COSTLY PRICE ADJUSTMENT: THEORY, EVIDENCE AND PROSPECTS

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I. INTRODUCTION.

Price rigidity – central to macroeconomics:
- easy way to explain short run money-output relationship.

More generally - stresses the importance of aggregate demand in short-run fluctuations.

Importance – underlined by Ball and Mankiw (1994): “A Sticky Price Manifesto”

Keynes (1936) – prices - fixed.

II. MODERN THEORIES OF PRICE RIGIDITY

1. Time-Contingent Pricing: Fisher (1977), Taylor (1980). Come from observation that nominal wages are fixed for extended periods of time.

⇒ - anticipated monetary policy has real effects;
- past expectations matter.

2. Uncertain, Sequential Trade Models (**UST**):
Prescott (1975), Butters (1977).

Sellers must make a commitment before they know the realisation of demand (for example set price).

Buyers – know the prices; buy the cheapest good. Level of demand – uncertain.

⇒ - positive correlation between unanticipated money and output;
- higher unanticipated money increases first output, then prices.

3. Costly Price Adjustment: Sheshinski and Weiss (1977). If price adjustment were costless – prices would have been continuously changing.

⇒ - anticipated inflation affects output;
- money is not superneutral;
- unanticipated inflation may raise output.

II. MODERN THEORIES OF PRICE RIGIDITY

4. Sticky Price Model: Calvo (1983).

A fraction of firms change price in a given period.
⇒ - depending on assumptions, both anticipated and unanticipated money may have real effects;
- past expectations matter.

5. Price-Contingent Pricing: Kashyap (1995).

Some prices are special (9.99 in Germany, 10 in Italy).
⇒ - Both anticipated and unanticipated money have real effects.

6. Customer Resistance: Rotemberg (2002).

Customers reacts negatively to prices they consider unfair.
⇒ - Unanticipated money has real effects.

7. Sticky Information: Mankiw and Reis (2002).

A fraction of firms get informed in a given period.
⇒ - Both anticipated and unanticipated disinflations reduce output (anticipated – less);
- gradual response of output to money;
- past expectations matter.

II. MODERN THEORIES OF PRICE RIGIDITY

A brief evaluation.

1. By observation:

Time-contingent models – as applied to wages;
Costly price adjustment;
Price- contingent pricing;
Customer reluctance.

2. In Friedman's (1953) tradition:

Time contingent models – as applied to prices of goods;
Uncertain and sequential trading;
Sticky price;
Sticky information.

"Markets are abstract constructs used to model the seller's choice of prices" (Eden, 2001);

How far has this literature progressed beyond Keynes?

Solow (1957), Lucas (1976)

III. FREQUENCY AND SIZE OF PRICE ADJUSTMENT.

1. Early Literature (based on Wolman, 2000).

Frederick Mills (1927): BLS wholesale bulletins 1890-27.

- monthly observations;
- averages across stores.

Wide variety of frequency:

- first quartile: Δ in fewer than 10% of months;
- last quartile: Δ more than 90% of months.

Bimodal distribution.

Figure 1.

Keynes (1928): "Mills starts without theory and ends without one."

Gardiner Means (1935): hypothesis of administered prices.

Bimodal distribution implies two types of markets:

- traditional – prices flexible;
- *administered*: "where production and demand are equated by inflexible administered price."

Stigler and Kindahl (1970) called Means one of the most influential economists in the country.

Tucker (1938): price changes more frequent in 1929-33.

III. FREQUENCY AND SIZE OF PRICE ADJUSTMENT.

Scitovsky (1941): U-shape of fig. 1 – result of using truncated distribution

Galbraith (1936): conversation with Means:

- firms have incentives to keep prices constant;
- otherwise – need to inform sales outlets;
- guard against a “leak” of new price;
- inform public.

Conclusion: Means first to
- introduce the concept of administered prices (no Walrasian auctioneer);
- think of costs of price adjustment.

III. FREQUENCY AND SIZE OF PRICE ADJUSTMENT.

2. Modern Literature.

Retailers: Danziger (1987), Lach and Tsiddon (1992, 1996a, 1996b), Tommasi (1993), Slade (1998), Levy, Bergen, Dutta and Venable (1997), Dutta, Bergen, Levy and Venable (1999), Levy, Muller, Dutta and Bergen (2002), Eden (2001), Kackmeister (2001), Owen and Trzepacz (2002), Bills and Klenow (2002); Konieczny and Skrzypacz (2003a, 2003b);

Wholesalers: Sheshinski, Tishler and Weiss (1981);

Catalogs: Kashyap (1995);

Periodicals and newspapers: Mussa (1981), Cecchetti (1986), Weiss (1993), Fisher and Konieczny (2000, 2003)

Industrial products: Mills (1927), Means (1935), Carlton (1986), Zbaracki, Ritson, Levy, Dutta and Bergen (2000);

Firm surveys: Hall, Walsh and Yates (1997), Blinder, Canetti, Lebow and Rudd (1998), Buckle and Carlson (2000).

Insurance: Dahlby (1992);
Internet: Chakrabarti and Scholnick (2001).

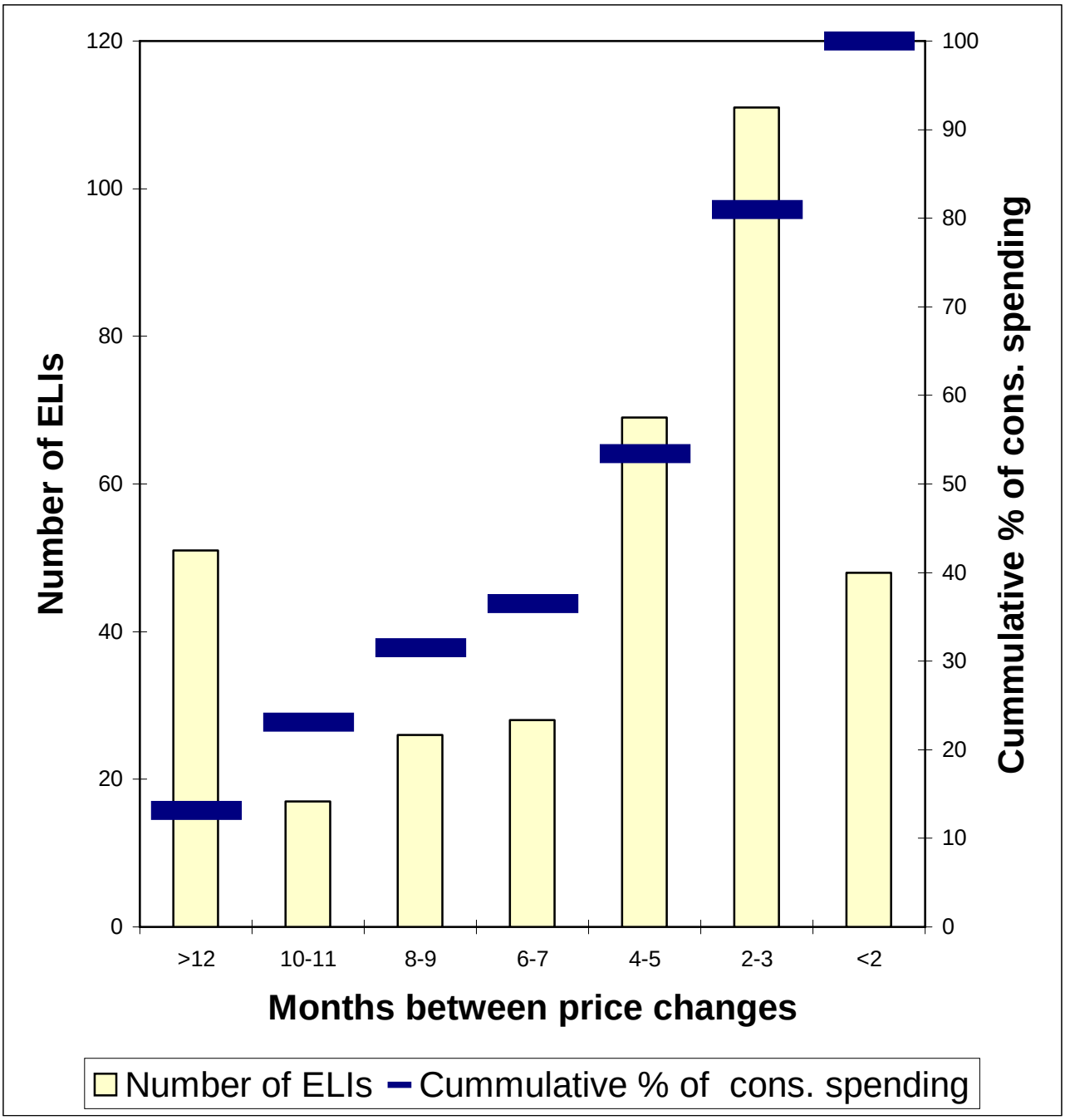
III. FREQUENCY AND SIZE OF PRICE ADJUSTMENT.

Frequency of adjustment: low inflation.

Study	Goods	Months	Notes
Cecchetti	magazines	24-170	
Fisher/Konieczny	newspapers	23	weekly delivery
		41	single copy
Kashyap	catalogue	15	
Dahlby	car insurance	13	
Chakrabarti,Scholnick	books, Amazon, Barnes and Noble	6	
Levy et al	supermarkets	1.5	
		4	P attached
Dutta et al	drugstore	3	
Blinder et al	mostly industrial	12	
Hall, Walsh, Yates	mostly manuf.	58% >12	
MacDonald, Arronson	restaurants	10	
Kackmeister	consumer products	3	excluding sales
		5	excluding sales
Bills and Klenow		4.3	
		6.2	excluding sales

III. FREQUENCY AND SIZE OF PRICE ADJUSTMENT.

Frequency of price changes in Bils and Klenow (2002)



III. FREQUENCY AND SIZE OF PRICE ADJUSTMENT.

Frequency of adjustment: high inflation.

Study	Year	Inflation	Probability
Lach/Tsiddon	1982	133%	0.61
K-S	1990/2-12	95%	0.62
Tommasi	1990	70%	0.46 change 0.30 increase
K-S	1991	60%	0.44 change 0.29 increase
Lach/Tsiddon	1978/6-1979	58%	0.39
K-S	1991	60%	0.44
S-T-W	1973-78	40%	0.27n, 0.35ic
K-S	1992	44%	0.38
	1993	38%	0.33

Other regularities:

Prices of perishable foodstuffs – changed most often
- durable foodstuffs
- manufactured
- services – least often.

Bills and Klenow extreme values:
- coin operated laundry and dry-cleaning - 80 months;
- regular unleaded gasoline – 0.6 months

III. FREQUENCY AND SIZE OF PRICE ADJUSTMENT.

Size of adjustment:

Study	Goods	Inf	% change
K-S	mostly foodstuffs	h	16
L-T	foodstuffs	h	13
Tommasi	foodstuffs	h	3-4.5
Cecchetti	magazine	l	25
F-K	newspapers	l	14 (27)
Dahlby	insurance	l	15
Kashyap	apparel	l	6-15

Conclusion:

In a variety of countries and inflationary environments – significant inflexibility of prices at the individual level.

IV. THE BASIC COSTLY PRICE ADJUSTMENT MODEL (SHESHINSKI AND WEISS, 1977).

Assumptions:

1. the inflation rate is expected to remain constant over the entire (infinite) planning horizon;
2. the firm is an unregulated monopoly;
3. the firm produces a single good;
4. the good is perishable;
5. the cost of changing the nominal price is fixed and independent of the size or frequency of adjustment;
6. the cost of adjustment is beyond the firm's control;
7. the real cost of production changes at the same rate as the general price level;
8. demand is stationary.

Optimal policy: (S, s).

Higher adjustment cost $\Rightarrow$ smaller, more frequent changes;
Higher inflation $\Rightarrow$ $S\uparrow$, $s\downarrow$, larger price changes; frequency – ambiguous;

Sufficient condition for higher frequency – profit function strictly quasiconcave in the log of the real price;

Higher real interest rate $\Rightarrow$ $S\downarrow$, $s\downarrow$, frequency – ambiguous.

V. EXTENSIONS OF THE BASIC MODEL.

1. Stochastic inflation:

Sheshinski and Weiss (1983), Caplin and Spulber (1987) – exponential distribution;
Danziger (1983), Dixit (1991) – Brownian motion;
Danziger (1984) – Poisson distribution.

Memoryless processes: future inflation depends on
- current value
- the characteristics of the inflationary process alone.

Comparative statics – similar to the simple model;
With deflation – may have four price bounds.

Deterministic assumption – not necessary;
Not clear what happens under more general behaviour
$\Rightarrow$difficult to reject.

2. Strategic interactions among market participants:

Halperin, 1990 and Slade, 1999 - some results for duopoly.

V. EXTENSIONS OF THE BASIC MODEL.

3. Many goods: Sheshinski and Weiss (1992)

Strategic complementarity

4. Durable goods: Bénabou (1988)

Even in the absence of uncertainty - random timing of price changes.

5. Variable price adjustment costs:

Rotemberg (1982) - quadratic costs;
Tsiddon (1993) - linear costs;
Cecchetti (1986) - evidence that the costs are not constant;
suggests that the costs vary either with the size or with the frequency of price changes.
Konieczny (1993) $\Rightarrow$
- optimal pricing policy is similar to basic model, but
- effect of inflation on price bounds and frequency - ambiguous.
Zbaracki, Ritson, Levy, Dutta and Bergen (2000), Levy, Muller, Dutta and Bergen (2002) – evidence that costs are not lump-sum.

V. EXTENSIONS OF THE BASIC MODEL.

6. Endogenous price adjustment costs:

Tomassi (1993) – evidence from Argentina;

Konieczny (1993) - firm that can invest in technologies reducing the cost of price adjustment (e.g. bar code readers).

Higher inflation $\Rightarrow$ investment $\Rightarrow$

$\Rightarrow$ effect on frequency stronger, on size weaker.

Levy, Bergen, Dutta and Venable (1997), Dutta, Bergen, Levy and Venable (1999) – direct evidence from firm selling cost-saving technology

7-8. Cost inflation different from the inflation rate; nonstationary demand:

Cecchetti (1986): if demand or real costs of production change over time, the optimal monopoly price changes and so do the price bounds.

VI. SOME INTERESTING IMPLICATIONS.

1. Small menu costs – large business cycles.

Mankiw (1995), Akerlof and Yellen (1995), Ball and Romer (1990)

2. Aggregation.

Caplin and Spulber (1987), Bénabou (1988), Caballero and Engle (1991), Caplin and Leahy (1997) – show conditions for log-uniform distribution of price changes in equilibrium.

Dotsey, King and Wolman (1999), Danziger (1999) – first GE models with fixed costs of adjustment.

3. Fixed nominal prices but no real effects of unexpected inflation.

Caplin and Spulber (1987).

4. Deterministic inflation – random timing of price changes.

Bénabou (1988).

VI. SOME INTERESTING IMPLICATIONS.

5. Money – not superneutral.

Kuran (1986), Naish (1986), Bénabou and Konieczny (1994).

6. Inflation may increase welfare.

Bénabou and Gertler (1993).

7. Credible disinflation is inflationary.

Ball (1994).

8. Can nominal rigidity be responsible for inflation/output persistence?

Bills and Klenow (2002).

9. Costly price adjustment and output-inflation tradeoff.

Ball, Mankiw and Romer (1987).

VII. TESTING

Need:

- prices of individual goods at individual sellers;
- transactions prices;
- no discounts, rebates, sales etc.
- same goods throughout the sample;
- no variation in characteristics to compensate for not changing price.

Plus the 8 assumptions mentioned above.

In practice – mostly retail prices, most assumptions violated.

2. Results – mixed:

Size:

Kashyap (1995), Lach and Tsiddon (1992) – several instances of size decreasing as inflation increases;

Cecchetti (1986), Dahlby (1992) – no effect of inflation on size.

Carlton (1986), Kashyap (1995) – many small price changes.

Not surprising since assumptions of the simple model not met.

Frequency – always increases with inflation.

VII. TESTING

If menu costs smaller – size smaller and frequency higher:
Levy, Bergen, Dutta and Venable (1997), Levy, Muller, Dutta and Bergen (2001), Owen and Trzepacz (2002).

Effect of the real interest rate – never as predicted.

Buckle and Carlson (2001): larger firms change prices more often.

Fisher and Konieczny (2003) – prices of Canadian monopoly and oligopoly newspapers.
Hoped for support for monopolies, rejection for oligopolies.

Discrete versus continuous approach – information matters.

VIII. THE NATURE OF PRICE ADJUSTMENT COSTS.

Three types of costs:
1. Physical costs of changing prices: new labels etc.
2. Decision costs.
3. Customer and competitor costs.

1. Physical costs of changing prices.

Menu costs (Mankiw).

Levy, Bergen, Dutta and Venable (1997): supermarkets
- cost per price change: $0.52
- yearly cost per store: $106000=0.7% of revenue, 35% of net margin.

Dutta, Levy, Bergen and Venable (1999): drugstores
- cost per price change: $0.33
- yearly cost per store: $20000=0.6% of revenue, 21% of net margin.

Overall: 20% of US retail sales, 2% of GDP.
For the rest of the economy – less relevant.

Chakrabarti and Scholnick (2001) – internet price rigidity!

VIII. THE NATURE OF PRICE ADJUSTMENT COSTS.

2. Decision and Customer/Competitor Costs.

Zbaracki, Ritson, Levy, Dutta and Bergen (2000): a manufacturing firm.

Total cost: > $1 mln, 1% of revenue, 20% of net margin;

Of the total:

3% - menu cost;

22% - decision cost;

75% - customer cost.

Managerial and customer costs – increase in the size of price change; physical costs – lump sum.

IX. EVALUATION.

Problems:

- economists know little about the nature of the costs;
- tests – often reject the model;
- macroeconomists use it nonetheless;
- optimal pricing under oligopoly – unknown.

Positive findings:

- nominal price changes are costly;
- in many markets price adjustment as implied by the simple model, even though assumptions – not met;
- outperform the Lucas (1972) incomplete information model (Lach and Tsiddon, 1992).

One possibility: rejections at the individual level – due to idiosyncratic shocks, which average out over many markets.

X. A TALE OF ONE DATA SET.

This is based on Konieczny and Skrzypacz (2003b).

Retail prices of 52-55 goods and services, in 47 stores each, 1990-6.
Frequency of observations: 1-4 per month.

1. Search, arbitrage and learning (K-S 2000);
2. Replicate Lach and Tsiddon (K-S 2003a).

A Simple Model:

search for the best price + costly price adjustment;

uniform distribution of search costs $\Rightarrow$ linear demand
log-uniform distribution of prices.

Show existence and uniqueness of equilibrium.

The more intensive is search for the best price, the more frequent and smaller are price changes.

Cross-sectional test - strong support when use panel data; frequent rejections at the level of individual goods.

X. A TALE OF ONE DATA SET.

Also:

1. The more intensive is search, the less frequent are prices equal to pricing points;

2. The lower is price changing frequency, the more likely is the firm to change price at the beginning of a month.

$\Rightarrow$ complete story may include state -, time- and price-contingent pricing;

search matters;

differences between firms (markets) due to differences in search behaviour and not cost of adjustment.

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