Discussion of: Lumpy Price Adjustments: A Microeconometric Analysis by Emmanuel Dhyne, Catherine Fuss, Hashem Pesaran and Patrick Sevestre

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I would like to thank the organizers for inviting me to this conference. By the way, I chatted with Daniel Levy who asked me to say that he really liked the paper.

This is a path-breaking paper. In the previous session Frank Smets remarked that understanding price adjustment requires evaluating the role of shocks on optimal prices at the individual level, and that this is not possible without cost data. Well, it turns out it is possible. The authors develop new econometrics techniques that allow, using price data alone, to identify the size of common and idiosyncratic shocks, and evaluate their impact on the decision to change prices at the level of an individual price setter. This is the most important contribution of the paper. It does what I, and many others, believed cannot be done.

The paper analyzes the contribution of shocks, both common to firms and idiosyncratic, to triggering price adjustment. This is an important issue because, as Golosov and Lucas (2006) stress, most price changes are caused by shocks to the optimal price, rather than by aggregate changes (e.g. inflation or monetary policy). In Golosov and Lucas (2006), the theoretical analysis is supported by just a shred of evidence. They look at the effect of shutting down the shocks on the average frequency of adjustment in in Lach and Tsiddon (1992) and in Bils and Klenow (2004) data sets. This effect is small in the Lach and Tsiddon (1992) data, which come from a high inflation environment (Israel, 1978-84) but very large in the low inflation Bils and Klenow (2004) data, which come from a low inflation environment (US, 1995-7). The conclusion is that both aggregate factors and idiosyncratic shocks affect adjustment. But, in the more interesting case of low inflation when aggregate factors have modest impact, mostly idiosyncratic shocks determine price adjustment.

[1] I would like to thank Emmanuel Dhyne, Attila Ratfai, Fabio Rumler and Andrzej Skrzypacz for helpful discussions. I am responsible for any remaining errors.

When I was asked to discuss the paper, I saw some bad news and some good news:

- the bad news: there is some complex and sophisticated econometrics in it, and I am not an econometrician;
- the good news: I have been thinking of those issues for a long time.

As I read the paper the bad news became worse, the good news better:

- estimation is indeed very complex, and there is little I can contribute to the econometric part in the discussion;
- this is an omnibus paper which deals with several issues I have been working on.

Bottom line: I will concentrate on the modeling aspects and on possible extensions.

I. PAPER GOALS:

1. Explain in a novel way the reasons for infrequent price adjustment. It is attributed to common and idiosyncratic shocks.

2. Account for the observed large differences in the frequency:

   - across broad good categories (energy, perishable food, durable food, manufactured, services);
   - across stores for a given good.

3. Ask whether the differences in the observed frequency of price changes can be accounted for by differences in menu costs (nominal rigidity).

Testing: Done using store level micro price data obtained within IPN.

This is work in progress. Results are available for a subsample of data. The reason – the estimation technique is very time-consuming. As was explained to me by Emmanuel Dhyne yesterday: estimating a single product takes about a week.

II. RESULTS:

1. Provide estimates of menu costs for various goods.

2. Differences across good categories – attributed to:

   - differences in menu costs (nominal rigidity);
   - common and idiosyncratic shocks (called real rigidity).

3. Frequency of price changes is a poor indicator of nominal rigidities:

   - can have high frequency with high costs (if shocks are large and frequent),
   - can have low frequency with low costs (if shocks are small or infrequent).

III. Estimating the Value of Menu Costs.

The only estimates in the literature:

Levy et al (1997) – for a grocery chain;

Zbaracki et al (2004) – for an industrial firm.

Both estimates were obtained by direct observation – costly.

In the paper with Andrzej Skrzypacz (2006) we have an equilibrium model with search and menu costs. We show that adjustment frequency depends on the concavity of the (quadratic) profit function and the size of adjustment costs:

(1) $$\text{adjustment frequency} = (\underset{(+)}{|F''|}, \underset{(-)}{c})$$

where *F* – (quadratic) profit function.

Hence there are various combinations of *F"* and *c* under which the frequency is constant.

We spent a lot of time thinking on how to estimate the value of menu costs from our data, which consist of disaggregated and aggregate prices alone. We could not figure out how to determine size of adjustment costs and so we came up with:

> Jurek and Andrzej's "indeterminacy principle": if only disaggregated price data are available, then the size of menu costs cannot be determined.

A simple example (from Bénabou and Konieczny, 1994). Assume that menu costs are small, inflation is low so that things can be approximated to third order. Then the difference between the upper adjustment bound and the monopoly price is given by:

(2) $$S - p^* \approx \left(\frac{3g}{2} \frac{c}{-F''(p^*)} \right)^{1/3}$$

where *p** - the monopoly price, *F*(.) - the profit function, c – the adjustment cost, g - the inflation rate

Conclusion:

at low inflation and menu costs, *S* - *p** depends on **the ratio *c/F"*(*p**)**, not just on *c*.

IV. ESTIMATED EQUATION:

(3) $$p_{it} = \begin{cases} p_{it}^{*} & \text{if } \left| p_{it}^{*} - p_{i,t-1} \right| > c_{it} \\ p_{i,t-1} & \text{if } \left| p_{it}^{*} - p_{i,t-1} \right| \le c_{it} \end{cases}$$

$$p_{it}^{*} = f_t + x'_{it}\,\beta + v_i + \varepsilon_{it}$$

where i indexes markets f_t – common shock, x_{it} - observed idiosyncratic characteristics in a given market, v_i – (fixed) differences across sellers, ε_{it} - idiosyncratic shocks, c – cost of adjusting p..

This equation – a bit non-standard. It says that adjustment takes place if the difference between the current price and the optimal price exceeds adjustment cost.

In general, however, adjustment takes place if the benefit from changing (in present value terms) is greater than the cost of adjustment.

Question: in what environment would formulation (1) hold?

The firm – monopoly. Every period a new customer arrives. She has inelastic demand for a single unit. p^* is the perceived (by the seller) reservation price of the buyer.

This is similar to Hong and Shum (2006). They use price distributions (knowing only prices) to estimate search cost, under the assumption that each customer buys exactly one unit.

This is a very special model. One good in DFPS sample it applies to: funeral. Bad news indeed.

Applications of the model are, in general, limited. This is because there are two types of adjustment costs: physical and relationship-related. Since the above model is a one-shot game, the only costs are of the physical type. But such costs are relatively small for an expensive good (funeral). If the good is cheap so that menu costs are relatively important – profits are minimal and the problem is not very interesting.

If n units sold – the adjustment cost is c_{it} / n.

Most goods analyzed by the authors – sold in quantities, with price-elastic demand.

Conclusion: c is not an adjustment cost, but rather the size (or about half the size) of the “inaction band” , which is in turn related to adjustment thresholds.

So: some good news and some bad news:

> the good news: Jurek and Andrzej's conjecture has not been overturned;
>
> the bad news: we still do not know how to extract the value of menu costs from price data alone.

To be fair, in equation (1) DFPS write "c_{it} – measures the extent to which price changes are costly", but afterwards use the terms "adjustment costs" and "adjustment thresholds" interchangeably.

This makes me a bit uneasy since, in just about any costly price adjustment model, adjustment costs and adjustment thresholds are different concepts.

V. WHAT DETERMINES ADJUSTMENT THRESHOLDS?

They are determined by three factors:

- the size of adjustment costs;
- the distribution of shocks, including any trend;
- the shape of the profit function over the entire pricing interval.

For example, in the absence of uncertainty, the adjustment thresholds are given by (Sheshinski and Weiss, 1977):

$$
\begin{aligned}
F(s) - F(S) + rc &= 0 \\
\int_s^S F'(z) z^{r/g} dz &= 0
\end{aligned}
\tag{4}
$$

The second equation says that the thresholds are set so that a (weighted) average of marginal profits over the pricing interval is zero.

The problem in the paper is that all the three factors affecting adjustment thresholds change. This is because the model focuses on firms (outlets) changing price in a given period. They play a different role than outlets that keep prices constant. So the model is, in effect, estimated on a constantly changing sample of firms (outlets). If the distribution of shocks, and the shape of the profit function differ across outlets – not an unreasonable assumption - this means that all determinants of adjustment thresholds change.

So in equation (3) there is a lot of action in c_{it} .

VI. THE RETURN POINT.

DFPS assume that the return point is equal to the momentary monopoly price and equal to (*S*+*s*)/2.

This is a special assumption. The necessary and sufficient conditions for $I = p^* = (S+s)/2$ are that:

(i) there is no discounting;
(ii) the profit function is symmetric;
(iii) expected shocks are symmetric (in particular – no trend).

ad (i) discounting (Sheshinski and Weiss, 1977):

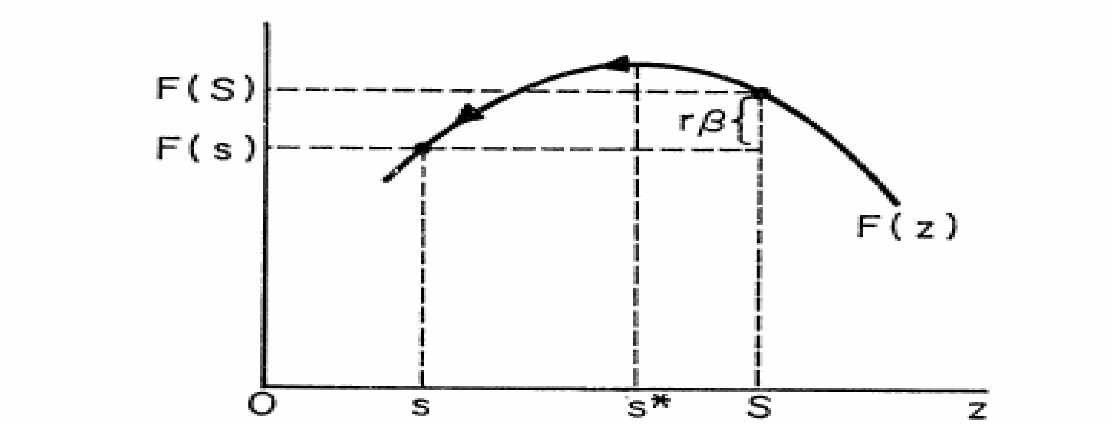

FIGURE 1

ad (ii) the shape of the profit function (Bénabou and Konieczny,1994):

Assuming the adjustment costs and inflation are small:

(6)
$$p^* - s \approx (S - p^*)\left[1 + \frac{2}{3}\left(\frac{r}{g} + \frac{F'''(p^*)}{F''(p^*)}\right)(S - p^*)\right]$$

The first term in the round brackets shows the effect of discounting on the asymmetry between *p*-s* and *S-p**; the second shows the effect of the shape of the profit function. Essentially, it is related to the ratio of its skewness to its concavity at the monopoly price.

ad (iii) shocks and trend (Tsiddon, 1993):

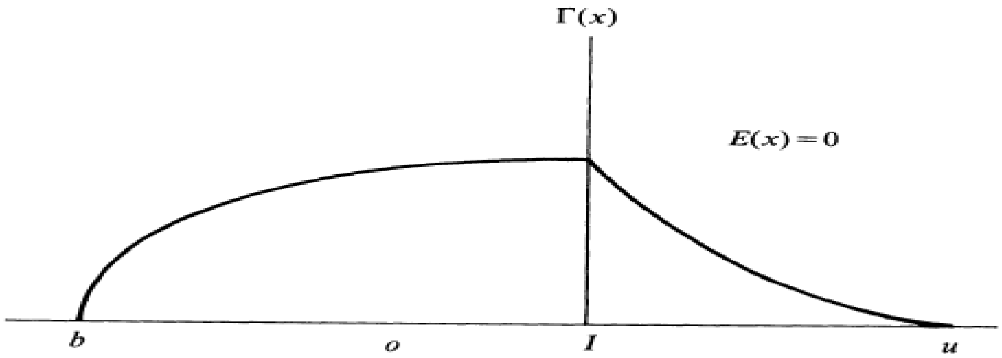

FIGURE 2
The steady state distribution of real prices for a positive inflation rate (μ is negative)

Figure 2 from Tsiddon (1993) shows the ergodic distribution of real prices. As there is trend inflation, the distribution is asymmetric and the return point is above the middle of the band.

VII. PROPOSED FORMULATION:

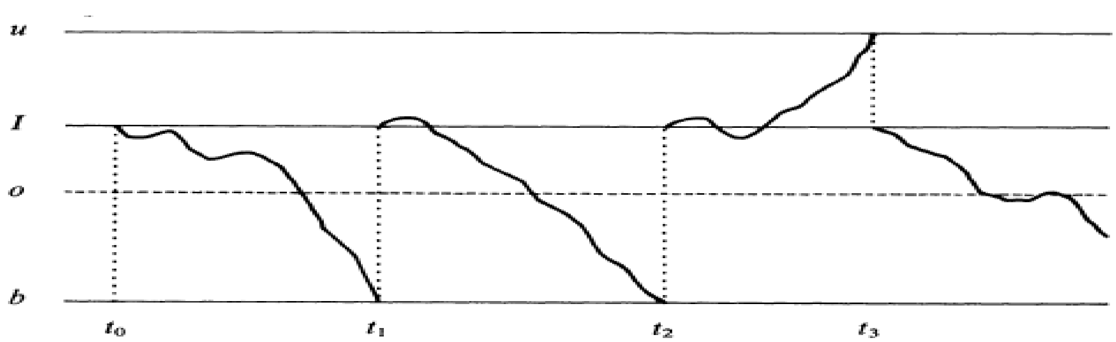

FIGURE 1

The above figure from Tsiddon (1993) illustrates the model the authors are estimating. Whenever the current real price reaches the upper or lower bound (*u* and *b* , respectively), the nominal price is reset to be equal to the common return point, *I*.

Equation (1) could be replaced with equation (5), based on Tsiddon (1993) and Ratfai (2006), in real terms:

$$(6) \qquad p_{it} = \begin{cases} I_{it} & \text{if} \quad \lim_{\tau \to t^-} P_{i,t-1} / \overline{P}_{i\tau} \le s_{it} \\ I_{it} & \text{if} \quad \lim_{\tau \to t^-} P_{i,t-1} / \overline{P}_{i\tau} \ge S_{it} \\ \lim_{\tau \to t^-} P_{i,t-1} / \overline{P}_{i\tau} & \text{if} \quad s_{it} < \lim_{\tau \to t^-} P_{i,t-1} / \overline{P}_{i\tau} < S_{it} \end{cases}$$

where I – return point; P – nominal price, $\overline{P}$ – price level, $\lim_{\tau \to t^-} P_{i,t-1} / \overline{P}_{i\tau}$ = real (or relative) price just prior to adjustment, (s_{it} , S_{it}) – adjustment thresholds: correspond to c_{it} in the paper.

The proposed approach would be to use equation (6) with:

$$(7) \qquad \begin{aligned} I_{it} &= f_t + x'_{it}\beta + v_i + \varepsilon_{it} \\ \hat{c}_{it}^{up} &= I_{it} - s_{it}\,; \\ \hat{c}_{it}^{down} &= S_{it} - I_{it} \end{aligned}$$

I do not know what effect the switch to the proposed approach would have on the results. Interpretation of c would be different but I am not sure how the numerical results may be affected.

Estimation of I_{it} and of p_{it}^* is probably similar since DFPS assume that $p_{it}^* = I_{it}$

This modification leads to two questions:

1. How different is estimating the return point I_{it} from estimating the adjustment thresholds s_{it} and S_{it}? I_{it} and s_{it} are observed whenever price is increased; I_{it} and S_{it} are observed whenever price is reduced. So perhaps more information can be extracted by estimating all three?

2. If $\hat{c}_{it}^{up}$ and $\hat{c}_{it}^{down}$ are correctly interpreted as the adjustment band, then the estimated values (around 30%) are surprisingly large since the average size of price changes in the data is about 10%.

VIII. REAL AND NOMINAL RIGIDITIES.

This is the last semantic point. DFPS relate nominal rigidity to the range of inaction (*s*, *S*), which in turn is related to adjustment costs.

Real rigidity is described as a situation in which shocks are small, so that the real price stays in the range of inaction.

This is a bit non-standard. Real rigidity is typically a situation in which, even though there is a reason for the relative (or real) price to change, it stays constant.

Perhaps a better term would be stability of the real price.

IX. ASYMMETRIC ADJUSTMENT THRESHOLDS.

The approach in the paper can be used to test two recent models of price adjustment, which imply $\hat{c}_{it}^{up}$ and $\hat{c}_{it}^{down}$ should differ.

In Levy, Chen, Ray and Bergen (2005) the argument based on rational inattention. Customers may not notice small price increases. This is to explain why there would be more small price increases than price decreases. The model implies $\hat{c}_{it}^{up} < \hat{c}_{it}^{down}$.

In Rotemberg (2005, 2006) customers prefer fair prices and resist unjustified price increases. It is not clear whether it would lead to increases being small and frequent or large and infrequent, but it implies, in any case, $\hat{c}_{it}^{up} \neq \hat{c}_{it}^{down}$.

The preliminary results of DFPS are interesting. When they estimate the model allowing $\hat{c}_{it}^{up}$ and $\hat{c}_{it}^{down}$ to differ, they find that the difference is statistically significant, but very small. This means that the two models stress elements of price adjustment that, while relevant, are of limited importance. In particular, the approach used by the authors can be applied to obtain the first tests of the fair-pricing theories of Rotemberg.

X. VARYING ADJUSTMENT COSTS?

The authors assume that adjustment costs differ across time and across outlets. Their motivation for varying costs is to account for:

(i) seasonality in price adjustment,

(ii) heterogeneity in the frequency at the store level.

Alternatives:

Ad (i) Seasonality in adjustment.

1. In Konieczny and Rumler (2006), we develop and test a model to explain seasonality in price changes and incidence of attractive prices. We consider two sources of differences across policymakers:

   - in terms of the shape of the profit function, as in Konieczny and Skrzypacz (2006). The shape depends on the intensity of consumer search for the best price.
   - in terms of menu costs, as in Dotsey, King and Wolman (1999).

We find evidence consistent with the first and inconsistent with the second.

So these results suggest that maybe the assumption of fixed adjustment costs is not so bad.

2. Seasonal shocks.

It would be interesting to use the methodology to determine whether seasonality in price setting is due to seasonality in shocks or changes in adjustment thresholds.

Ad (ii) Store – level heterogeneity:

Lach and Tsiddon (2006): argument based on complementarities in price setting. If there are increasing returns to price adjustment, at the time of adjustment the firm will also change prices of goods that did not reach thresholds.

This explains higher adjustment frequency for large stores than for small stores.

On the other hand, modelling adjustment thresholds as varying across time and markets makes perfect sense.

XI. ESTIMATING ADJUSTMENT THRESHOLDS.

The approach can be used to test information cost story of Mankiw and Reis (2002) and Reis (2006).

In Fisher and Konieczny (2006) we test a simple (s,S) model under two assumptions to estimate s and S:

(i) the firm continuously monitors current conditions;
(ii) the firm sets the price bounds (s,S) optimally and monitors only the price level. The bounds are reestimated at each adjustment.

Under (i) s_{it} is determined optimally on the basis of information available at t.

Under (ii) s_{it} is determined on the basis of information available at the time of the time of the previous adjustment.

The second approach, which saves information costs, is supported by the data. This can be easily checked by DFPS, using more sophisticated econometric approach.

XII. HOW TO EXPLAIN THE FACT THAT THE PROPORTION OF PRICE INCREASES IS OVER 50%.

The approach in the paper: consider asymmetric adjustment costs.

Alternatives:

- asymmetric effect on profits of too high price versus too low price (Ball and Romer, 1990).

- trend inflation:

  Theory (Tsiddon, 1993) implies that this is due to trend inflation.

  Although Klenow and Kryvtsev (2005) and Gagnon (2006) find that the proportion is stable for low inflations, there is extensive evidence (Dhyne et al, 2006, Nakamura and Steinsson, 2006, and many others) that the proportion of price changes that are increases is positively related to inflation rate.

- in oligopolistic markets, price decreases may be relatively rare as they may lead to price wars.

XIII. DISCRETE PRICE OBSERVATIONS.

Price data – available once a month. This leads to three problems:

(i) adjustment frequency is underestimated;

(ii) adjustment size may be overestimated;

(iii) if shocks are autoregressive, the thresholds s_{it} , S_{it} are underestimated.

ad (i): whenever there are multiple price changes within a month, frequency is higher than recorded.

ad (ii) if following a price change, the probability of the next change in the same direction is greater than in an opposite direction, the size is underestimated.

The biases are stronger for goods more frequent are price changes (for Belgium: the monthly probability for energy is over 73%; for services less than 4%).

ad (iii) price is adjusted whenever the threshold is crossed within the month, but observation is made at the end of the month. The thresholds are underestimated if shocks autoregressive.

One way to address this is to convert the data to bi-monthly and check whether results are affected. In Konieczny and Skrzypacz (2006) we have some data collected 3 times a month and find that there are 13-26% more price changes than in monthly data

XIV. CONCLUSIONS:

1. Paper – an important attempt to explain large differences of adjustment frequency across broad good categories.

2. The most important contribution - identification of:

- common shocks,

- changes in adjustment thresholds, c_{it}.

- idiosyncratic shocks ε_{it}.

Particularly notable is the approach to distinguishing between c_{it} and ε_{it} .

What is remarkable is that the shocks are identified using, in effect, price data alone (the idiosyncratic information x_{it} in the data is very limited).

3. The most interesting finding: frequency of adjustment described well by the ratio

$$\frac{\text{standard deviation of shocks}}{\text{size of the } (s,S) \text{ band}}$$

Simple correlation – 0.7 (Belgium), 0.85 (France).

DFPS say this is not surprising. True, but it is good to know. This is not something I would have thought of in advance. In a standard menu cost model the variability of shocks affects the price bounds: the more variable are the shocks, the wider is the inaction band. The results suggest that this effect is limited.

4. Explain the differences in the frequency of price changes across broad categories:

Price changes are most frequent for energy, followed by perishable and durable foodstuffs, manufactured and services. This ranking is remarkably consistent across countries: Dhyne et al (2006) report it is the same in all countries (with the exception of Portugal, where energy prices are regulated). The same ranking holds in the Polish data in Konieczny and Skrzypacz (2006); similarly, Bils and Klenow (2004) report that the frequency is higher for raw than for processed goods. Explaining the differences is, therefore, very important.

5. Results suggest important role of idiosyncratic shocks – as in Golosov and Lucas (2006).

6. The shocks that matter are shocks at the level of products, rather than stores.

7. The reading of the paper suggests to me that the limit of what can be extracted from price data alone is being reached.

Further developments – would require cost data. The Wage Dynamics Network can provide wealth of cost information, especially for services.

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