EXPLAINING PRICE TRANSMISSION ASYMMETRY IN THE US PEANUT MARKETING CHAIN

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I. Introduction

The objective of the paper is to analyze how changes in raw peanut prices have been reflected in the prices of peanut butter, the most important product of peanut processing. Specifically, we are interested in the observed asymmetry of raw peanut to butter price transmission and in identification of its possible causes. The findings allow us to discuss the likely distributional effects of the changes in the producer support introduced by the 2002 Farm Act, *i.e.*, to examine the extent to which reduction in peanut prices caused by the introduction of the 2002 Farm Act may benefit the consumers of the products of peanut processing, the processing companies, and peanut growers. Given the absence of peanut butter consumption data, the analysis relies on observed changes in the peanut butter prices: the presumption is that a reduction in the price of peanut butter following a proportionate reduction in peanut prices should indicate an increase in the consumer surplus.

The issue of price transmission - the proportion of an (interim) input price change that is passed on to the output prices - has always been hot in agricultural economics. It is particularly important in the analysis of welfare effects of changes in agricultural policies, like elimination of farm price support programs or introduction of alternative support mechanisms, and in the analysis of economic effects of new technologies (e.g., more productive equipment or genetically modified crops that reduce producers' costs). Of particular importance is the issue of asymmetric manufacturer or processor price responses to exogenous changes in marginal (variable) input costs. In many industries, it has been observed that, while increases in input prices are almost instantaneously reflected in the output prices, input price decreases are usually followed only by delayed

and partial drops in the output prices (Peltzman, 2000). In the economic theory, this phenomenon has been explained in terms of two major influences: possible market power of the manufacturers and profit maximizing inventory management. As both factors are important in the analysis of food processing industries, they are the most likely explanations of the asymmetry in question.

The change in peanut production support policies introduced by the 2002 Farm Act has led to a significant drop in raw peanut prices. Under the now-eliminated peanut marketing quota, the quota peanuts - peanuts purchased for the edible market (e.g., for peanut butter and snack production) were sold at a support price of $610/ton. The Farm Act replaced the quota support system with the marketing loan program that, effectively, established a much lower price floor of $314/ton and removed quantity constraints. As a result, the average price of the 2002 crop dropped to $380 per short ton (38%). While we do not possess the most current market data, findings about the level and structure of price transmission in the past may suggest how the surplus generated by the price drop is shared between the producers and consumers.

In spite of the vast literature on the asymmetry of price transmission (see Peltzman, 2000, for an extensive review), only two applied studies on peanut butter prices have been undertaken. Zhang et al. (1995) analyzed the effect of price transmission from shelled peanuts to peanut butter for the period of 1984-1992 and found that, in the short run, peanut butter prices responded to increases in peanut prices faster than to decreases. However, the pass-through effect was found to be symmetric in the long run. Deodhar et al. (1998) also studied the pass-through effect, but now with a focus on testing competitiveness of the peanut butter manufacturing industry. Their results showed

that the industry was competitive in the short run but there were some indications of non-competitiveness in the long-term.

The rest of the paper is structured as follows. First, we briefly review the methods used for testing for asymmetric price transmission and theoretical explanations that have been offered. Second, we present some results of empirical tests for the asymmetry of transmission of peanut price changes to wholesale peanut butter prices changes and from wholesale to retail peanut butter price changes. Then, we discuss possible causes of the price transmission asymmetry in the peanut markets, and well as the implications of the changes in the production support policies.

II. Testing Asymmetry of Price Transmission

The issue of asymmetric price transmission has attracted much attention and raised a few issues in economics. The interest was spurred by both positive and normative aspects of the phenomenon. On the one hand, despite the fact that asymmetry in price transmission has been frequently observed empirically, economic theory has not fully incorporated it. On the other hand, economic policies also fail to account for consumer effects of asymmetric price transmission.

Empirical work on finding evidence of price transmission asymmetry has focused mainly on the agricultural and food processing industries (see Harper and Goodwin, 1999, for a discussion), on gasoline and fuel markets (Borenstein, Cameron, and Gilbert, 1997), and on financial markets (for example, Enders and Gardner, 1998, found evidence of asymmetric adjustment between interest rates of different maturities). A much more comprehensive study of several hundred producer and consumer goods in the US

performed by Peltzman (2000) finds evidence of asymmetric price transmission in over two-thirds of the markets, which makes asymmetric price transmission a rule rather than an exception.

Perhaps the most significant problem that has prevented direct incorporation of asymmetric price transmission into economic theory and policies is that existing econometric methods used for detecting it could not clearly differentiate among the possible causes of this phenomenon. One should mention that price transmission asymmetry arguments are different from explanations of different levels, or percentages, of price transmission, though the two sets of arguments are related. While the latter is mostly cost, supply, and demand elasticity related, the former has somehow more sophisticated explanations.

The two main culprits for price transmission asymmetry that have been suggested are abuse of market power (imperfect competition) and profit maximizing inventory management. The logic of the market power argument is simply that firms in a tacitly collusive industry earning abnormal profits tend to simultaneously increase their margins in response to a drop in the input costs thereby passing only a small fraction of the decrease on to the output prices. At the same time, collusive behavior facilitates passing (almost) all of the input price increase to the output price. The magnitude of such transmission asymmetry depends not only on the firm behavior but also on the economies of scale and demand and supply elasticities (McCorriston, Morgan, and Rayner, 2001). The differences between the long and short run transmission effects in the market power logic are determined by the importance of capital costs and/or capacity adjustment and on the time that this adjustment takes.

The inventory management argument is based on dynamic models of profit maximizing inventory management as in Zabel (1972), Blinder (1990), and Phlips (1980). The general result of such models is that the presence of inventories introduces additional price rigidity, which is consistent with maximizing behavior: because of the "cushioning" effect of inventories, prices tend to move sluggishly in industries whose outputs (inputs) are storable, as price responses are substituted by quantity responses. Thus, sectors with perishable inventories are more likely to exhibit more price flexibility than those with easily storable stocks.

The explanation of price transmission asymmetry based on the models of inventory management is akin to that of downward price rigidity. The argument is that, when negative inventories ("unfilled orders") are prohibited, which is quite a realistic assumption, there will be asymmetric price responses: prices will react more strongly to increases in demand than to decreases in demand. In other words, the sales (quantity) response is smaller when a firm has stocked out (as a result of an increase in demand or decrease in supply), and thus the price response must be greater, hence the asymmetry result. The important feature of this argument is that it does not require the assumption of imperfect competition. The inventory argument is more robust when applied at the macro level, as it is likely that the number of firms experiencing stock-outs is greater at higher levels of macroeconomic activity, and thus price responses to demand shocks should be greater there (Blinder, 1990).

Apart from the market power and inventory management arguments, asymmetric price transmission has also been attributed to cost adjustment rigidities, like menu costs

or sticky wages, in those cases when input price change is significant enough to warrant production volume or capacity adjustment.

Regardless of the reason behind asymmetric price transmission, several econometric methods have been used in testing it. Most attempts have been based on a variable splitting technique for detecting irreversible supply reactions originally developed by Wolfram (1971), and later adapted by Houck (1977) and Ward (1982). A different approach was used by Cramon-Taubadel (2000) who showed that an asymmetric error correction model (ECM) based on Granger and Lee (1989) can be more applicable than the Houck approach if the price data being studied are cointegrated. However, Harper and Goodwin (1999) used a threshold autoregressive test for unit roots to test for the presence of asymmetric price transmission and argued that this method has several advantages over the asymmetric ECM.

It has been argued that the latter two methods are also more useful in the presence of the so-called structural breaks (Cramon-Taubadel, 2000). A structural break occurs when events like increasing industry concentration or changes in government policy that affect market outcomes lead to changes in structural relationships linking prices at various levels of the marketing chain. This is an important attribute of the models as it allows avoiding model mis-specification: tests for asymmetric price transmission that are based on models that assume the presence of a unique and stable vertical relationship between prices are likely to be misleading if the assumption is false. Cramon-Taubadel (2000) found that the presence of structural changes in price data lead to far more rejections of the null hypothesis of symmetric transmission than appropriate and thus

create a false impression of asymmetric price transmission that should, in fact, be attributed to other causes.

The dataset used in testing peanut prices transmission asymmetry consists of monthly price data that covers a period from 1984 to 1999. The monthly data on shelled peanut prices come from USDA's Peanut Marketing Summary reports and the Federal State Market News. The monthly peanut butter prices and the prices of other peanut processing products are reported by the Bureau of Labor Statistics. The software used in estimation is EViews.

A starting point for testing asymmetry is to verify whether the time series possess unit roots, since it implies a different econometric method (cointegration approach). Table 1 presents the augmented Dickey-Fuller test for unit roots. As shown in the table, the hypothesis of unit roots is rejected in all the cases.

Table 1: Augmented Dickey-Fuller Test 1/

Series	**Statistics**	
	Augmented Dickey - Fuller	Critical Value (5%)
Peanut prices	-3.90	-3.43
Wholesale Peanut Butter Price	-3.94	-3.43
Retail Peanut Butter Price	-3.62	-3.44

1/ Dickey-Fuller test with intercept, trend and 12 lags.

The next step is to test for asymmetry from peanut prices to wholesale peanut butter prices and from wholesale peanut butter prices to retail peanut butter prices. We ran two regressions for each case using two types of equations. The first type of equation considers the regression of the first difference in the downstream price in the supply

chain on the first difference in the price immediately upstream in the supply chain (e.g., first difference in the wholesale peanut price on to the first difference in the peanut price).

$$\Delta P_{Dt} = \alpha_0 + \alpha_1 \Delta P_{Ut}^{UP} + \alpha_2 \Delta P_{Ut}^{DOWN} + \varepsilon_t$$

where $\Delta P_{Dt} = P_{Dt} - P_{Dt-1}$ is the downstream price difference, and $\Delta P_{Ut}^{UP} = P_{Ut} - P_{Ut-1} > 0$ and $\Delta P_{Ut}^{DOWN} = P_{Ut} - P_{Ut-1} < 0$ are the upward and downward movements in the upstream prices, respectively. This specification accommodates only one lag and thus only allows testing for short term price transmission asymmetry.

The second type of equation, which includes multiple lags, allows testing long term response (e.g., dynamic behavior).

$$\Delta P_{Dt} = \alpha_0^* + \sum_{l=1}^{k} \alpha_{1l} \Delta P_{Ut-l}^{UP} + \sum_{l=1}^{k} \alpha_{2l} \Delta P_{Ut-l}^{DOWN} + \varepsilon_t$$

The results are presented in table 2.

In contrast with the results by Zhang et al. (1995) and Deodhar et al. (1998), our results show that the peanut price transmission effects are not symmetric in the long-term. However, the data show similar differences in transmission lags following increases and decreases in the prices of shelled peanuts. Thus, it appears that asymmetric price transmission has manifested itself once again.

Table 2: Tests of Assymetric Price Transmission

	Peanut Price to Wholesale Peanut Butter Price						**Wholesale Peanut Butter Price to Retail Peanut Butter Price**					
	Coeff.	t	Sum	Coeff.	t	Sum	Coeff.	t	Sum	Coeff.	t	Sum
Constant	0.22	2.75		0.04	0.73		0.18	3.11		0.00	-0.06	
ΔPB+	0.09	13.32	**0.09**	0.09	22.89	**0.24**	0.32	2.78	**0.32**	0.16	1.50	**1.38**
ΔPB+(-1)				0.09	21.62					0.64	5.85	
ΔPB+(-2)				0.04	9.84					0.11	0.97	
ΔPB+(-3)				0.00	0.64					0.23	1.97	
ΔPB+(-4)				0.00	0.93					0.30	2.43	
ΔPB+(-5)				0.01	1.27					0.13	1.07	
ΔPB+(-6)				0.00	0.30					-0.19	-1.59	
ΔPB-	0.09	11.23	**0.09**	0.10	20.58	**0.11**	-0.49	-1.07	**-0.49**	-0.54	-1.34	**0.28**
ΔPB-(-1)				-0.01	-2.25					0.04	0.10	
ΔPB-(-2)				0.01	2.16					1.15	2.90	
ΔPB-(-3)				0.00	-0.19					-0.22	-0.56	
ΔPB-(-4)				0.00	0.40					0.20	0.51	
ΔPB-(-5)				0.00	0.16					-0.52	-1.32	
ΔPB-(-6)				0.01	1.34					0.16	0.40	

III. Discussion of the results

There are both long- and short-term price transmission asymmetries observed in the peanut processing industry. This suggests that the dynamic inventory management explanation of the asymmetry is less relevant here, as the essential feature of the logic of the inventory argument is that the asymmetry is always temporary, *i.e.*, the presence of inventories buffers supply (or demand) shocks, making their effects eventually disappear. Besides, the inventory argument implies an assumption of possibility of stockouts. Industry information that we possess does not indicate that either peanut sheller or peanut butter manufacturer stockouts are common.

The permanence of price transmission effects established by the estimation speaks more in favor of the market power argument. The persistence of asymmetry suggests that the firms in the industry have been behaving collusively over time, which shifted the gains from input price decreases from consumers and producers to the processors. The estimation methodology used in this paper does not allow separating the transmission effects on the consumers and on the producers. However, it is likely that sharing surpluses between agricultural producers and processors is relatively more dependent on their relative bargaining power and on the types of contractual arrangements between them. In the light of our findings at this stage, it is likely that, over the analyzed time period, most of the producer cost reductions passed on to the processors, while cost increases have been mostly absorbed by the producer.

An interesting observation can be made with regard to the vertical industry structure. Evidence of price transmission asymmetry, and perhaps collusive behavior, has been found at two levels of the marketing chain: peanut shelling and peanut butter

manufacturing. If the market power explanation is accepted, there is a processor (sheller) oligopsony in the peanut market, processor - butter manufacturer oligopoly-oligopsony situation in the market for shelled peanuts, and another oligopoly-oligopsony situation in the wholesale market for peanut butter. Butter manufacturers always sell their produce wholesale to the retail stores and do not market it themselves. While the brand names are manufactured by corresponding companies, store brands are usually produced by smaller manufacturers that do not have a brand name, which invites asymmetry explanations based on firm heterogeneity and differentiated goods (Dung, 1993; Anderson *et al*, 2001).

Thus, the negative effects of market concentration (horizontal industry structure) are made even worse by the vertical industry structure, *i. e.*, by the presence of oligopoly/oligopsony at different levels of the marketing chain. In other words, there can be an issue of double marginalizaton: a negative externality that arises in a successive (multi-stage) oligopoly (Tirole, 1988). The firms set perceived marginal revenue equal to marginal cost, and the marketing chain is characterized by successive markups that sum up to more than a single markup that an integrated industry would set, particularly when downstream firms do not take upstream firms' prices as given (the is, when the "arms-length" pricing assumption is relaxed). This is likely to be the case, as the nature of the contracts between manufacturing and retailing sectors reflects distribution of power in a bilateral bargaining problem. Depending on the distribution of the bargaining power, the contracts may include a number of the so-called vertical restraints, termed in economic literature as "full-line forcing", exclusive distribution, exclusive territories, and slotting allowances (McCorriston, 2002). However, the impact of a specific vertical restraint depends on the characterization of the vertical market structure. In different structures,

vertical restraints may either worsen or ameliorate the double-marginalization problem that characterizes successive oligopolies. Overall, the current literature suggests that vertical restraints arise from market power and in situations that involve information asymmetry (Dobson and Waterson, 1997; Kuhn, 1997).

The contracts that involve peanuts and peanut processing products have not been studied extensively, and we are researching it at the moment. Overall, it appears that the peanut marketing chain has not been affected by the wave of mergers and acquisitions observed in other food industries. Theory suggests that these activities may actually be welfare enhancing in successive oligopoly situations. Consolidation in the peanut industry may be taking place in the form of binding contractual agreements between vertically related trading parties. For example, peanut shellers have introduced several types of binding forward contracts that tie up the producer stocks in under the marketing loan. Similarly, peanut butter manufacturers are using increasingly more binding contracts with the shellers.

Unfortunately, limited availability of most recent data prevents explicit analysis of the effects of the significant peanut price decreases caused by the elimination of the peanut quota program under the 2002 Farm Act. However, our findings suggest that the input price decrease is not likely to be entirely passed on to the consumers: it is divided among all the economic agents involved, with the more powerful getting more of it.

III.a. Explaining observed asymmetry in terms of inventory management in an imperfectly competitive environment.

In this subsection, we sketch a model that tries to explain price transmission asymmetry in terms of a simple inventory management argument in an imperfectly

competitive environment. The model does not need the usual additional assumptions that are required in the traditional market power models of asymmetric price transmission, and this might help in the interpretation of the results from the previous section. Let us consider a vertical processing industry that regularly purchases its main input (shelled peanuts) from producers and transforms it in peanut butter.

The idea behind the model is that, on the one hand, a peanut butter processing firm will pass a permanent increase in the peanut prices to the peanut butter price in order to maintain its purchasing power (i.e., purchase the same amount of peanuts to serve the usual demand). On the other hand, a permanent decrease in peanut prices is only passed after the stocks of previously purchased more expensive peanuts have been depleted. It should be noted that, in the latter case, a requirement for a firm not to reduce its price in the full amount of the decrease in peanut prices is to have some market power. If the firm is in a competitive environment, then the result may depend on the interaction with the other firms. If the other firms reduce their output price, then the firm will be forced also to reduce its price in order to avoid a decrease in the demand for its output.

Let us call w_t the price of shelled peanuts at time t, and p_t the corresponding price of peanut butter at t. At w_t, the firm purchases enough stock to carry its business until period t+1 (given an expected demand). If at time period $t+\alpha$, where $\alpha < 1$, the price of peanuts changes and, depending on the direction of the change, the firm responds:

(a) If $w_{t+\alpha} < w_t$, a firm with some market power would not decrease its output price $p_{t+\alpha}$ until the current stock is depleted. Only after it is depleted, there will be an adjustment of the output price. In this case, we have an asymmetric response with lags.

(b) If $w_{t+\alpha} > w_t$ then the firm will adjust its output price upward immediately due to the fact that it needs to replenish the stock of peanuts that have become more expensive.

Such firm behavior produces asymmetric response with lags.

IV. Conclusions

Economic analysis of the input-output retail price transmission is important for at least two reasons: first, because it produces evidence about how changes in marginal costs (e.g., permanent shocks inflicted by changes in the legislation) affect consumers of the final product and, second, because it allows us to get a better understanding of how vertically integrated industries, especially food processing and manufacturing industries, actually operate.

Our results and conclusions may illustrate a change in the market behavior of the peanut butter industry from relatively more competitive, as evidenced by the information up to 1992, to less competitive thereafter. In addition, this non-competitiveness may be linked to an increased concentration and anti-competitive behavior of the firms in the industry. This observation has direct welfare implications for the effects of the 2002 Farm Act that significantly affected peanut and oilseed production. It is also important for the analysis of the structure of contracts that are used by the firms in the industry.

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