“Accounting for Incomplete Pass-Through”
Nakamura and Zerom (Restud 2010)

Nice discussion of literature on incomplete pass-through
(1) the role that mark-up change can partially absorb cost change
(2) the role of local costs

A lot of literature is on exchange rates. Could be lot of macro things going on in the background.

Coffee a clean case:

- weather shocks handy for identification
- local cost not too big
- argue coffee relatively representative consumer product

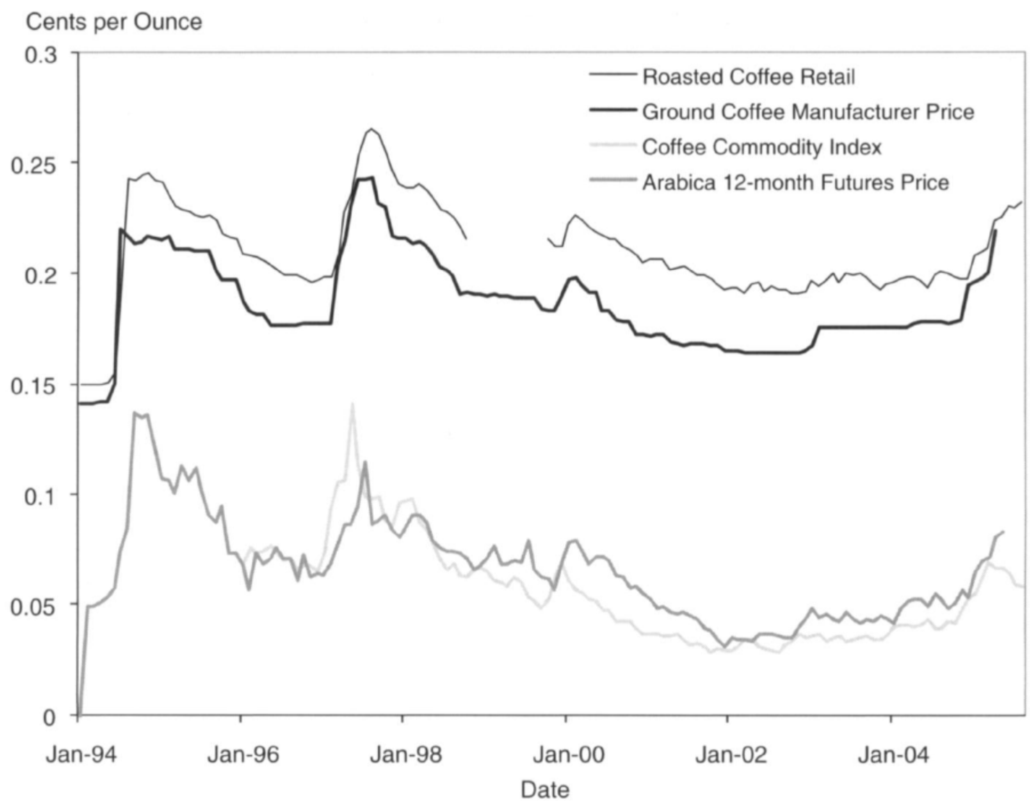

FIGURE 1

Retail, wholesale and commodity prices

The roasted coffee retail and ground coffee manufacturer prices are average prices from the Bureau of Labor Statistics (the "ground coffee" retail price index and the "roasted coffee" wholesale price index). The Arabica 12 month futures price is from the New York Board of Trade. The coffee commodity index is the "composite commodity index" discussed in Section 2. The gap in the retail price series from November 1998 to September 1999 arises from missing data.

$$\Delta \log p^{l}_{jmt} = a + \sum_{k=1}^{6} b_k \Delta \log C_{t-k} + \sum_{k=1}^{4} d_k q_k + \epsilon, \tag{1}$$

TABLE 1
Pass-through regressions

Variable	Log specification: Retail	Log specification: Wholesale	Levels specification: Retail	Levels specification: Wholesale
Δ Commodity cost (t)	0.063 (0.013)	0.115 (0.018)	0.142 (0.040)	0.218 (0.061)
Δ Commodity cost ($t-1$)	0.104 (0.008)	0.169 (0.013)	0.446 (0.024)	0.520 (0.043)
Δ Commodity cost ($t-2$)	0.013 (0.007)	−0.010 (0.010)	0.016 (0.019)	0.029 (0.028)
Δ Commodity cost ($t-3$)	0.031 (0.006)	−0.016 (0.009)	0.080 (0.018)	0.004 (0.026)
Δ Commodity cost ($t-4$)	0.048 (0.007)	0.007 (0.013)	0.144 (0.018)	0.023 (0.030)
Δ Commodity cost ($t-5$)	0.007 (0.006)	0.025 (0.011)	0.070 (0.017)	0.067 (0.031)
Δ Commodity cost ($t-6$)	−0.015 (0.008)	−0.026 (0.012)	0.017 (0.021)	−0.009 (0.029)
Constant	0.033 (0.003)	−0.004 (0.003)	0.007 (0.0004)	0.001 (0.0005)
Long-run pass-through	0.252 (0.007)	0.262 (0.018)	0.916 (0.023)	0.852 (0.052)
Number of observations	40,129	2867	40,129	2867
R-squared	0.079	0.141	0.088	0.134

Notes: The retail price variable is the change in the UPC-level retail price per ounce in a particular US market over a quarter. The wholesale price variable is the change in the wholesale price per ounce (including trade deals) of a particular UPC in a particular US market over a quarter. The standard errors are clustered by unique product and market to allow for arbitrary serial correlation in the error term for a given product. The data cover the period 2000–2005.

$$\Delta p^r_{jmt} = \alpha^r + \sum_{k=0}^{2} \beta^r_k \Delta p^w_{jmt-k} + \sum_{k=1}^{4} \gamma^r_k q_k + \epsilon, \tag{2}$$

TABLE 2

IV regression of retail on wholesale prices

	Retail prices
Δ Wholesale price (t)	0.958 (0.131)
Δ Wholesale price ($t-1$)	−0.050 (0.180)
Δ Wholesale price ($t-2$)	−0.027 (0.129)
Constant	0.005 (0.001)
Quarter dummies	Yes
Number of observations	2792
Instruments	Commodity costs

Notes: The dependent variable is the change in the UPC-level monthly average of the retail price per ounce in a particular US market over a quarter. The wholesale price variable is the change in the wholesale price per ounce (including trade deals) of a particular UPC in a particular US market over a quarter. The standard errors

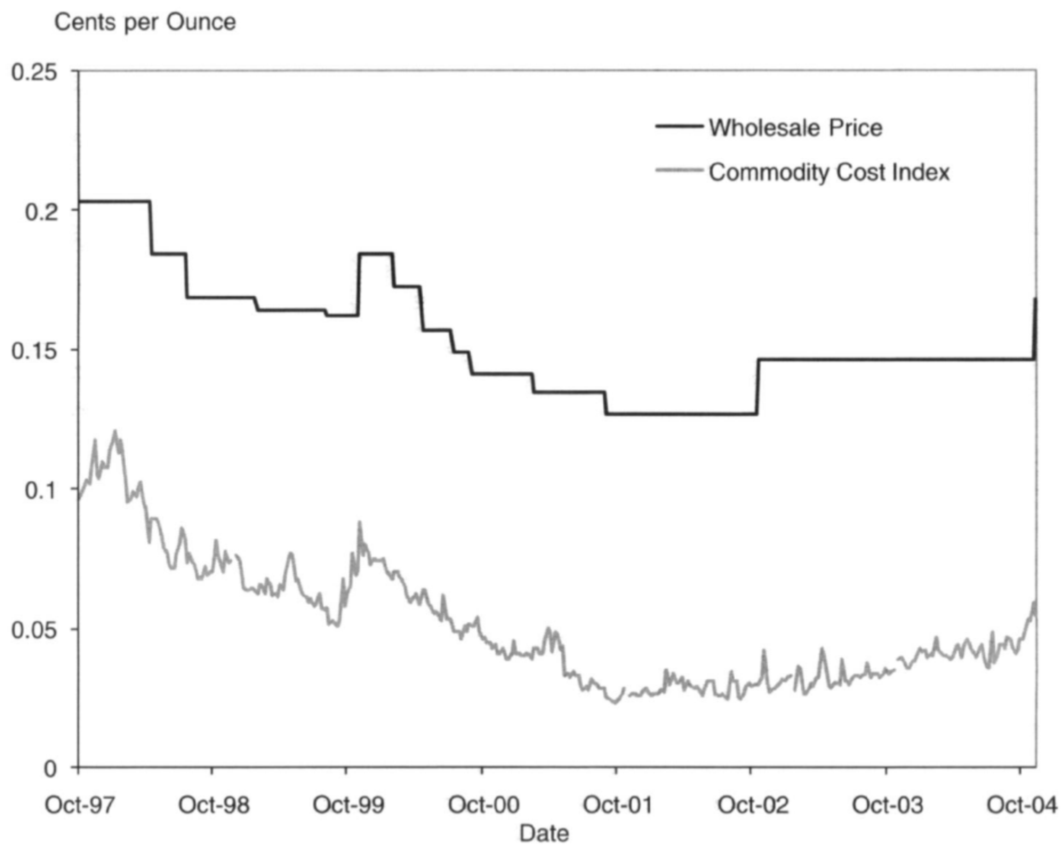

FIGURE 2

A typical wholesale price series

The wholesale price depicted is for a leading coffee brand. The coffee commodity index is the "composite commodity index" discussed in Section 2. The gap in the retail price series from November 1998 to September 1999 arises due to missing data.

TABLE 3

Annual frequency of price change

	Retail prices	
Wholesale prices	Without retail sales	With retail sales
1.3	1.5	3.1

Notes: The wholesale price statistics are based on weekly wholesale price data for the period 1997–2004. The first column presents the statistics for regular prices (excluding trade deals). The observations are weighted by average retail revenue over the period 2000–2004. The second and third columns of present statistics on the frequency of price change for retail prices of ground coffee from Nakamura and Steinsson (2008) based on monthly data from the CPI research database collected by the Bureau of Labor Statistics.

TABLE 4

Frequency of price change and commodity cost volatility

Year	Average number of price changes	Standard deviation of commodity cost index
1997	4.3	2.1
1998	1.7	1.6
1999	1.7	0.8
2000	3.0	0.9
2001	1.0	0.4
2002	0.4	0.3
2003	0.2	0.1
2004	0.6	0.5

Notes: The second column gives a size-weighted average of the annual frequency of wholesale price change, not including trade deals. These statistics are based on weekly wholesale price data for the period 1997–2004. The observations are weighted by average retail revenue over the period 2000–2004 (the period covered by the retail data). The third column gives the standard deviation of the coffee commodity index in units of cents per ounce.

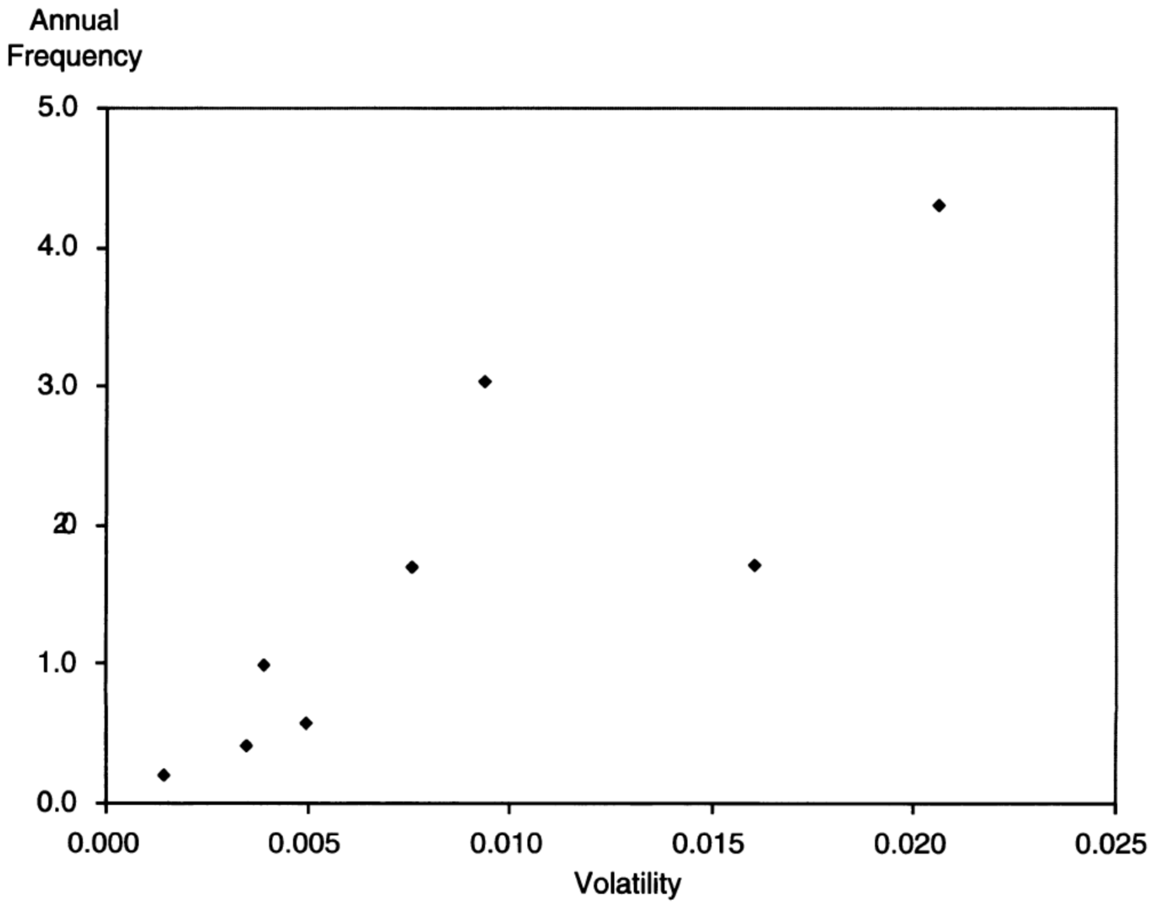

FIGURE 3

Price change frequency versus commodity cost volatility

The figure plots the revenue-weighted average annual frequency of price change for the wholesale price (not including trade deals) vs. the volatility of the commodity cost index for each of the years 1997–2004. The revenue weights are constructed from average retail revenue over the period 2000–2004.

Consumer Demand

Standard Differentiated Products Approach (follows BLP)

Discrete Choice Demand

$$U_{ijmt} = \alpha_i^0 + \alpha_i^p (y_i - p_{jmt}^r) + x_j \beta^x + \xi_{jmt} + \epsilon_{ijmt}, \quad (3)$$

If we shut down individual specific parameters the formulas for the market shares are (taking logs)

$$\log s_{jmt} - \log s_0 = \alpha^0 - \alpha^p p_{jmt}^r + x_j \beta + \xi_{jmt}, \quad (4)$$

(Were good 0 is the "outside good"

Discussion of market:
Coffee Manufacturers:
Folgers (Proctor and Gamble), Maxell House (Kraft Foods)
Across markets, median Herfindahl is 0.35, median fraction of Folders+Maxell house alone is 0.80.
(Note Folgers big in West Coast/Midwest, Maxwell House big in East)

For demand model,
Take top 15 products by volume 2000-2004 (87% total ahsre)
Total Market: 2 cups of caffienated coffee (made from ground coffee purchased at supermarkets) for every individual 18 or over in a given market are per day. (outside good likely a big share!)

TABLE 5
Demand estimates

	Logit						Random coefficients
	OLS1	OLS2	IV1	IV2	IV3	IV4	IV
Price	2.92 (0.37)	10.59 (1.05)	16.16 (2.16)	14.60 (1.17)	12.67 (3.59)	17.29 (1.33)	17.76 (0.78)
Random coefficients							
π_{y0}							−1.03 (1.31)
π_{yp}							−3.24 (0.09)
Large size (>24 ounces)	0.47 (0.13)	0.12 (0.10)	−0.16 (0.13)	−0.08 (0.10)	0.14 (0.19)	−0.21 (0.10)	−0.28 (0.08)
Total advertising (1000's, quarterly)	0.45 (0.02)	0.05 (0.004)	0.15 (0.10)	0.13 (0.02)	0.26 (0.03)	0.20 (0.01)	0.20 (0.02)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Christmas dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Brand × region dummies	No	Yes	Yes	Yes	Yes	Yes	Yes
Instrument			Hausman	Commodity cost	Exchange	Weather	Weather
Median price elasticity	0.54	1.96	2.99	2.69	2.34	3.20	3.46* [2.59 4.48]
Number of observations	22,411	22,411	22,411	22,411	22,411	22,411	22,411

Notes: The demand system is estimated using monthly averages of UPC-level retail prices per ounce in US markets. The IV specifications use instruments for both prices and advertising. Commodity cost instruments: the commodity cost index, current, one and three lags. Hausman instruments: average price of product within the census division, current and three lags. Exchange rate instruments: Brazil/US exchange rate and Colombia NEER (Source: IFS). Weather instruments: lagged minimum and maximum temperatures for the Sao Paulo/Congonhas (Brazil) and the Cali/Alfonso Bonill (Colombia) weather stations. The standard errors are clustered by unique product and market to allow for arbitrary serial correlation in the error term.

*The 95% confidence interval is constructed using a parametric bootstrap. We draw from a joint normal distribution representing the joint distribution of the coefficients.

Comments about demand

- Firm level demand elasticity is (median) 3.46. Similar to other work using different estimation strategies. Haltiwanger and Syverson (2008) is 3.65, Broda and Weinstein (2006) is 3.1
- Super Elastictity? percent change in price elasticity from a percent change in price. (Dixit Stiglitx with CES, this is 0). Here 4.64

Local Costs

Profif of Manufacturer

$$\pi_{jmt} = \sum_{k \in \Upsilon_j} (p^w_{kmt} - mc_{kmt}) M s_{kmt} - F_{km}, \qquad (11)$$

Bertrand-Nash Price Competition
FONC:

$$s_{kmt} + \sum_{k \in \Upsilon_j} (p^w_{kmt} - mc_{kmt}) \frac{\partial s_{kmt}}{\partial p^r_{kmt}} = 0. \qquad (12)$$

TABLE 6

Markup and local costs

Median implied markup	Median fraction of costs accounted for by coffee
58.3%	44.7%

Notes: The first statistic gives the median percentage markup of prices over marginal costs. The second column gives the median fraction of marginal costs accounted for by green bean coffee.

Let us define the matrix Φ such that the element Φ_{kj} is defined as $-\partial s_{kmt}/\partial p^{r}_{jmt}$ for k, $j = 1, \ldots, J$, and the matrix $\hat{\Omega}$ is defined such that the element $\hat{\Omega}_{kj}$ equals 1 if the same firm owns both products k and j, and equals 0 otherwise. Finally, let us define $\Omega = \Phi \cdot \hat{\Omega}$. The first-order conditions may then be written in matrix form as,

$$s_{mt} - \Omega(p^{w}_{mt} - mc_{mt}) = 0, \tag{13}$$

where s_{mt}, p^{w}_{mt} and mc_{mt} are vectors consisting of s_{kmt}, p^{w}_{kmt} and mc_{kmt} for $k = 1, \ldots, K$, respectively. This equation may be inverted to give the following expression for the absolute markup of wholesale prices over marginal costs,

$$p^{w}_{mt} - mc_{mt} = \Omega^{-1} s_{mt}. \tag{14}$$

Mark-up (as defined by the macro/intl literature,
m*= (p-mc)/~~p~~ mc median is 58.3%

Price-cost margin (PCM) (p-mc)/p, median 36.8% (compare to Nevo)
Now back at share of local costs from p and margin and observed coffee cost

Note: hard work of getting parameters mostly done before we even have to write down the dynamic game! (Well, cutting corners here, as the paper makes clear.)

A Menu Cost Model of Oligpoly

6.1. *Model*

The model consists of a small number of oligopolistic firms. Firm j seeks to maximize the discounted expected sum of future profits,

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\pi_{jmt}(p_{mt}^w, C_t) - \gamma_{jmt} 1(\Delta p_{jmt}^w \neq 0) \right], \tag{15}$$

where p_{mt}^w is the vector of wholesale prices (per ounce) in market m at time t, π_{jmt} is the firm's per-period profit, C_t is the commodity cost, β is the firm's discount factor, γ_{jmt} is a random

menu cost the firm pays if it changes its prices, and $1(\Delta p_{jmt}^w \neq 0)$ is an indicator function that equals one when the firm changes its price.[34] Each firm maximizes profits. We assume that $\beta = 0.99$. The firm's profits $\pi_{jmt}(p_{mt}^w, C_t)$ are given by expression (11) above, where the relationship between retail and wholesale prices is discussed below. The firm's profits depend both on its own prices and the prices of its competitors through this profit function.[35]

The menu cost γ_{jmt} is independent and identically distributed with an exponential distribution; i.e. $F(\gamma_{jmt}) = 1 - \exp(-\frac{1}{\sigma}\gamma_{jmt})$. The firm's draw of the menu cost γ_{jmt} is private information. In every period, the pricing game has the following structure:

1. Firms observe the commodity cost C_t and their own draws of the menu cost γ_{jmt}.
2. Firms choose wholesale prices p_{jmt}^w simultaneously (*without* observing other firm's draws of γ_{jmt}).

The Bellman equation for firm j's dynamic pricing problem is thus,

$$\begin{aligned} &V_j(p_{mt-1}^w, C_t, \gamma_{jmt}) \\ &\quad = \max_{p_{jmt}^w} E_t \left[\pi_{jmt}(p_{mt}^w, C_t) - \gamma_{jmt} 1(\Delta p_{jmt}^w \neq 0) + \beta V_j(p_{mt}^w, C_{t+1}, \gamma_{jmt+1}) \right], \end{aligned} \tag{16}$$

Markov Perfect Equilibrium

Assumptions to maket things tractable

One price per firm (move various brands in product line together)

To make the problem computationally tractable, we make the following simplifying assumptions. First, we assume that the prices for different sizes of the same brand move together (i.e. if the per-ounce price of Folgers 16 ounce coffee increases by 10 cents then the same thing happens to the per-ounce price of Folgers 40 ounce coffee). Hence, we have,

$$p^w_{kmt} = p^w_{jmt} + \alpha_k, \tag{17}$$

for all $k \in \Upsilon_j$, where α_k is a known parameter. This assumption is motivated by the fact that empirically, the timing of price changes is often coordinated across products owned by the same brand.[36]

Retail sector constant margin

Second, we assume that retail prices equal wholesale prices plus a known constant margin ξ_k,

$$p^r_{kmt} = \xi_k + p^w_{kmt}. \tag{18}$$

Marginal cost

Marginal cost is modelled as the sum of a product-specific constant μ_k and the commodity cost,

$$mc_{kmt} = \mu_k + C_t. \tag{19}$$

Cost uncertainty, random walk with bounds

$$C_t = a_0 + \rho_C C_{t-1} + \epsilon_C, \tag{20}$$

Choice of price change

$$\Delta W = W_{ch} - W_{nch}, \tag{21}$$

where W_{ch} is the discounted expected value of the firm if it adjusts its price and W_{nch} is the discounted expected value of the firm if it maintains a fixed price, based on the firm's expectations regarding its competitors' prices. (Recall that the menu costs of a firm's competitors are assumed to be private information.) Given the pricing policies of its competitors, the firm adjusts its price if the benefits of doing so outweigh the costs. The firm's pricing policy is given by the following policy rule,

$$p_{jmt} = \begin{cases} p^{w}_{jmt-1} & \text{if } \Delta W < \gamma_{jmt} \\ p^{w*}_{jmt} & \text{otherwise} \end{cases} \tag{22}$$

where the firm's price conditional on adjustment is given by,

$$p^{w*}_{jmt} = \arg\max_{p^{w}_{jmt}} E_t \left[\pi_{jmt}(p^{w}_{mt}, C_t) + \beta V_j(p^{w}_{mt}, C_{t+1}, \gamma_{jmt+1})\right]. \tag{23}$$

We parameterize the demand curve according to the random coefficients discrete choice model estimated in Section 4. The demand curve also plays an important role in parameterizing local non-coffee costs. In our baseline specification of the dynamic model, we make use of the estimates of average non-coffee costs, μ_{km}, implied by the static pricing model described in Section 5. Specifically, we take μ_{km} to be the average non-coffee costs,

$$\mu_{km} = \frac{1}{T} \sum_{t=1}^{T} \left[\hat{p}^{w}_{kmt} - \Omega^{-1} \hat{s}_{kmt} - C_t \right]. \tag{24}$$

Only parameter to be estimated is distribution of menu cost sigma

Indirect Inference

Fit moment of observed frequency of wholesale price change

The remaining parameter is the mean of the menu cost distribution, σ. We estimate this parameter to match the observed frequency of wholesale price change using the indirect estimation approach of Gourieroux, Monfort and Renault (1993) for dynamic models. In particular, we use the following procedure in selecting the menu cost parameter. For different values of the menu cost parameter σ, we simulate the model for the actual observed values of the commodity cost index over the 2000–2005 period. We then carry out a grid search over alternative possible values of σ. The menu cost estimate is chosen to minimize the loss function,

$$L = (f - \hat{f})^2, \tag{25}$$

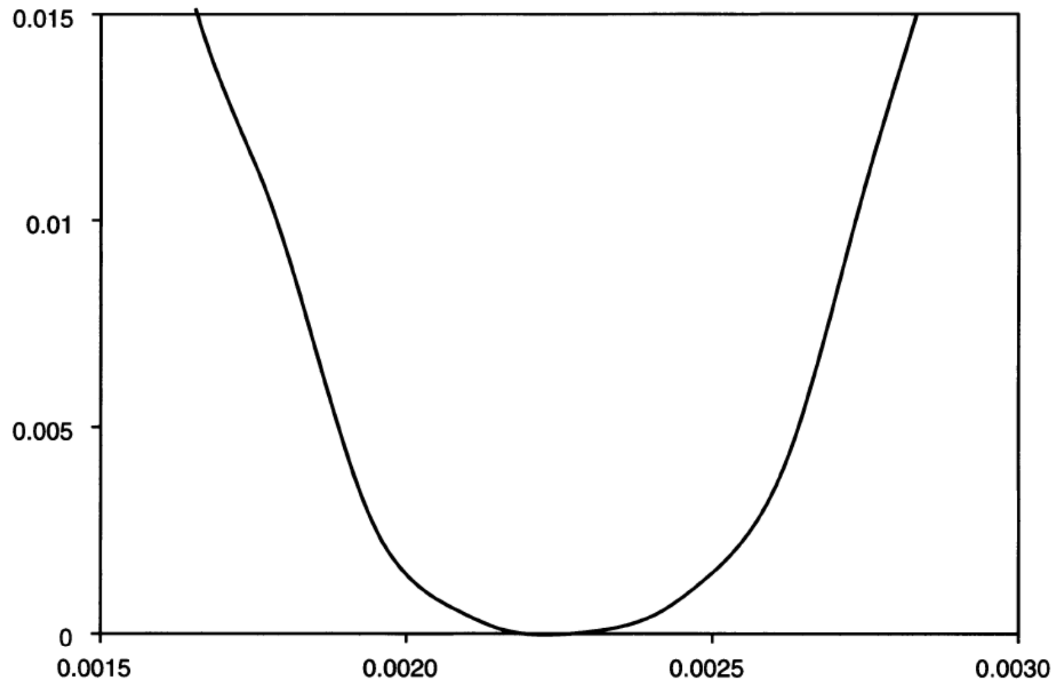

FIGURE 4

Squared deviation between observed and predicted price change frequency

The figure plots the squared deviation between the average observed frequency of price change over the 2000–2005 period and the frequency of price change predicted by the menu cost oligopoly model as a function of the menu cost. The menu cost is reported as a fraction of average annual retail revenue per firm (calculated over the 2000–2005 period).

TABLE 7

Menu cost estimate

Absolute size	As a fraction of average annual firm revenue
7000 (2806)	0.22% (0.09)

Notes: The table presents menu cost estimates in dollars and as a fraction of average annual firm revenue.

Now that we have an estimate of the firm's pricing policy, let's look at it

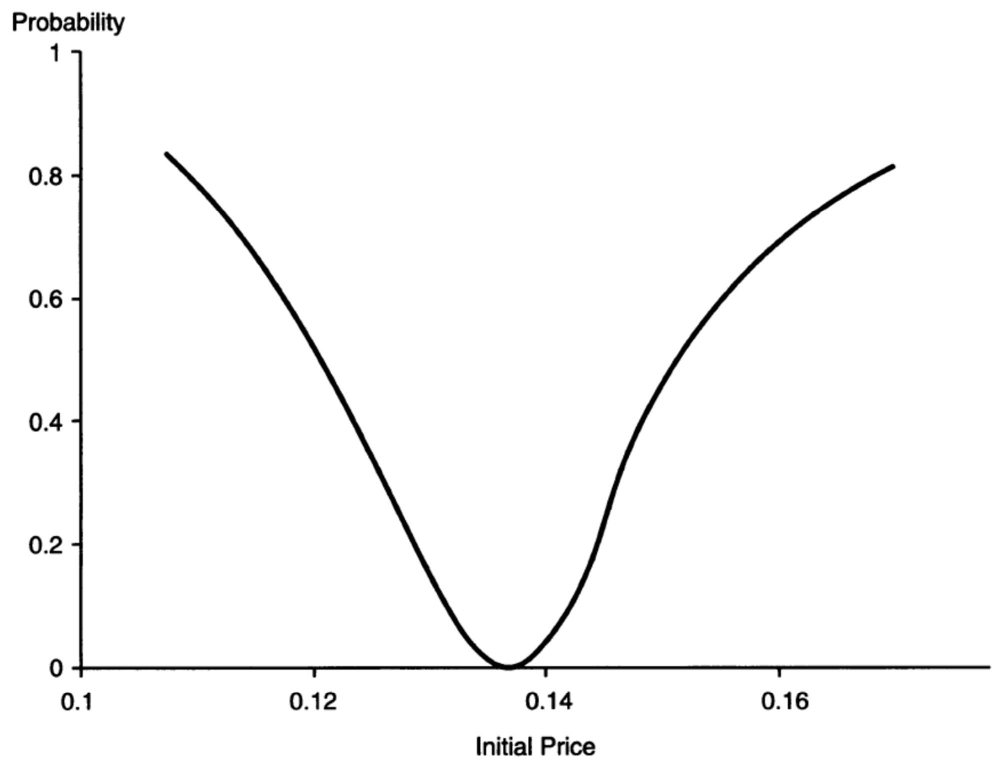

FIGURE 5

Probability of adjustment versus initial price

This figure plots an example of the relationship between the probability of adjustment and the initial price in the menu cost oligopoly model.

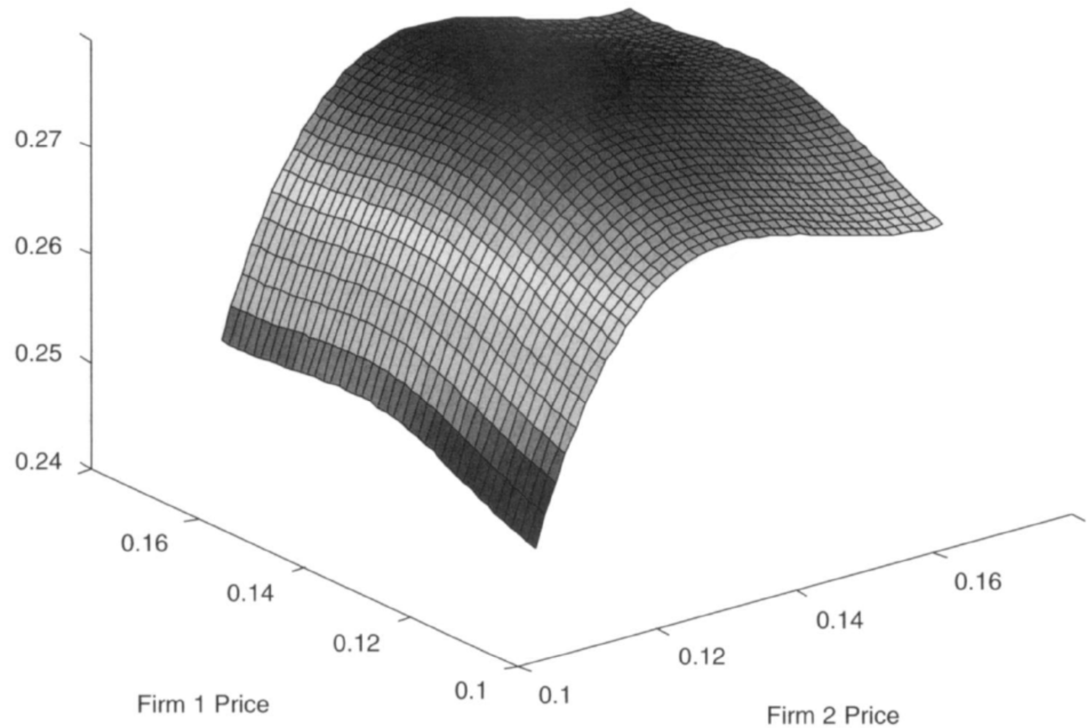

FIGURE 6

Probability of adjustment as a function of competitors' prices

This figure plots the probability of adjustment as a function of competitors' prices for a particular firm and state vector, based on the menu cost oligopoly model.

Goodness of Fit: By construction, fits the long run average. But what about year to year?

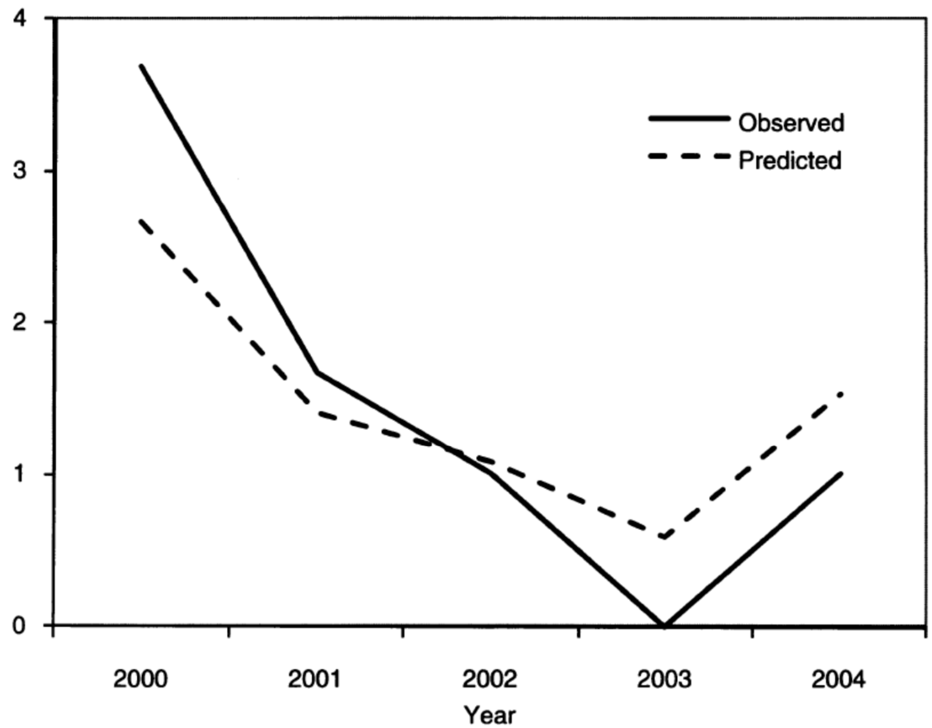

FIGURE 7

Annual predicted versus observed frequency of price change

The "predicted" statistics are the annual frequency of price change for the menu cost oligopoly model over the years 2000–2005 based on 10000 simulated series. The "observed" statistics are the observed frequency of price change for wholesale prices over this period.

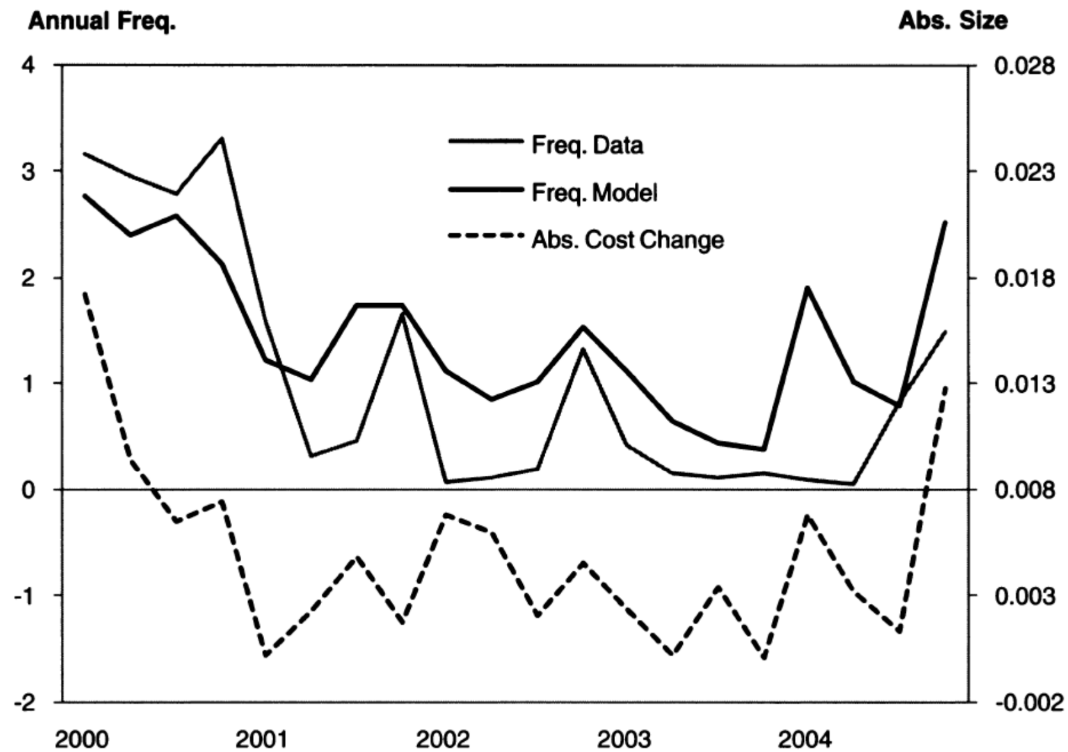

FIGURE 8

Predicted and observed frequency of price change versus absolute cost change

The figure plots the predicted quarterly frequency of price change for the menu cost oligopoly model over the years 2000–2005 (based on 10000 simulated price series) as well as the observed average frequency of wholesale price changes in the data, and the average absolute size of commodity cost changes by quarter.

TABLE 8

Pass-through regressions for simulated data

Variable	Log specification			
	Dixit–Stiglitz (no local costs)	Dixit–Stiglitz (local costs)	Static discrete choice	Dynamic discrete choice
Δ Commodity cost (t)	1	0.407	0.213	0.105
Δ Commodity cost ($t-1$)	0	0.028	0.063	0.117
Δ Commodity cost ($t-2$)	0	−0.005	0.025	0.033
Δ Commodity cost ($t-3$)	0	−0.015	0.004	−0.007
Δ Commodity cost ($t-4$)	0	−0.011	−0.024	−0.011
Δ Commodity cost ($t-5$)	0	0.006	−0.021	0.020
Δ Commodity cost ($t-6$)	0	−0.003	0.014	0.016
Constant	0	0.011	0.009	−0.0008
Long-run pass-through	1	0.407	0.273	0.272

Notes: The dependent variable in all of the specifications is the simulated retail price per ounce in a particular market and quarter. The price and cost variables are in logs. The second column gives the implications of a Dixit–Stiglitz model. The third column gives the implications of a Dixit–Stiglitz model modified to allow for local costs. The fourth column gives the implications of the static discrete choice model, allowing for local costs and markup adjustment. The fifth column gives the implications of the dynamic discrete choice model allowing for local costs, markup adjustment and menu costs.

confused about Dixit-Stiglitz local cost version...and static discrete choice

Counterfactuals (more macro style, rather than IO style policy analysis)

We next carry out a quantitative investigation of a number of the factors discussed above, the volatility and persistence of costs, the timing of price adjustments and the curvature of demand, in explaining the short-run and long-run dynamics of pass-through. We do this by repeating the types of quantitative experiments we carried out above for various alternative parameter values.

TABLE 9

Pass-through regressions for simulated data (counterfactual parameters)

		Alternative cost persistence		Calvo		High heterogeneity
Variable	Baseline $\rho_c = 1$	$\rho_c = 0.5$	$\rho_c = 0.9$	Baseline $\rho_c = 1$	$\rho_c = 0.9$	Baseline $\rho_c = 1$
Δ Commodity cost (t)	0.105	0.118	0.089	0.066	0.072	0.104
Δ Commodity cost ($t-1$)	0.117	0.085	0.097	0.098	0.103	0.117
Δ Commodity cost ($t-2$)	0.033	0.001	0.021	0.042	0.015	0.079
Δ Commodity cost ($t-3$)	−0.007	−0.044	−0.013	0.009	−0.015	0.017
Δ Commodity cost ($t-4$)	−0.011	−0.016	−0.013	0.000	−0.020	−0.013
Δ Commodity cost ($t-5$)	0.020	0.017	0.013	0.017	0.010	0.014
Δ Commodity cost ($t-6$)	0.016	0.000	0.014	0.016	−0.003	0.036
Constant	−0.0008	−0.009	0.001	−0.004	−0.010	0.013
Long-run pass-through	0.272	0.161	0.210	0.249	0.162	0.353

Notes: The dependent variable in all of the specifications is the simulated retail price per ounce. The price and cost variables are in logs. The second column repeats the results for the baseline model. Columns 3 and 4 present pass-through regressions for the cases where cost persistence $\rho_c = 0.5$ and 0.9, respectively. Columns 5 and 6 present results for the Calvo model for the cases where $\rho_c = 1$ and 0.9, respectively. Column 7 presents results for the case where consumer heterogeneity is 350% what it is in the baseline parameterization.

TABLE 10

Menu cost estimates (counterfactual parameters)

		Alternative persistence parameters		Alternative volatility parameters		Static model
	Baseline $\rho_c = 1$	$\rho_c = 0.5$	$\rho_c = 0.9$	Low volatility	High volatility	Discount factor = 0
Menu cost estimate (%)	0.22	0.049	0.11	0.33	0.13	0.065

Notes: The table presents menu cost estimates as a fraction of average annual firm revenue in the Syracuse market. The second column repeats the baseline results. Columns 3–7 present results for counterfactual parameter values. Columns 3 and 4 present results for the cases where $\rho_c = 0.5$ and 0.9, respectively. Columns 5 and 6 present results for the low- and high-volatility cases described in the text. Column 7 presents results for a case where $\beta = 0$, that is, there is no forward-looking behaviour.

Mention of broader literature

- “rockets/feathers?
- macro literature milking Neilsen data base