Heterogeneity in Price Rigidity: Evidence from Primary Micro-Level Data*

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Abstract

We combine two unique data sets to document and explain a time varying price rigidity. The first data set consists of the time series of actual retail and wholesale transaction prices, and a measure of upstream commodity cost for 12 products in refrigerated and frozen orange juice categories collected weekly over a three-year period, 1989–1992, at a large midwestern supermarket chain. A special feature of these data is that they contain two episodes of major unanticipated exogenous commodity cost shocks. The examination of the cost-price relationship suggests that the manufacturers’ and the retailer’s reactions to these two costs shocks were very different. Specifically, we find that prices exhibit significantly more rigidity in response to the second cost shock than to the first. The second data set was collected in order to determine the possible reasons for this variation in price rigidity. Specifically, we undertook an exhaustive search of all publicly available sources of information to learn more about the events surrounding the two cost shocks. Based on content analysis of all the information collected we conclude that there were three fundamental differences between the two cost shocks. First, the first cost shock was almost twice as large as the second. Second, the first cost shock had a more permanent nature while the second had a more temporary nature. Third, we find that the market participants had a lot more information on the first cost shock than on the second. We conclude that price adjustment is more flexible in response to cost shocks that are larger in size, that are more permanent, and on which the market participants have more information. Thus, we provide micro level evidence that the size of a cost shock, the degree of their persistence, and the associated informational imperfection, may be important determinants of the degree of individual price rigidity.
1. Introduction

Variation in price rigidity has been an issue of considerable interest in economics.¹ For example, according to Gordon (1981, p. 517), understanding the reasons for price rigidity variation “... is crucial for the theory of price adjustment.” In a recent survey of this literature, Caplin (1993, p. 21) describes it as unfortunate “... that so little attention has been given to characterizing the circumstances that give rise to high and low levels of nominal price inertia. Progress in this dimension calls for more detailed empirical work and for increased understanding of the manner in which corporations actually arrive at pricing decisions.” Weiss (1993, p. 15) echoes similar sentiments suggesting the importance of studying these issues through the “... incorporation of all relevant information at the level of the firm, including costs and demand data.” Indeed, as emphasized by authors such as Carlton (1986), Gordon (1990), and Kashyap (1995), there are only a handful of time series studies of price flexibility that use actual transaction prices.

In this paper, we combine two unique data sets to document and explain a time varying price rigidity.² The first data set consists of the time series of actual retail transaction prices, actual wholesale transaction prices, and a measure of upstream commodity cost for 12 products in refrigerated and frozen orange juice categories collected weekly over a three-year period, 1989–1992, at a large midwestern supermarket chain. A special feature of this data set is that it contains two episodes of major unanticipated exogenous commodity cost shocks. The examination of the cost-price relationship suggests that manufacturers’ and retailer’s reactions to these two costs shocks were very different. Specifically, we find that prices exhibit significantly more rigidity in response to the second cost shock than to the first cost shock.

The second data set was collected in order to assess the possible reasons for this variation in price rigidity. Specifically, we undertook an exhaustive search of all publicly available sources of information to learn more about the events surrounding the two cost shocks. These sources include


²Many authors have emphasized the importance of using firm-level data to study price rigidity. For example, Carlton (1986), Gordon (1990), and Kashyap (1995) have mentioned the benefits of firm level data, emphasizing the importance of using actual transaction prices. Authors such as Williamson (1985), Lach and Tsiddon (1992), and Blinder (1994) emphasize the importance of using individual firm-level data because they “... most closely resemble the data envisioned by the cost of adjustment theory: price quotations at the level of the price setter” Lach and Tsiddon (1992, p. 351).
local and national newspapers, other print media including trade journals and the U.S. Department of Agriculture reports, local and network TV, the CNN, the Florida Department of Citrus, University of Florida Center for Citrus Research and Education, and Florida Agricultural Statistics Service. Based on content analysis of all the information collected we conclude that there were three fundamental differences between the two cost shocks.

First, we find that the two cost shocks differed in size. Specifically, we find that during the first cost shock there was a 60 percent increase in the commodity spot prices in contrast to only 36 percent increase during the second cost shock.

Second, we find important differences in the persistence of the shocks across these two episodes. Specifically, we find that the first shock was caused by a freeze, one of the 9 major Florida freezes over the last forty years, whereas the second was caused by the USDA’s crop forecast lower than what the market expected. Virtually all available information indicated that the first cost shock was more permanent than the second in the sense that its effect was more long-lasting. For example, as a result of the freeze, the entire state of Florida was declared a disaster area during the first cost shock. The second shock, in contrast, has been described as an “aberration” that would not have any long term negative effect on citrus output. Virtually all the print media reports seem to suggest that the second cost shock was more of a temporary nature. Also, during the first shock, the commodity cost level remained high for over 6 months before it started to decline. During the second cost shock, in contrast, the commodity cost of frozen concentrated orange juice started to decline immediately after the shock.

Third, we find that the market participants had a lot more information on the first shock than the second. Specifically, we find that the first cost shock was widely documented in newspapers and other print media with at least 28 mentions, with most of the reports talking about the extensive damage to the citrus crop. There were also six TV reports on the freeze talking about the significantly reduced crop prospects. The freeze was extensively mentioned also in five reports of the Florida Department of Citrus and the USDA. In contrast, we find only 17 reports about the second shock, of which 11 mentioned that prices were going up. However, the reports also indicated that this increase was due to speculative and psychological effects, and six of them indicated that prices of orange juice had started to come down, and the first of such reports appears within two weeks after the shock.

We conclude that price adjustment is more flexible in response to cost shocks that are larger in size, that are more permanent (or that have longer-lasting effect), and on which the market participants have more information. We thus provide micro level evidence that the size of a cost shock, the degree
of their persistence, and the associated informational imperfection, are important determinants of the degree of price rigidity.

The idea that the size of a shock may determine the extent of price rigidity/flexibility has been recently exploited by Ball and Mankiw (1995) to examine empirical validity of the menu cost theory. Specifically, they predict that when price adjustment is costly, firms adjust to large shocks but not to small shocks, and so large shocks have disproportionate effects on the price level. Indeed, they show that this theoretical result can explain a large fraction of movements in the postwar U.S. inflation. A distinguishing characteristic of our result is that we find it at the level of individual product using actual transaction prices.

The theoretical possibility that shock persistence may have an important effect on price rigidity has been suggested by numerous authors. For example, an explanation for price rigidity put forth recently by Meltzer (1995) is based on the temporary/permanent shock distinction. However, most of the existing empirical evidence on the importance of shock persistence for price rigidity is provided in studies that use aggregate level data, and more importantly, they all provide the evidence indirectly. The advantage of the way we identify the relationship between shock persistence and price rigidity is due to the novel method we use to identify the persistence of the shocks. The usual practice in macroeconomics is to econometrically identify temporary and permanent components of the shocks and then estimate their effects. The reason for this practice, as Meltzer (1995) indicates, is that it is difficult to learn about how people decide on the degree of persistence of economic variables, and therefore, the identification of shock persistence needs to be done econometrically. In this paper we were able to overcome these difficulties since in this study we are focusing on two specific upstream commodity cost shocks and by studying in detail their actual causes and effects we are able to assess their likely permanence. Thus, we identify the persistence of these shocks by matching them with actual events that took place in the orange juice market.

Macroeconomic importance of imperfect information has long been recognized. However, usually it is difficult to determine what information do economic agents actually have and use.

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4 Carlton (1989) and Carlton and Perloff (1994) also suggest the possibility that a firm may be reluctant to raise its price in response to unanticipated temporary cost increases.

5 See Brunner and Meltzer (1993), and Meltzer (1995) for a survey of these studies. See also Mankiw and Romer (1991), Sheshinski and Weiss (1993), Andersen (1994), and the studies cited therein.

6 See, for example, Lucas (1972).

7 Several authors have suggested the importance of information and the extent of uncertainty associated with it for
Therefore, most empirical macroeconomic studies are forced to make ad hoc assumptions of various kinds about the content of this information. For example, most of the empirical studies that make use of anticipated or unanticipated series have to rely on forecast generating equations with some autoregressive (AR or ARMA) or autoregressive-distributed lag structures.\(^8\) In contrast, here we study a very micro-level and well-specified product market where determination of the relevant information set is less ambiguous (in comparison to, say, studies that use aggregate level data). Specifically, we collected all the relevant publicly available information we could find about the causes and effects of the shocks, and by analysing the content of these information we were able to assess the extent of the actual information the orange juice market participants likely had.

Finally, our data set allows us to control for other, more commonly used explanations of variation in price rigidity. These include market structure and industry concentration, the length of long term relationships, the number of stages of processing, and so forth, because these factors do not vary over the sample period we study. Therefore, the variation in price rigidity we document here cannot be explained by variation in any of these factors.

The rest of the paper is organized as follows. In section 2, we describe the two data sets used in this study in more detail. In section 3, we interpret the data by analyzing the retailer’s and manufacturers’ reactions to the two cost shocks. In section 4, we document the differences between the two cost shocks in terms of their size, persistence, and information. In section 5, we discuss the implications of our findings in the context of the existing theories of price rigidity and suggest directions for future research. In Appendix 1, we describe the methods used in collecting the orange juice market information data and their content analysis. In Appendix 2, we describe in detail all the information collected. Finally, in Appendix 3, we specify and estimate a simple econometric model to provide a statistical evidence that is consistent with our interpretation of the data.

2. Data

Cost-Price Data

The cost-price data we use has numerous unique features which make them particularly suitable determination of the degree of price rigidity (e.g., Alchian, 1969; Phelps and Winter, 1970; Okun, 1975 and 1981; Streissler, 1977; Hey, 1979; Stiglitz, 1984; Gordon, 1990; Meltzer, 1995; Roufagalas, 1994; and Ball and Mankiw, 1995). Ball and Mankiw (1995, p. 29) emphasize the importance of informational imperfections and suggest that “... the most important costs of price adjustment are the time and attention required of managers to gather the relevant information ...”

\(^8\)See Levy (1990) for a detailed discussion.
for studying variation in price rigidity. The most important aspect of the data set is that it consists of actual retail transaction prices, actual wholesale transaction prices, and a measure of commodity costs of 12 orange juice products (6 frozen concentrated and 6 reconstituted from frozen concentrate), collected weekly over a three-year period from 1989 to 1992.

The cost and price data we use cover the period from September 7, 1989 to November 19, 1992 and consists of 168 weekly observations of spot, wholesale, and retail level prices of 12oz and 16oz frozen concentrated orange juice, and 64oz and 96oz (128oz for the private label) refrigerated orange juice made from concentrate. We look at three brands: two national brands, Tropicana and Minute Maid, and one private label, the Store Brand, which is the name we use here for the retailer’s in-house brand.

Chart 1, which displays a general schematic description of the frozen concentrated orange juice market, indicates that the product flow path in this market consists of two channels: the retail level channel, which represents the final goods level of the market, and the manufacturer level channel, which represents the intermediate goods level of the market.\(^9\) Thus, the market we study is characterized by a hierarchical structure, similar to “stages of processing” structure studied by Blanchard (1983).\(^{10}\)

The empirical notion of price rigidity we employ follows the one used by Cecchetti (1986), Hannan and Berger (1991), Neumark and Sharpe (1993), Kashyap (1995), and Slade (1996a, 1996b). According to this notion, “Price rigidity is said to occur when prices do not vary in response to fluctuations in costs and demand” (Carlton and Perloff, 1994, p. 722 ). Due to the lack of cost data, however, most of the existing empirical literature on price rigidity is forced to measure the extent of price rigidity indirectly, by examining the frequency of price changes, average time span between consecutive price changes, etc. According to Blinder (1991, pp. 93–94), however, “From the point of view of macroeconomic theory, frequency of price changes may not be the right question to ask ... We are more interested to know how long price adjustments lag behind shocks to demand and cost.” The availability of both, the price data as well as the cost data for the same products, enable us to study this broader notion of price rigidity. Below we describe these price and cost series in more detail.

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\(^9\) In this paper the cost-price relationship at the manufacturing (intermediate goods) level is sometimes described as spot-to-wholesale, and the cost-price relationship at the retail (final goods) level is described as wholesale-to-retail. Similarly, in the case of the effect of upstream costs on retail price, we use the term spot-to-retail.

\(^{10}\) This is different from the input-output structure emphasized by Gordon (1990), Meltzer (1995), and Basu (1995). As Gordon (1990) suggests, the input-output view of the market organization is better suited for more aggregated (e.g., industry level), and more complex products produced using many inputs. In contrast, here we study individual products, and also the products themselves are simple, produced with few inputs.
Retail Prices: For the final price to consumers at the retail level, we use weekly data from the scanner database of the supermarket chain. The prices are the actual transaction prices consumers paid at the cash register that week. This chain changes prices once a week which is the common practice in this industry as documented by Levy, et al. (1996, 1998 MDE). Thus, the prices we report are the actual shelf prices in effect for that week. Further, the prices are set on a chain-wide basis at the corporate headquarters, and we have chosen a representative store of this chain located in the Chicago metro area. These type of product- and store-level price data are particularly suitable for studying price rigidity since this is where retail prices are actually set (Lach and Tsiddon, 1992; Caplin, 1993).

Wholesale Prices (Retailer’s Costs and Manufacturers’ Prices): For the wholesale price to retailers we use weekly data, which also come from the supermarket scanner database. This is the price the retailer paid the orange juice manufacturer, and is the cost measure the retailer uses when making pricing decisions. Having access to this actual cost data allows us to use a direct measure of cost rather than an indirect or aggregate measure. This makes our dataset particularly unique given that these cost data are proprietary and rarely available.

Manufacturers’ Costs: As a measure of the cost incurred by manufacturers we use the spot market price for that week. To arrive at the spot cost, we use the nearest futures price of frozen concentrated orange juice in the commodities’ exchange market. This nearest futures price was adjusted for storage and carrying costs to compute the spot cost using the cash-and-carry arbitrage formula.

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11 Our retail prices reflect any retailer’s coupons or discounts, but do not include manufacturer coupons. Fortunately, during the period covered in this study, manufacturer coupons were rarely used to promote orange juice sale in this market. Further, according to the pricing managers of the chain, these product categories are not used as loss-leaders.

12 These wholesale price series are computed by the retailer as the weighted average of the amount the retailer paid for all their inventory. For example, if the retailer bought its current stock of frozen concentrate Tropicana 12oz in two transactions, the wholesale price is computed as the average of these two transaction prices. No FIFO or LIFO accounting rules are used in these computations. The effect of these calculations on the accuracy of the wholesale price series is not likely to be large since the inventory turnover in the orange juice category is very fast: frozen orange juice turns over every 6–7 days and refrigerated orange juice turns over every 7–9 days. (The reason for this high turn over rate is the high storage cost of both types of juice.) Since the inventory turns over approximately once a week, the wholesale price series is quite reflective of the current manufacturer wholesale prices. It should be noted also that this wholesale price does not include lumpy payments like slotting allowances. However, our discussion with the managers who set the retail prices indicate that these kind of payments were not common in the orange juice category during the period covered in our study. Further, these managers indicated that they rely on this wholesale price series for making their pricing decisions.

13 Gordon (1990) and Basu (1995) emphasize the importance of using direct cost data for studying pricing decisions.
In practice, manufacturers can acquire frozen concentrated orange juice in two main ways. First, they can purchase it at the current price, which reflects current market supply and demand conditions, from independent growers, growers’ participation plans, or growers’ cooperatives. Second, they can sign a contract with the participation plan members. The contract may either specify a price or leave the price open to be determined at the time of delivery. During the 1980’s, about 67 percent of the frozen concentrated orange juice was sold based on market prices, and the remaining 33 percent was purchased by contract, which may still be based on market conditions since, as mentioned above, many contracts may leave the price open (Ward and Kilmer, 1989, Table 3.3, 1980–87 averages). Since spot price reflects current and expected market supply, demand, and weather conditions, and since most of the frozen concentrated orange juice is sold by growers to manufacturers at prices that reflect current market conditions, we believe that the use of spot price as a proxy for manufacturers’ costs is reasonable for this market. Although the spot cost cannot be a perfect measure of the true manufacturers’ cost, it probably represents an improvement over various aggregate cost measures that have been used to study price rigidity in the past.

Other Advantages of the Price and Cost Data: These price and cost data offer a unique setting for isolating the effects of shock persistence on price rigidity. First, we control for various features of the market that have been proposed in the existing empirical literature as the main explanatory factors of variation in price rigidity. For example, over the three year period we study, variables like market structure and industry concentration did not change. Similarly, the nature of long term relationships and contractual arrangements have remained unchanged during the sample period. Further, the

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14 The use of nearest futures price as a proxy of the spot price means that once each month there is a possible change from the month \( n \) contract to the month \( n + 1 \) contract which may pose a problem. The adjustment of these series for storage and carrying cost is designed to resolve this problem. We used the interest rate on 6-month treasury bill to compute the storage cost. Monthly carrying cost is based on the information provided by NYCE and is described in Florida Department of Citrus’ (1994) Citrus Reference Book. The computed spot cost was divided by 1,600 to get a dollar/oz price of frozen orange concentrate. The price quoted at NYCE is for orange concentrate level of 57˚ Brix. (A Brix is a temperature-adjusted measure of the pounds of solids and the sugar content in one gallon of juice.) From the information provided by the retailer, and also documented by the Florida Department of Citrus (1994), we found that the Brix level of frozen orange concentrate (both national brand and private label) is 41.8˚ and the Brix level of refrigerated juice (both national brand and private label) is 11.7˚. Therefore, we adjusted downwards the NYCE spot price to ensure identical quality (as measured by Brix solid content per oz) of the orange juice at all levels of the channel. The spot cost figures used in the analysis of the refrigerated juice data are identical to the spot cost figures used for frozen concentrated juices except that they are adjusted for the Brix-level differences between frozen concentrated and refrigerated orange juices.

15 The use of spot price as a proxy for manufacturers’ costs is also necessitated by the fact that the market prices at which the manufacturers purchase the frozen concentrated orange juice are not publicly available on a weekly basis.
number of stages of processing did not change. Thus, these aspects of the market remain unchanged over the sample period we study, and therefore the specific form of variation in price rigidity we are documenting here cannot be explained by any of them.

Another useful feature of our data is that the products we study have a constant quality which eliminates the possibility of quality adjustment in response to cost changes. According to Florida Department of Citrus (1994, pp. 64–68), the quality of orange juice is monitored by the Florida Department of Citrus and USDA. Frozen concentrated orange juice quality is further controlled by setting upper limits on the amount of sinking and washed pulp solids. Also, the concentrated orange juice needs to pass the gel test which guarantees that no gel pulp will be left after reconstitution. In the retail market, the minimum Brix content of the frozen concentrated orange juice and of refrigerated orange juice (both national brand and private label) are 41.8˚ and 11.7˚, respectively. Any decrease in these figures would amount to cheating. Further, a large-scale inventory adjustment in response to cost changes is unlikely in this market.16

In addition, the time series we use are weekly, which is useful for studying price-setting behavior in the market where the actual observed pricing cycle is weekly. Further, these data allow us to examine the effect of exogenous cost changes on prices almost as if it were a controlled experiment. Changes in retail cost are exogenous with respect to retail price because: (i) the market we study is of a hierarchical nature since the retailer follows the manufacturers in the channel of distribution; (ii) the manufacturers in this study sell nationally, while the retailer we study is one of many regional sellers in the Chicago metropolitan area; and (iii) as an orange juice seller, the retailer is significantly smaller than the manufacturers themselves. For similar reasons, we argue that the commodity spot cost from the New York Cotton Exchange can be treated as exogenous with respect to the wholesale as well as retail prices, as suggested by Roll (1984) and Baur and Orazem (1994).

Finally, in the analysis that follows, we assume that most of the variation in the product prices we study is driven by supply shocks. Therefore, we abstract from demand shocks and try to explain the variation in prices using costs, as it is usually done in the empirical cost-price pass-through literature (e.g., Borenstein, Cameron, and Gilbert, 1992). This assumption is supported by the empirical findings reported by Roll (1984) that most of the orange juice commodity price volatility is

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16 In terms of the inventory management, retail chains of the type studied here usually store the juice (both frozen and concentrate) in metropolitan warehouses. Typically, manufacturers deliver the produce to these warehouses twice a week who deliver the produce to individual stores. The amount of inventory held in these warehouses on average is about 2–4 days supply. Because of the high storage cost, retailers try to avoid larger inventory holdings.
due to supply shocks. Further, we searched the relevant trade publications, like *Progressive Grocer* and *Citrus Futures*, as well as the *Wall Street Journal, New York Times* and major Midwestern newspapers, and found no evidence suggesting demand changes during this time period. The studies conducted by Florida Citrus Commission and University of Florida Center for Citrus Research and Education reach a similar conclusion. Finally, variation in orange juice demand is unlikely since orange juice is a staple item that is routinely bought and consumed on a weekly basis, similar to milk and bread.\(^\text{17}\)

**Information Data**

The data in our sample contain two episodes of major unanticipated exogenous cost increases. See, for example, the spot cost series’ plot in Figure 1. According to the plot, the orange juice commodity cost jumped significantly during the second half of December 1989 (observations 15–17). Another big jump occurred during the second half of October 1991 (observations 110–112). It is the difference in the reaction of manufacturers and retailers to these two cost shocks that comprises the variation we document in this paper.

In order to evaluate the actual and perceived extent of these cost shocks’ persistence and the amount of information available to market participants—consumers, manufacturers and retailers—at the time of occurrence of these cost shocks, we undertook an exhaustive search of all publicly available sources of information. These sources include local and national newspapers, other print media including trade journals, U.S. Department of Agriculture reports, local and network TV, the CNN, the Florida Department of Citrus, Produce Manufacturing Association, University of Florida Center for Citrus Research and Education, and Florida Agricultural Statistics Service.\(^\text{18}\) For each cost shock we looked at all information starting two months before the price increase and tracked all information till two months after the prices had come down to the same level from which they had started rising.

To collect information on the cost shocks from the print media, an initial list of potential sources was generated through Lexus/Nexus using in the search the following key words: “FCOJ,” “frozen concentrated orange juice,” “FCOJ,” “FCOJ and freeze,” “orange,” “orange juice,” “orange juice and freeze,” “citrus,” and “beverage.” We also contacted the Produce Manufacturing Association (PMA)

\(^{17}\)In the econometric analysis described in the appendix we considered two aggregate demand shocks that could possibly affect the orange juice market. The first is the Kuwait War which began on January 17, 1991 and ended on February 27, 1991. The second event we considered is the July 1990–March 1991 recession. Our econometric findings are not affected from the inclusion of dummy variables corresponding to these aggregate demand shocks in the estimated VAR equations.

\(^{18}\)The list of all sources consulted is provided at the end of Appendix 2.
which routinely collects various trade information on produce including orange juice. We contacted
the PMA personnel in charge of keeping track of this information, and she helped us to compile all
information pertaining to orange juice around the time of the two cost shocks in their list of trade
publications. These publications include *Citrus and Vegetable Magazine, Florida Shipper, Grocery
Marketing, The Packer, Produce Business, Progressive Grocer,* etc.

In addition, we contacted all the local TV stations in the Chicagoland area and the networks
including CNN. We asked them to provide us with all stories they ran on O.J. around the time of the
two cost shocks. We got information from WGN-Channel 9 and CNN.19

After collecting the articles and reports from all the above sources, we analyzed their content.
*Content Analysis* is a systematic technique for analyzing message content (Holsti, 1969; and
Kassarjian, 1977).20 The existing practical experience with content analysis suggests that the
process should be guided by an explicit set of rules to minimize the possibility that the findings reflect
the analyst’s subjective predispositions rather than the actual content of the documents under analysis
(Holsti, 1968; and Kassarjian, 1977). One test of objectivity often followed in content analysis is to
see if multiple researchers following identical procedures with the same set of data, arrive at similar
conclusions. Following this practice, we had two researchers independently analyze the contents of
all the reports and articles collected. Each researcher independently assessed the content of each
report and summarized their main theme.21 The identification and classification of the information
reported below is based on consensus between these two independent researchers regarding the
content of these reports. This is a conservative approach since it requires that both researchers agree
on the theme of all the reports. In published studies, an 80% or higher agreement across independent
researchers is considered an acceptable criteria (Kassarjian, 1977).22

Based on content analysis of all the information collected we conclude that there were some
fundamental differences between the two cost shocks in terms of their size, persistence, and
information. These findings along with the information we collected are described in detail in Section

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19 The other stations refused to provide the information either because they did not have records going so far back or
did not have the information readily available in their archives. We also contacted all the local radio stations.
Unfortunately they do not have documents or well-organized archives so we could not get any information on the
cost shocks from the radio stations.

20 This methodology is often used in political science, social psychology, communications research, and market
research.

21 A “theme” is the most common unit of focus in content analysis (Holsti, 1968; and Kassarjian, 1977).

22 See Tse, Belk, and Zhou (1989), and Bergen, Dutta, and Shugan (1996) for recent examples of studies that use
content analysis.
4 where we discuss the differences we found between the two shocks. But first, we describe the retailer’s and the manufacturers response two the two cost shocks.

3. Retailer’s and Manufacturers’ Reaction to the Cost Shocks

Reaction to the First Cost Shock

We provide a sample plot of the cost-price data on Figure 1. On the figure we provide the spot price, the wholesale price, and the retail price series. All series are measured in dollars/oz. The weekly time series data span the period from September 7, 1989 to November 19, 1992 containing 168 observations. The focus of this study is on the effect of two exogenous upstream (i.e., the spot) cost shocks on the wholesale and retail prices. The first big cost shock occurred during the second half of December 1989, observations 15–17, and the second—during the second half of October 1991 (observations 110–112).

First noticeable feature we see in Figure 1 is the frequent sales and promotion related fluctuations in the retail and wholesale prices. These fluctuations are particularly pronounced in the retail prices where these ups and downs seem to occur approximately every 3–5 weeks. These systematic promotional patterns are standard practice for retailers of these and similar products. For example, Dutta, et al. (1997, 1999), and Levy et al. (1997, 1998) have documented the fact that supermarkets of the type and size studied here every week change the prices of about 15 percent of the products they carry because of the competitive nature of the retail food industry. For the purpose of our analysis these promotional sale activities can be considered exogenous and therefore the estimation results should by unbiased. These sales may, however, raise the noise level.

Focusing first on the manufacturers response to the exogenous commodity cost shock, we see that the wholesale price increase precedes the spot cost increase by about two weeks. Since the information we gathered suggests that the weather conditions responsible to the shock were unanticipated, it is likely that the initial wholesale price increase around the 13th week of the sample period is merely a reflection of seasonal factors: orange juice is an agricultural commodity and therefore, under normal circumstances, its price displays a typical seasonal pattern.

Following the initial spot cost shock, which begins in the week of December 21, 1989, observation 15, the wholesale price begins to climb until it reaches the peak in the week of April 12, observation 23. The cost-price data of the other brand/size products exhibit similar behavior. They are not shown here to save space but are available upon request.
1990, observation 31. Once the spot cost increases, it remains at that high level for about 24 weeks, observations 20–44. The wholesale price exhibits a similar pattern, although it remains at the peak level for only 17 weeks, from March 29, 1990 till July 19, 1990. On July 19, 1990, the wholesale price begins a downward adjustment to the commodity spot cost. The adjustment is gradual, and seems to be slower than the spot cost decrease. It takes the wholesale price over a year from the time its starts to decline (around observation 47), until it reaches the pre-cost-shock level (around observation 100), while the spot price completes its decline to the pre-cost-shock level by the 58th week.

The response of the retail price to the wholesale price increase seems faster than the response of the wholesale price to the spot cost increase. In fact, the plot indicates that the retail price may be increasing faster than the wholesale price during the 20th–28th weeks, suggesting that the retailers may be responding, at least in part, to the spot cost increase. This is clearly possible from informational point of view: as shown in the next section, the retailers, like other market participants, already had substantial amount of information available on the cause, severity, and possible consequences of this cost shock several weeks earlier. The retail price increases first to 13.3 cents/oz on week 21, to 14.1 cents/oz on week 29, and finally to 14.9 cents/oz on week 49, before starting to decline. The retail price remains at or above 14 cents/oz for almost 36 weeks, but it seems to adjust downwards, once the adjustment begins, rather quickly. The decrease in the retail price begins on the 64th week, and seems to be fully complete on the 82nd week. Thus, the plot suggests that the retail price adjusts to the wholesale price substantially faster in comparison to the adjustment of the wholesale price to the spot cost. Overall, these data indicate that the commodity spot cost shock leads to an increase in the wholesale price and consequently to an increase in the retail price. The upward adjustment of both series seems to be proportional to the size of the cost shock.

**Reaction to the Second Cost Shock**

The second commodity cost shock occurs on the week of October 17, 1991 (110th observation). Here the retail price shows no response to the spot cost increase. The wholesale price does indicate an increase but the increase merely takes the wholesale price back to the level it was on the week 98–102, which is the same level as the pre-first-cost-shock level. The spot price begins declining almost as soon as it increases. The wholesale price, however, does not decline in response to this decrease. This pattern of behavior of the wholesale price suggests that its increase on the 110th week was merely a correction to the over-reaction it experienced during the weeks 98–102.\(^{25}\)

\(^{24}\)A formal econometric analysis of the first cost shock data discussed in the Econometric Appendix produces results that are consistent with this interpretation.
Thus, the data suggest that both the wholesale and the retail price responded to the first cost shock, but they did not respond to the second cost shock.

### 4. Differences between the Two Cost Shocks

The finding that manufacturers’ and retailer’s responses to upstream cost shocks are more rigid in response to the second cost shock than to the first cannot be explained by variations in industry concentration, in the nature of long terms relationships, and in the number of stages of processing, since these factors have remained unchanged during the period covered in this study. This led us to assess if there were any fundamental differences between the two cost shocks that may explain our findings. In order to evaluate the nature of the two cost shocks we undertook an exhaustive search of all publicly available sources of information on these cost shocks. For each cost shock, we looked at all information starting two months before the price increase and tracked all information till two months after the prices had come down to the same level from which they had started rising. Two researchers independently analyzed the contents of these reports across all media and the summary of the collected information we report below is based on the consensus across these two coders regarding the content of these reports. For a detailed description of all these information, see Appendix 2.

Before discussing the two cost shocks in detail, it is worth mentioning that according to the Florida Department of Citrus (Dr. Ed Moore, personal communication) and Florida Agricultural Statistics Service (Dr. John Attaway, personal communication) officials, neither of the two cost shocks were anticipated. The first shock was caused by a severe freeze in Florida. The freezes of this type are unpredictable except perhaps 2–3 days prior to the freeze, and even then they can not predict its severity (Roll, 1984; and Baur and Orazem, 1994). The second cost shock began when the crop forecast by the USDA in October 1991 turned out to be lower than what the market expected. As Fortenbery and Sumner (1993) and Baur and Orazem (1994) indicate, the release of the USDA orange crop reports is widely anticipated, especially the October report. However, the specific information contained in the report is not known.

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25 A formal econometric analysis of the second cost shock data discussed in the Econometric Appendix produces results that are consistent with this interpretation.

26 USDA is required by law to issue a monthly report in which it provides estimates (predictions) of Florida crop for the remainder of the orange growing season. The first report is released on the second week of October followed by monthly updates of that report all the way till July. The goal of these reports is to help the growers, processors, and other market participants to plan their future market activities and learn about expected market trends.

27 Since the effect of its crop estimates (projections) on the frozen concentrated orange juice futures market can be dramatic, USDA keeps the content of the report extremely secret until its release which is almost always delayed till
Below we demonstrate how the two shocks differed by comparing and contrasting their causes and effects in detail along several dimensions. In Table 3 we summarize the results of these comparisons.

**The Cause of Shocks**

*First Cost Shock:* The first cost shock, which occurred on December 23–24, 1989, was caused by a severe freeze. The Florida Department of Citrus (1994, p. 36) lists this freeze among the 9 most “Significant Florida Citrus Belt Freezes” that occurred since 1957. The freeze was particularly significant since the temperature dropped to below 25˚ F and stayed there for almost two days.

*Second Cost Shock:* The second cost shock occurred on October 13, 1991, when the U.S. Department of Agriculture released a forecast of a lower than expected citrus crop in its October 1991 report. As stated in *The Wall Street Journal* (October 14, 1991), “Behind the move was what traders and analysts called a ‘shocking’ government forecast for a Florida crop of 136 million 90 pound boxes, or 10% below last year’s crop. Industry analysts expected the government to predict that the Florida crop would be as much as 10% bigger than last year.” The USDA report was released on October 12, 1991, at 3:00pm, after the closing of the NY Cotton Exchange. The spot price has responded to this by an increase during the next three trading days followed by smaller increases during the following two weeks. This cost increase shows up in our weekly data exactly during the October 17, 1991–October 31, 1991 period.

**The Effect on Crops**

*First Cost Shock:* The freeze destroyed about 20 percent of the trees. In addition, a portion of the fruit on tree was lost. As a result, the Florida orange crop dropped from 146.6 million boxes to 110.2 million boxes, a decrease of 24.83 percent.

The extent of the damage can be seen in Table 1 where we report the Florida orange crop, price, and yield estimates for the period 1988–93. As the table indicates, the output of oranges during the 1989–90 growing season has dropped by 24.8 percent in comparison to the 1988–89 season. The severity of the damage can also be seen by looking at the last row of Table 1. The figures in this row

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28 According to Dr. John Attaway of the University of Florida Center for Citrus Research and Education (personal communication), Florida Department of Citrus defines as a “significant freeze” any freeze that results in a 25 percent of more decrease in crop. Indeed, as Table 1 indicates, the orange crop during the 1989–90 season was down by 24.8 percent and the yield was down by more than 26 percent.
measure the yield as measured by number of boxes per acre. According to the table, during the 1989–90 growing season the yield was below the previous season by more than 26 percent. This sharp decline in the orange crop was accompanied by 35.5 percent increase in the Florida orange prices (Table 1).

Another indicator of the severity of the damage caused by the December 1989 freeze is the gallons per Brix yield estimate which is reported in Table 2. This is a measure of the solid content of oranges and thus an indicator of the quality of orange crop. As the table indicates, Gallons/Brix yield estimate has dropped from 1.48 in December 1989 to 1.21 in April 1990, which is a 18 percent drop. This basically measures the extent of the damage caused to fruit’s quality.

Second Cost Shock: All the available reports on this cost shock suggest that this cost increase began when the crop forecast by the U.S. Department of Agriculture in October 1991 turned out to be lower than what the market expected. However, these reports also indicate that this was an aberration that would not have any long term negative effects on citrus output. The actual Florida orange crop dropped from 151.5 million boxes in the 1990–91 season to 139.8 million boxes in the 1991–1992 season, a decrease of 7.78 percent (see Table 1). The reason for this decline was lower than normal temperatures during January and February and higher than normal temperatures during spring months of 1992 (Florida Agricultural Statistics Service, 1993, p. 1). As a result, harvest began unusually early because of the early bloom and consequently it was concluded earlier than normal. However, winter minimums were not below freezing and so no damage to trees or fruit was reported in any area of the State. Therefore, no decline in gallons per Brix yield is observed here. Actually, there was a slight increase, 2.7 percent, in this measure of yield.

The Effect on Prices
First Cost Shock: Spot prices witnessed an increase of 60% or $0.0353 per ounce during this cost shock. According to the plot of the weekly commodity spot price in Figure 1, after the initial jump the price level remained high for over 6 months period (29 weeks) before starting declining.

Second Cost Shock: Spot prices increased by 36% or $0.0211/oz during this cost shock. In contrast to the first cost shock, Figure 1 indicates that during the second cost shock the price level started declining immediately after the jump. This is an indicator of the temporary nature of the second shock, especially in comparison to the first shock.
Media Reports

First Cost Shock: The first cost shock was widely documented in newspapers and other print media with at least 28 mentions between December 1989 and March 1990. *The New York Times* and *The Wall Street Journal* (December 20 and 22, 1989) state that forecasts of extremely cold weather in Florida started the cost shock. Further analysis of the contents of the reports in the newspapers and other print media between December 1989 and March 1990 reveals that almost all the reports (23 out of the 28 reports documented) talked about the extensive damage to the citrus crop in Florida and about the increased commodity costs due to this freeze. In fact, the Governor of Florida declared the entire state a disaster area due to citrus crop damage and asked for Federal assistance to farmers (*The New York Times* and *The Wall Street Journal*, December 29, 1989). Further, we were able to find and document at least six TV reports on this freeze between December 22, 1989 and January 22, 1990 on a local TV channel (WGN, Channel 9, Chicago) and on the CNN. All six reports, talked about the significantly reduced crop prospects due to the freeze which had caused extensive damage to citrus crops in Florida, which accounts for 70 percent of the orange juice sold in the U.S.

Second Cost Shock: The analysis of the contents of the newspapers and other print media between October 1991 and January 1992 revealed that there were 17 documented reports about this shock. Between October 1991 and November 1991 there were 11 documented reports which mentioned that prices were going up. However, these reports also seemed to indicate that this increase was not due to any significant impact on the citrus output but rather due to speculative and psychological effects. For instance, *The Wall Street Journal* (November 7, 1991, p. 16) reported that “the cold in North Florida is not expected to affect the orange crop but the cold spell is having a psychological effect on the market.” Between January 7, 1992 and January 25, 1992 there were six documented reports on orange juice prices and all six indicated that prices of orange juice had started to come down. Thus, all the print media reports seemed to suggest that this shock was of a temporary nature.

Government Reports

First Cost Shock: This freeze was extensively mentioned at least in five reports of the Florida Department of Citrus and the USDA. According to the USDA reports, the reduced crop prospects were due to the expected negative effect of a minor freeze that occurred in February 1989 (Florida Department of Citrus, 1989, p. 1). The reports dated after the freeze of December 1989 mentioned that in addition to reducing the overall output, the December 1989 freeze had also reduced the yield
per box of frozen concentrated orange juice to 1.23 gallons per box compared to a pre-freeze yield of 1.48 gallons per box (USDA Report, July 12, 1990). These reports also suggested that commodity prices would go up due to reduced availability. And, as mentioned above, this freeze has been classified by the Florida Department of Citrus as one of the 9 major freezes over the last forty years.

Second Cost Shock: The Florida Citrus Department and USDA reports seemed to suggest that the lower-than-expected 1991–92 crop was an aberration and did not change their forecast of record crops in the future. In fact, in December 1991, the USDA (USDA Report No. 91/92-3) revised upward its citrus crop estimate for the 1991–92 growing season from 191,195,000 boxes to 198,180,000 boxes. The actual production for that season turned out to be 208,170,000 boxes (USDA Report No. 92/93-1).

Summary

In sum, the first cost shock was characterized by a severe freeze which decreased the crop by almost 25 percent leading to price increases. The prices remained high for over 6 months period before starting declining. These events were frequently discussed in the print and electronic media. Finally, the entire state of Florida was declared a disaster area because of the severity of the freeze and the damage it caused. In contrast, the second cost shock was prompted by an unexpected low crop forecast which was interpreted as an aberration that would have no long term effect. There was no freeze. The 7.7 percent decrease in crop was caused by the less than normal temperatures of January and higher than normal temperatures in Spring. The resulting price increase was short lived in the sense that prices started coming down immediately after the increase. There was much less media reporting, and some of the reports actually mentioned price declines. Thus, comparing and contrasting the two supply shocks, all indicators discussed above suggest that the second cost shock was more temporary in nature than the first shock.

5. Discussion of the Results and Conclusions

In section 4 we showed that prices are more rigid in reaction to the second cost shock than to the first cost shock. In section 5 we demonstrated that the second cost shock is more temporary in nature than the first cost shock, it is also smaller in size than the fist shock, and market participants had far less information on it than on the first shock. Combining these findings, we conclude that (i) prices are more rigid in response to cost shocks that are more temporary than to cost shocks that are more
permanent, (ii) prices are more rigid in response to small cost shocks in comparison to large shocks, and (iii) prices are more rigid in response to shocks on which there is incomplete information in comparison to shocks on which the available information is more complete. In the Econometric Appendix we report empirical findings that are consistent with this interpretation of the data.

The findings we report in this paper provide new micro-level empirical support for economic theories which predict that shock persistence will have an important effect on price rigidity. For example, our findings are consistent with Carlton’s (1989) and Carlton and Perloff’s (1994) argument that a firm may be reluctant to raise its price in response to unanticipated temporary cost increases for fear that their customers will mistake the current price increase as being permanent and react to it in the long run by substituting away from the store. The firm, therefore, may have incentive to absorb temporary cost increases in order to signal to its customers that the firm’s future prices are not expected to deviate from the current price. Similar arguments have been made by Okun (1981) and Haddock and McChesney (1994) in the context of customer markets. Further, Carlton (1989, p. 932, Footnote 19) suggests that his findings of frequent small (such as one percent) changes in intermediate goods’ prices “... could be consistent with a significant fixed cost of changing price that causes prices to remain rigid for temporary shifts in supply and demand, but not for permanent ones. Although this explanation is possible, I have seen no evidence to suggest it to be true.” The evidence presented in this paper seems to support this line of explanation, at least for our data set.

From a macroeconomic perspective, our findings support the explanation of price rigidity put forth recently by Meltzer (1995). He illustrates theoretically that the path by which prices adjust—or the degree to which they are sticky—depends on the temporary/permanent nature of the shocks. The existing empirical evidence on the importance of shock persistence for price rigidity is provided indirectly in studies that use aggregated datasets.29 We provide direct micro-level evidence in support of the importance of the distinction between temporary and permanent shocks for price rigidity.

Shock persistence has not received as much attention in the empirical literature on price rigidity as other factors like industry concentration.30 Yet Carlton (1989, p. 911) suggests that differences in market characteristics such as shock persistence “... may well be of more importance to macroeconomists than the effects of differences in concentration.” Further, there seems to be a substantial amount of variation in the extent of shock persistence across industries and markets.31

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29 See Brunner and Meltzer (1993) and Meltzer (1995) for a survey of these studies.
30 Carlton (1989, p. 911) indicates that variation in industry concentration is the most commonly cited reason for variation in price rigidity.
Therefore, it is possible that some of the variation in price rigidity observed in actual data, may indeed be driven by the variation in shock persistence.

Finally, there are many features of our data set that make our findings particularly useful for the macroeconomics literature. First, the store-level price and cost data have been suggested as the appropriate market level for studying price rigidity, since this is where the prices are actually set and is the type of data that is envisioned by various costs of adjustment theories (Lach and Tsiddon, 1992; Caplin, 1993). Second, the availability of direct retail costs (the wholesale prices) is a unique feature of our data that is rarely available in scanner data sets, and allows us to study cost-based measures of price rigidity which have been suggested as the most appropriate notion of price rigidity (Gordon, 1981; Blinder, 1991; and Carlton and Perloff, 1994). Third, the variation we document is particularly interesting given that we find it in time series data that cover only about three years period. The shortness of the sample period allows us to rule out variety of other possible explanations of the variation, such as variation in industry concentration, variation in long term contracting, variation in number of stages of processing, etc. Finally, we should emphasize that we uncover the permanence of the shocks in a way which is different from traditional approach. The usual practice in macroeconomics is to econometrically identify temporary and permanent components of the shocks and then estimate their magnitude. In this study, in contrast, we identify the shocks observed in our data with actual events that took place in the orange juice market, collect information that various market participants had about the causes of these specific shocks, and then use content analysis of this information to assess the likely persistence of the shocks.

Our results, however, should be interpreted in the context of their limitations, which suggest directions for future research. We do not want to overemphasize our findings as they are based on a limited number of products and on a limited number of data points. However, our product categories are widely used and representative of many typical retail items. Further, the pricing practices of the supermarket chain are representative of many large U.S. retail grocery chains. Thus, the retailer, the manufacturers, and the products we study are reasonably representative of the U.S. grocery industry. Nevertheless, future research should examine these issues across other product categories and other retail stores in order to see if these findings generalize to other products and markets such as consumer durables or business-to-business sales.

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References


Caplin, Andrew and John Leahy (1991), “State-Dependent Pricing and the Dynamics of Money
Florida Department of Citrus (1989), *Florida Citrus Outlook, 1989–90 Season* (Economic
Research Department), October 25.
Florida Department of Citrus (1994), *Citrus Reference Book* (Economic and Market Research Department), Revised in October.


Data Appendix

The Information Collected on Each Cost Shock

Below we report only those news reports or stories which mentioned price of O.J. or any information pertaining to the supply and demand of O.J. around the time of the two cost shocks. We first summarize the major characteristics of the two shocks from all the sources and then provide detailed description on each of them from each media source.

Characteristics of First Cost Shock: Summary of Findings from All Sources

The first cost shock was very widely and frequently reported across different media. This ensured that in addition to the processors and retailers, the consumers were also aware of the disastrous impact of the freeze on the supply of citrus crop. Further, almost all the information provided suggested that O.J. prices would go up because of reduced crop prospects. Thus there was little uncertainty that O.J. prices would go up. We discuss below the nature of this cost shock as reported in different media.

Print media:

The first cost shock was widely documented in newspapers and other print media with at least 28 mentions between December 1989 and March 1990. The New York Times and The Wall Street Journal (December 20 and 22, 1989) state that forecasts of extremely cold weather in Florida started the cost shock. This was right around the second increase in the spot cost in our sample. Further analysis of the contents of the newspapers and other print media between December 1989 and March 1990 reveals that almost all the reports (23 out of the 28 reports documented) talked about the extensive damage to the citrus crop in Florida and increased commodity costs due to this freeze. In fact, the Governor of Florida declared the entire state a disaster area due to citrus crop damage and asked for Federal assistance to farmers (The New York Times and The Wall Street Journal, December 29, 1989).

Television:

There were at least six TV reports filed on this freeze between December 22, 1989 and January 22, 1990 on local TV and CNN. All six reports talked about the significantly reduced crop prospects due to the freeze which had caused extensive damage to citrus crops in Florida, which annually supplies 70 percent of the orange juice consumed in the U.S. Some of these stories also talked about the hardship to citrus growers resulting from this freeze.

Florida Department of Citrus and USDA Reports:

There were at least five mentions of this freeze in the Florida Department of Citrus and/or USDA reports. These reports suggested that production for the 1989–90 season would be 24.8% lower than the previous season (Florida Department of Citrus, 1989) due to the freeze. Further, the reports mentioned that in addition to reducing the overall output, the freeze had also reduced the yield of frozen concentrated orange juice to 1.23 gallons per brix compared to a pre-freeze yield of 1.48 gallons per brix (USDA Report, July 12, 1990). These reports also suggested that commodity prices would go up due to reduced
availability. Finally, this freeze has been classified by the Florida Department of Citrus as one of the 9 major freezes over the last forty years (Florida Department of Citrus, 1994).

Characteristics of Second Cost Shock: Summary of Findings from All Sources

All the available reports on this cost shock seemed to suggest that this cost increase began when the crop forecast by the U.S. Department of Agriculture in October 1991 turned out to be lower than what the market expected. However, these reports also indicated that this lower than expected output was an aberration which would not have any long-term negative effects on citrus output. In fact, a number of media reports seemed to suggest that this price increase was influenced by speculative and psychological factors. This cost shock was not as widely reported as the first cost shock, for instance, there was no TV reporting of this spot cost increase. The information about this cost shock was not as easily available to consumers as the first cost shock. Further, the information available to manufacturers/processors and retail managers seemed to suggest that the effects of this shock would be temporary. We discuss below the nature of this cost shock as reported in different media.

*Print media:*

The second increase in spot cost occurred when the USDA released its forecast of a lower than previously expected citrus crop in October 1991. As stated in *the Wall Street Journal* (October 14, 1991), “Behind the move was what traders and analysts called a ‘shocking’ government forecast for a Florida crop of 136 million 90 pound boxes, or 10% below last year’s crop. Industry analysts expected the government to predict that the Florida crop would be as much as 10% bigger than last year”. This was right around the second increase in the spot cost in our sample. Further analysis of the content of the newspapers and other print media between October 1991 and January 1992 revealed that there were 17 documented reports about this shock. Between October 1991 and November 1991 there were 11 documented reports which mentioned that prices were going up. However, these reports also seemed to indicate that this increase was not due to any significant impact on the citrus output but rather due to speculative or psychological effects. For instance, *the Wall Street Journal* (November 7, 1991, p. 16) reported that “The cold in North Florida is not expected to effect the orange crop but the cold spell is having a psychological effect on the market.” Between January 7, 1992 and January 25, 1992 there were six documented reports on orange juice prices. All six reports indicated that prices of orange juice had started to come down because the fear of freeze seemed unwarranted. Thus, all the print media reports seemed to suggest that this shock was temporary in nature.

*Television:*

There was no mention of this cost shock in any of the local and network TV reports. In fact, the only TV reporting around that time suggested that citrus production had picked up from the previous season (CNN, December 24, 1991).

*Florida Department of Citrus and USDA Reports:*

Finally, the Florida Department of Citrus and USDA reports seemed to suggest that the lower-than-expected 1991–92 crop was an aberration and did not change their forecast of record crops in the
future. In fact, the USDA (Report No. 91/92-3) revised upward its estimate of the 1991–92 citrus crop from 191,195,000 boxes to 198,180,000 boxes in December 1991. The actual production for that season was 208,170,000 boxes (USDA Report No. 92/93-1).
# Information on First Cost Shock

## Newspapers and Other Print Media

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<td>Freeze severely damages orange crop in Florida.</td>
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<tr>
<td>12/20/1989</td>
<td>NYT</td>
<td>Business</td>
<td>16</td>
<td>O.J. price up from fear of freeze.</td>
</tr>
<tr>
<td>12/21/1989</td>
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<td>&quot;</td>
<td>14</td>
<td>O.J. price up from fear of freeze.</td>
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<tr>
<td>12/22/1989</td>
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<td>O.J. price up, frigid weather forecast.</td>
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<td>O.J. price drops sharply, skittish players take profit before holidays.</td>
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<td>12/24/1989</td>
<td>CT</td>
<td>&quot;</td>
<td>4</td>
<td>O.J. future prices soar as cold threatens Florida.</td>
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<tr>
<td>12/24/1989</td>
<td>NYT</td>
<td>&quot;</td>
<td>12</td>
<td>O.J. prices up with prospect of freeze.</td>
</tr>
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<td>12/27/1989</td>
<td>CT</td>
<td>&quot;</td>
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<td>Florida Governor declared the entire state a disaster area due to the impact of the freeze on the orange crop. Has sought Federal aid and low-interest loans for farmers.</td>
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<td>12/29/1989</td>
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<td>Florida Governor declared the entire state a disaster area for orange crop following freeze.</td>
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<td>12/29/1989</td>
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<td>Business</td>
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<td>Brazil suspends exports sending prices up.</td>
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<td>12/30/1989</td>
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<td>O.J. prices up as Florida faces warm weather (means oranges fall from trees and rot).</td>
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<td>1/3/1990</td>
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<td>Brazil suspends exports to assess price situation.</td>
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<td>1/6/1990</td>
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<td>O.J. prices rise as producers raise prices.</td>
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<td>Citrus production severely reduced by cold.</td>
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<td>Sharp cutback on orange crop estimates.</td>
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<td>Citrus production off 25% for 1989-90.</td>
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<td>O.J. prices up to record high with reports of damages higher than expected.</td>
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<td>19</td>
<td>O.J. prices down, strongest since freeze.</td>
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<tr>
<td>1/31/1990</td>
<td>&quot;</td>
<td>C</td>
<td>7</td>
<td>O.J. is going to get more expensive, says Dan Shafer of Minute Maid. Crop reduced 30% by freeze. Brazil price 132-192 per pound this week. Dr. Bob Behr of Florida Department of Citrus says price increase will not be felt until late February, prices should go up 20%, yearly average of up only 8.5%.</td>
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Newspapers and Other Print Media (Cont.)

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<td>O.J. prices down, retreating from December highs</td>
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<td>2/8/1990</td>
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<td>O.J. prices up, freeze heading South?</td>
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<td>O.J. prices down, actual production up over January estimates.</td>
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<td>3/8/1990</td>
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<td></td>
<td>19</td>
<td>O.J. prices up on speculation that Department of Agriculture would revise crop estimate downward. (Report came out on March 9, 1990.)</td>
</tr>
<tr>
<td>10/12/1990</td>
<td>NYT</td>
<td></td>
<td>13</td>
<td>O.J. price falling as US predicting big crops.</td>
</tr>
<tr>
<td>10/13/1990</td>
<td></td>
<td></td>
<td>41</td>
<td>O.J. prices collapse to four year low.</td>
</tr>
<tr>
<td>10/18/1990</td>
<td></td>
<td></td>
<td>20</td>
<td>O.J. price down with speculation Brazil would dump frozen concentrate.</td>
</tr>
</tbody>
</table>

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Television

**WGN-Channel 9, Chicago:**

WGN Ran a one minute twenty seven second story on the noon broadcast on Sunday, 23 December 1989 discussing the Florida freeze and its disastrous impact on the citrus crop (according to News Production Manager Tony Noce).

**CNN:**

Reporter Chris Abel, ran two minutes and one second story on 12/22/89, talking about the disastrous impact of freeze on citrus growers.

Reporter Dan Ronin, ran two minutes one second story on 12/23/89, discussing the effect of cold Florida weather on orange juice, travel and other effects.

Reporter Grant Perry ran one minute forty three seconds on 12/26/89 that was exclusively devoted to the damaged orange crop due to freeze and reduced crop prospects.

Reporter John Zarrella, ran one minute and fifty two second story on 1/22/90, reporting on the impact of freeze on the orange crops in Florida.

Reporter John Zarrella, ran three minutes and twenty eight second story on 5/21/90, talking about the devastation of orange groves due to cold weather in Polk, Lake and Orange Counties of Florida, driving citrus industry to move further South in Florida.
<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Page</th>
<th>Summary of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/25/1989</td>
<td>Citrus Outlook</td>
<td>1</td>
<td>USDA’s October 12, 1989 crop forecast placed Florida’s 1989–90 round-orange and Temple production at 133.0 million boxes, 17.3 million lower than production in 1988–89. The reduced crop prospects stem from the effects of a February [1989] freeze which hurt a significant amount of early bloom and reduced the amount of fruit set.</td>
</tr>
<tr>
<td>10/25/1989</td>
<td>”</td>
<td>4</td>
<td>U.S. per capita orange-juice consumption has averaged 5.0 SSE gallons during this decade. The annual figures for the 1980’s, as reported by Florida Department of Citrus (1994, p. 60), tend to fluctuate around this average.</td>
</tr>
<tr>
<td>10/25/1989</td>
<td>”</td>
<td>8</td>
<td>USDA’s October 12, 1989 crop forecast estimates the 1989–90 juice yield at 1.48˚ Brix gallons per box, 3.3 percent lower than in 1988–89.</td>
</tr>
<tr>
<td>1/11/1990</td>
<td>U.S.D.A. Citrus Estimate</td>
<td></td>
<td>Estimates for 1989-90 Florida Oranges were revised downwards in January to 157,950,000 boxes from October and December 1989 estimates of 194,350,000 boxes.</td>
</tr>
<tr>
<td>7/12/1990</td>
<td>Florida Agricultural</td>
<td>37</td>
<td>The Florida Citrus Processors Association’s Report No. shows that all orange FCOJ yield for 1989-90 season to be 1.226 gallons per box. Prior to the December 1989 freeze, the total yield was projected to be 1.48 gallons per box.</td>
</tr>
<tr>
<td>10/24/1990</td>
<td>Citrus Outlook</td>
<td>6</td>
<td>Retail sales of orange juice in 1989-90 are being affected by high prices due to reduced availability.</td>
</tr>
</tbody>
</table>
### Information on Second Cost Shock

#### Newpapers and Other Print Media

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Section</th>
<th>Page</th>
<th>Summary of the Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/8/1991</td>
<td>”</td>
<td>”</td>
<td>20</td>
<td>O.J. prices up after Department of Agriculture forecast.</td>
</tr>
<tr>
<td>10/14/1991</td>
<td>WSJ</td>
<td>Money</td>
<td>12</td>
<td>O.J. prices up after Department of Agriculture forecast of a 10% smaller crop than the previous year, when industry analysts expected 10% larger crop.</td>
</tr>
<tr>
<td>10/22/1991</td>
<td>”</td>
<td>”</td>
<td>20</td>
<td>O.J. price up fifth straight day.</td>
</tr>
<tr>
<td>10/25/1991</td>
<td>”</td>
<td>”</td>
<td>13</td>
<td>O.J. price up with speculation.</td>
</tr>
<tr>
<td>10/31/1991</td>
<td>”</td>
<td>”</td>
<td>1</td>
<td>O.J. price up sharply in trading after two days of lower prices.</td>
</tr>
<tr>
<td>11/5/1991</td>
<td>”</td>
<td>”</td>
<td>22</td>
<td>O.J. price up, though cold weather not to effect Florida.</td>
</tr>
<tr>
<td>11/7/1991</td>
<td>WSJ</td>
<td>Money</td>
<td>16</td>
<td>O.J. prices up, because Brazil and U.S. processors raise prices. The cold in North Florida is not expected to effect the orange crop, but the cold spell is having a psychological effect on the market.</td>
</tr>
<tr>
<td>11/12/1991</td>
<td>NYT</td>
<td>Business</td>
<td>21</td>
<td>O.J. up sharply after two down days.</td>
</tr>
<tr>
<td>1/7/1992</td>
<td>”</td>
<td>”</td>
<td>20</td>
<td>O.J. down.</td>
</tr>
<tr>
<td>1/8/1992</td>
<td>”</td>
<td>”</td>
<td>14</td>
<td>O.J. down second consecutive day.</td>
</tr>
<tr>
<td>1/18/1992</td>
<td>”</td>
<td>”</td>
<td>45</td>
<td>O.J. down, reversed fears on cold weather.</td>
</tr>
<tr>
<td>1/21/1992</td>
<td>”</td>
<td>”</td>
<td>17</td>
<td>O.J. down fifth day.</td>
</tr>
<tr>
<td>1/22/1992</td>
<td>”</td>
<td>”</td>
<td>13</td>
<td>O.J. down sixth day, fear of freeze abates.</td>
</tr>
<tr>
<td>1/25/1992</td>
<td>”</td>
<td>”</td>
<td>45</td>
<td>O.J. down rumors Brazil crop up next year.</td>
</tr>
</tbody>
</table>

#### Television

**CNN:**

Reporter Robert Vito, produced a one minute and fifty three second story on December 24, 1991, mentioning that orange crops had picked up after previous year’s weak crop.

Reporter John Zarrella, ran a one minute and fifty five second story on November 27, 1992, reporting that near perfect growing conditions had produced the third largest crop ever of citrus fruits in Florida, which will help lower prices.
Florida Department of Citrus: Economic Research Department and U.S.D.A Reports

<table>
<thead>
<tr>
<th>Date</th>
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<th>Page</th>
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</tr>
</thead>
<tbody>
<tr>
<td>10/23/1991</td>
<td>Citrus Outlook</td>
<td>1–2</td>
<td>Florida citrus production is expected to approach record levels during the 1991-92 season even though they fall well below the expectations according to USDA’s October 10 forecast. The lower-than-expected 1991-92 crop estimate was attributed to the moderate winter weather prior to the bloom period, which caused the trees to be in a vegetative state. The downturn in forecast orange production for the 1991-92 season should be viewed as an aberration. This season’s forecast does not change the trend of much larger, if not record, crops in the years ahead.</td>
</tr>
<tr>
<td>11/12/1991</td>
<td>U.S.D.A. Citrus Estimate Report No. 91/92-3</td>
<td></td>
<td>U.S.D.A estimate for 1991-92 in October 1991 was 191,195,000 boxes of Florida orange. This was revised upward to 198,180,000 in December.</td>
</tr>
<tr>
<td>8/19/1992</td>
<td>U.S.D.A. Citrus Estimate Report No. 92/93-1</td>
<td></td>
<td>According to the U.S.D.A, the actual crop for the 1991–92 period was 208,170,000 boxes of Florida orange. Projections for 1992-93 in October were 256,350,000 boxes.</td>
</tr>
</tbody>
</table>
List of Sources Consulted

Governmental Sources
Agricultural Prices: Department of Agriculture
Agricultural Statistics: Department of Agriculture
Citrus Outlook: Economic Research Department, Florida Department of Citrus
Citrus Reference Book: Economic and Market Research Department, Florida Dept. of Citrus
Crop Production: Department of Agriculture
Fruit and Tree Nuts Situation and Outlook Report: Department of Agriculture
Producer Price Indexes: Bureau of Labor Statistics

Trade Publications

Newspapers/Popular Magazines
Chicago Tribune (CT)
New York Times (NYT)
Time
USA Today (USAT)
Wall Street Journal (WSJ)

Television Stations (in Chicago)
WLS [ABC]
WMAQ [NBC]
WBBM [CBS]
WGN
CNN

Radio Stations (in Chicago)
NPR
WMAQ
WBBM
Chart 1. Schematic Description of the Florida Frozen Concentrated Orange Juice Market

Note: This chart is a simplified description of the organizational structure of the Florida orange juice market. Orange juice growers sell the fruit to orange juice manufacturers/processors who convert the oranges into frozen concentrate. There are two types of processors: one group of processors are privately owned and produce orange juice for private label. The other group of processors are owned by national orange juice manufacturers like Tropicana and Minute Maid, and they produce nationally branded products. The manufacturersprocessors package and sell the concentrated juice to retailers, either in its frozen form or reconstituted from concentrate and packaged as refrigerated juice. Oranges are also sold for other uses such as for preparing freshly-squeezed juice, for table use, for producing food additives, and so forth through other channels of distribution. These additional uses and their associated channels are not shown on the chart since in this paper we only study the market for frozen concentrated and refrigerated (reconstituted from frozen concentrated) orange juice. See Ward and Kilmer (1989) for details.
Figure 1. Cost and Price Series of Frozen Heritage House, 12oz, Original Data (dollars/oz)
Table 1. Crop, Price, and Yield of Florida Oranges, 1988–93

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange Crop (million box)(^1)</td>
<td>146.60</td>
<td>110.20</td>
<td>151.50</td>
<td>139.80</td>
<td>186.60</td>
</tr>
<tr>
<td>Florida Oranges Price (per box)(^2)</td>
<td>7.61</td>
<td>10.31</td>
<td>8.46</td>
<td>8.52</td>
<td>3.80</td>
</tr>
<tr>
<td>Yield Per Acre (box)(^3)</td>
<td>377.00</td>
<td>276.00</td>
<td>360.00</td>
<td>315.00</td>
<td>381.00</td>
</tr>
</tbody>
</table>

Notes:  
1. 90 pound box; Source: Florida Department of Citrus (1994, p. 10).  
3. 90 pound box; Source: Florida Agricultural Statistics Service (1994, p. 8).

Table 2. USDA Estimates of Florida Frozen Concentrated Orange Juice Gallons-per-Brix Yield

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>1.52</td>
<td>1.48</td>
<td>1.52</td>
<td>1.50</td>
<td>1.48</td>
</tr>
<tr>
<td>November</td>
<td>1.52</td>
<td>1.48</td>
<td>1.52</td>
<td>1.50</td>
<td>1.48</td>
</tr>
<tr>
<td>December</td>
<td>1.52</td>
<td>1.48</td>
<td>1.50</td>
<td>1.50</td>
<td>1.48</td>
</tr>
<tr>
<td>January</td>
<td>1.50</td>
<td>1.30</td>
<td>1.48</td>
<td>1.50</td>
<td>1.52</td>
</tr>
<tr>
<td>February</td>
<td>1.52</td>
<td>1.29</td>
<td>1.48</td>
<td>1.51</td>
<td>1.55</td>
</tr>
<tr>
<td>March</td>
<td>1.52</td>
<td>1.24</td>
<td>1.48</td>
<td>1.52</td>
<td>1.57</td>
</tr>
<tr>
<td>April</td>
<td>1.53</td>
<td>1.21</td>
<td>1.47</td>
<td>1.52</td>
<td>1.57</td>
</tr>
<tr>
<td>May</td>
<td>1.53</td>
<td>1.22</td>
<td>1.45</td>
<td>1.54</td>
<td>1.58</td>
</tr>
<tr>
<td>June</td>
<td>1.53</td>
<td>1.23</td>
<td>1.45</td>
<td>1.55</td>
<td>1.58</td>
</tr>
<tr>
<td>July</td>
<td>1.53</td>
<td>1.23</td>
<td>1.45</td>
<td>1.55</td>
<td>1.58</td>
</tr>
</tbody>
</table>

Notes: Measurement units are 42˚ Brix gallons.  
Source: Florida Department of Citrus (1994, p. 15).
Table 3. Summary of the Information on the Two Cost Shocks

<table>
<thead>
<tr>
<th></th>
<th>First Shock</th>
<th>Second Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date:</strong></td>
<td>December 23–24, 1989</td>
<td>October 13, 1991</td>
</tr>
<tr>
<td><strong>Cause:</strong></td>
<td>A severe freeze.</td>
<td>USDA’s October 12 “shocking” forecast of 10% lower than last year’s crop. The market expected 10% higher than last year’s crop.</td>
</tr>
<tr>
<td><strong>Temperature:</strong></td>
<td>Below 25˚F for two days.</td>
<td>January 1992 temperature was below normal. Spring temperatures and rainfall were above normal. As a result, harvest began early and it was concluded earlier than normally.</td>
</tr>
<tr>
<td><strong>Damage to fruit:</strong></td>
<td>A portion of the fruit on trees is lost.*</td>
<td>No damage to fruit.</td>
</tr>
<tr>
<td><strong>Damage to trees:</strong></td>
<td>About 20% destroyed.</td>
<td>No damage to trees.</td>
</tr>
<tr>
<td><strong>Effect on crop:</strong></td>
<td>24.8% decrease in orange crop.</td>
<td>7.7% decrease in orange crop.</td>
</tr>
<tr>
<td><strong>Effect on yield:</strong></td>
<td>26.8% decrease in boxes/acre and 13.2% decrease in gallons/brix.</td>
<td>12.5% decrease in boxes/acre and 2.7% increase in gallons/brix.</td>
</tr>
<tr>
<td><strong>Prices:</strong></td>
<td>Stay high for about 28 weeks after the increase.</td>
<td>Start to decline immediately after the increase.</td>
</tr>
<tr>
<td><strong>Print media:</strong></td>
<td>28 mentions (23 reports mention extensive damage to the citrus crop and the resulting price increase.)</td>
<td>17 mentions (11 reports mention price increase). But some suggest speculative and psychological reasons for it. 6 reports in January 1992 mention OJ prices actually coming down because the fear of freeze seem unwarranted.</td>
</tr>
<tr>
<td><strong>TV Reports:</strong></td>
<td>6 reports (WGN-Chicago and CNN): all 6 discuss the severity of the damage.</td>
<td>No TV report on price increase. The only report (on CNN, December 24, 1991) actually mentioned increased orange crop expectations.</td>
</tr>
<tr>
<td><strong>FDC &amp; USDA:</strong></td>
<td>5 reports: all predict low output and high price. The freeze has been classified by FDC as one of the 9 major freezes over the last 40 years.</td>
<td>One report: lower-than-expected 1991–92 crop was an aberration and did not change their forecast of record crops in the future.</td>
</tr>
<tr>
<td><strong>Emergency:</strong></td>
<td>Governor of Florida declares the entire state a disaster area and asks for Federal assistance.</td>
<td>None.</td>
</tr>
</tbody>
</table>

* About 90% of the fruit was still on trees when the freeze occurred.