, "When is current demand for eggs high?" Periods of high demand would provide us with the time periods to look for evidence of defection. As the graph below indicates, there are two large spikes in average demand during week 658 and 710. Week 658, which falls in 1992, ranges from Monday, April 13th until Sunday, April 19th. Week 710, in 1993, ranges from Monday, April 5th through Sunday, April 11th 1993.



4/19/92 and 4/11/93 are the dates for the traditional Christian holiday, Easter.

The next question is, how do prices change across firms prior to and during periods of expected demand?



Looking at average retail prices, and with red bars marking the periods of Easter, we see that prices drop prior to Easter during both years.

Controlling for a number of variables, average prices drop by about 5 cents during Easter. All price changes are significant at the 1% level.

This tells us that during periods of expected demand, prices peak. In fact, in the second year, prices are at an all-time high in the weeks leading up to Easter. The sudden drop in prices suggests the possibility of a price war.

Finally, I tested to see how current margins respond to expected future demand. I find that margins increased by 7 cents two weeks before Easter, but dropped by 5 cents during the week of Easter. 1 week after Easter, margins drop by an additional 3 cents, reflecting further casualties of the price war. All results are significant at the 1% level. (Table 2)

Conclusion

The results of this analysis are consistent with the Rotermberg and Saloner's theory of collusive pricing models: controlling for commodity prices and seasonal trends, there is an increase in margins when expected demand is high, and a fall in prices and margins during period of high seasonal demand.

There is much that is missing from this model that could help bring more robust results. One is the possibility of the effect of advertising on consumer choices. The availability of information on price advertising for eggs. Specifically, we do not have explicit evidence that advertised goods are discounted at these seasonal peaks in demand.

Table 1:
Regression of Retail Prices on Expected Demand

averageQ	-0.0000716 (.00000979)
averagewp	0.4276277 (.0180174)
week	0.0037116 (.0000573)
easter	**-.0475237** **(.0040753)**
urban	-.0015636 (.0011072)
year	-.1164656 (.0026656)
year_2	-.0625954 (.0012956)
Summer	-.5103257 (.0231367)
Summer_Temp	.0075863 (.0003378)
averageTemp	-0.0007526 (.0004581)
gasprice	-.0008204 (.0002577)
corn	.0633783 (.0034019)
beforeeaster1	**-.008411** **(.0028103)**
beforeeaster2	.0810868 (.0046078)
beforeeaster3	.0121796 (.0033701)
aftereaster1	-.0338464 (.0032624)
aftereaster2	**.0160898** **(.0032357)**
aftereaster3	**.0088051** **(.0032347)**
wholesalelag	-.0968006 (.0094998)
_cons	230.3194 (.0070549)
R^2 Overall	0.8085

Table 2: Regression of Profit Margins on Expected Demand

	1	2	3	4	5
averageQ	-0.00023	-0.0001062	-0.0001566	-0.0001415	-0.000088
	(.0000449)	(.0000466)	(.0000543)	(.0000542)	(.0000582)
averagewp	0.058456	-0.3998702	-0.6631914	-0.4983824	-0.5674607
	(.0541253)	(.0678361)	(.0939648)	(.099939)	(.1069928)
week	0.0006013	0.0018036	0.0024469	0.0032137	0.0030722
	(.0000927)	(.0002327)	(.0002841)	(.0003263)	(.0003365)
easter	-0.0029044	-0.0356501	-0.0216506	-0.0368029	**-0.050614**
	(.0217954)	(.0221158)	(.0232559)	(.0233852)	**(.0241939)**
urban	-0.1605769	-0.1587524	-0.1582523	-0.158346	-0.1583448
	(.0066658)	(.0066031)	(.0065975)	(.0065839)	(.0065807)
year		-0.0586842	-0.0939347	-0.1185338	-0.1136427
		(.0103552)	(.0137055)	(.0154893)	(.0157813)
year_2		-0.0669439	-0.070529	-0.0612376	-0.0608479
		(.0062653)	(.0066636)	(.007581)	(.0076801)
Summer			-0.3501187	-0.3643308	-0.3955974
			(.1242732)	(.1362281)	(.137511)
Summer_Temp			0.0052894	0.0055542	0.0059948
			(.001815)	(.0019918)	(.0020076)
averageTemp			-0.0012641	-0.0008208	-0.0007526
			(.0003586)	(.000455)	(.0004581)
gasprice				-0.0019003	-0.0016892
				(.0014747)	(.0015159)
corn				0.0866125	0.0817304
				(.0171293)	(.0199426)
beforeeaster1					-0.0139783
					(.0166054)
beforeeaster2					**0.0745115**
					(.0273122)
beforeeaster3					0.0024591
					(.0199547)
aftereaster1					**-0.0348287**
					(.0193655)
aftereaster2					0.0100717
					(.0192015)
aftereaster3					0.0012031
					(.0191786)
wholesalelag					0.0387657
					(.0433832)
_cons	0.155629	116.5088	186.5273	234.8847	225.2214
	(.0739)	(20.50179)	(27.17737)	(30.75075)	(31.3326)
R^2 Overall	0.0561	0.0608	0.0615	0.0624	0.0629