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IMPERFECT EXCHANGE RATE PASSTHROUGH: STRATEGIC PRICING AND MENU COSTS

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Abstract

A large body of literature finds that exporters do not pass nominal exchange rate movements fully through to destination market prices over short time horizons. This imperfect passthrough has been widely attributed to strategic "pricing-to-market", whereby exporters deliberately accept changes in the home currency value of export prices in order to gain or defend market share. We show that imperfect passthrough in the short run may also arise from simple menu costs. In contrast to strategic pricing, however, the long run passthrough is complete under menu costs — with associated implications for trade adjustment. Examining the cover prices of two magazines, *The Economist* and *Business Week*, we find support for menu costs as a partial explanation of imperfect passthrough.

JEL Classification: F3, E3, D4

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1. Introduction

A number of empirical studies have found that exporters do not fully pass through exchange rate changes to the destination market prices in the short run. This imperfect passthrough has been widely attributed to deliberate decisions ("strategic pricing") by firms opting to accept reductions of profit margins in return for market share or other strategic factors. For example, the 1987 *Economic Report to the President* remarks upon *"the choice of foreign producers to boost profit margins as their currencies depreciate against the dollar and to allow these margins to narrow so as to maintain market share as their currencies appreciate against the dollar."* (Page 116).

A large theoretical literature explores optimal pricing strategies in a variety of competitive settings.[2] The literature shows that, in a wide range of circumstances, it is indeed optimal for an exporter to adjust destination market prices only partially in response to nominal exchange rate movements. Imperfect passthrough of exchange rate movements to prices, and strategic pricing-to-market, however, are not two sides of the same coin. Indeed, imperfect passthrough is neither a necessary nor a sufficient condition for strategic pricing-to-market (defined in the narrow sense of price changes being based primarily on market share and competition considerations).

The first part of this qualification is well understood. A range of models of strategic pricing-to-market comprise parameter values for which full passthrough is optimal. Therefore, the absence of imperfect passthrough does not rule out departures from the perfectly competitive model [Goldberg and Knetter (1995)]. The second part of the argument is perhaps less widely appreciated. In this paper, we pursue menu costs as an alternative (complementary) explanation for imperfect passthrough.[3] While menu costs have been extensively studied in closed economy settings and appear to be quite important[4], their role in international pricing has been studied less, with the notable exception of Delgado (1991).

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[2] See Dornbusch (1987), Froot and Klemperer (1989), Krugman (1987) inter alia for early work in this area, Goldberg and Knetter (1997) and Menon (1995) for surveys.

[3] The ability to postpone price adjustment in the presence of menu cost of course also implies some market power, hence, strictly speaking, a menu-cost based explanation could be subsumed under the heading of "strategic pricing". We use the term "strategic pricing" in the narrower sense of price setting explicitly motivated by market share or competition considerations, in contrast to the menu cost approach based on the actual cost of changing prices.

[4] According to a survey conducted by Blinder (1991), forty-three percent of managers surveyed classified the actual cost of price changes as an important factor in deciding on price changes. See Mills (1927). Means (1935), Godley and

The cause of imperfect passthrough is of some importance. Destination market prices react sluggishly to contemporaneous exchange rate movements both in the presence of strategic pricing to market and in the presence of menu costs. Yet, their longer-term implications are quite different. Under menu-costs, complete passthrough occurs when prices do adjust, so that the adjustment of trade balances to the exchange rate is merely delayed rather than vitiated. In contrast, under strategic pricing-to-market the failure of the law of one price is fundamental, reflecting deliberate price discrimination across destination markets.

The two explanations are likely to yield observationally equivalent outcomes in terms of aggregate price indices. Under most models of strategic pricing-to-market without menu costs, positive but non-zero (and normally below unitary) passthrough is observed every time the nominal exchange rate changes.[5] Under menu costs, a (possibly quite long) sequence of zero passthrough observations is followed by a single observation with complete passthrough of the cumulative change in the exchange rate since the last price change (and thus possibly more than unitary passthrough of the contemporary exchange rate). If menu costs differ across products (and price changes are staggered), a regression using an aggregate price index averages the two sets of observations across many products, likely yielding a non-unitary but also non-zero, estimated passthrough elasticity. Indeed, by the same logic, the standard tests for imperfect passthrough will not differentiate between strategic pricing and menu costs even for price series of individual goods: again, the sample under menu costs co-mingles a (large) set of observations with zero passthrough with a few large passthrough observations.

Figures 1 to 3 illustrate the problem with a simple simulation for a one-product firm. The home price of the product is set equal to one, and remains constant through time. The nominal exchange rate (defined as units of destination market currency per unit of home currency) begins at a level of 100, and changes by a random percentage between –5% and +5% per period. The starting

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Gillian (1965), Stigler and Kindahl (1970), Carlton (1986) Kashyap (1987) and Blinder (1991, 1994) for discussions in the closed economy context.

[5] As the observation periods becomes shorter, most goods save exchange traded commodities will not be continuously priced, the distinction made hence depends on a sufficiently long observation period. In contrast, the distinction will usually be quite blurred in aggregate indices: if different products face different menu costs and adjust at different instances, the telltale discrete price adjustment pattern will be smoothed out.

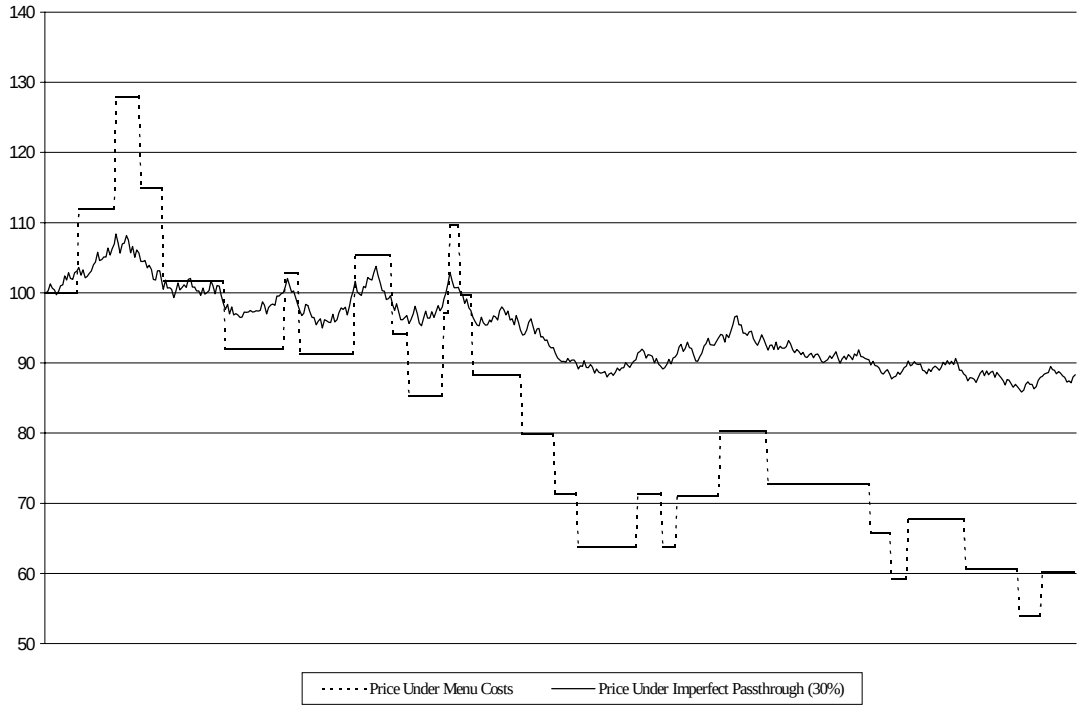
level of the destination price is set to 100, thus the law of one price holds in the starting period, with a relative common currency price of one.

We consider two pricing rules with respect to exchange rate variations. Rule I is a simple imperfect passthrough rule, under which the destination market price changes by 0.3 times the change in the nominal exchange rate.[6] Rule II is a simple menu cost with a ten percent band: whenever the common currency relative price either exceeds 1.1 or falls below 0.9, the destination price is reset so that the relative common currency price again equals 1, and thus the law of one price holds.

Figure 1 plots the time path (for 250 periods) of the destination market price for the two pricing rules, for the identical random path of the nominal exchange rate. The time path of prices under the menu cost rule shows the telltale pattern of multi-period stability followed by one-period sizeable adjustments. Estimating a standard passthrough regression of the change in the destination market price on the change in the nominal exchange rate for this sample yields an estimated coefficient of 0.3. By construction, the price sequence under the imperfect passthrough rule yields an identical passthrough coefficient. Though radically different, both price series are thus indistinguishable based solely on the estimated passthrough elasticity in the standard regression.

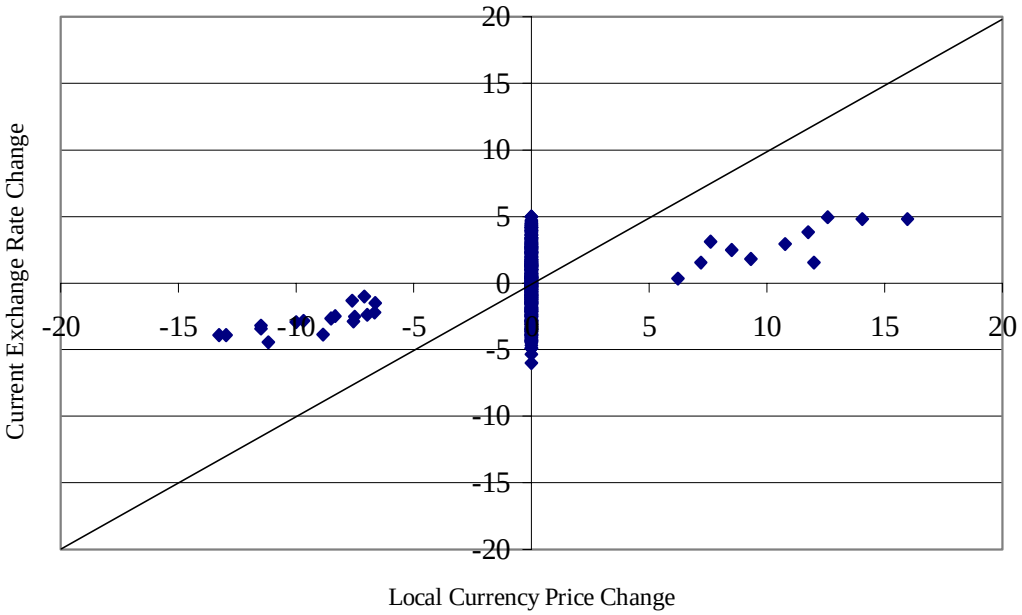
[6] Thus a first period increase in the exchange rate from 100 to 110 would lead to a change in the destination market price from 100 to 103, and thus to an increase in the common currency price in the home market relative to the foreign market from 1 to 1.067.

Figure 1: Simulated Local Currency Price Under Menu Costs and 30 Percent Exchange Rate Passthrough



Figures 2 plots the price change under the menu cost rule against the contemporaneous change in the nominal exchange rate. The figure reveals two stylized features. The first is the cluster of exchange rate change observations around the zero price change level: in most periods, the observed passthrough is zero. The second stylized feature is that in those periods in which destination market prices are adjusted, the passthrough elasticity with respect to the contemporaneous exchange rate change is generally above one (in absolute terms) since the price adjustment takes into account not the contemporaneous exchange rate change but the cumulative change since the last period in which prices were adjusted. As is apparent from the Figure, the

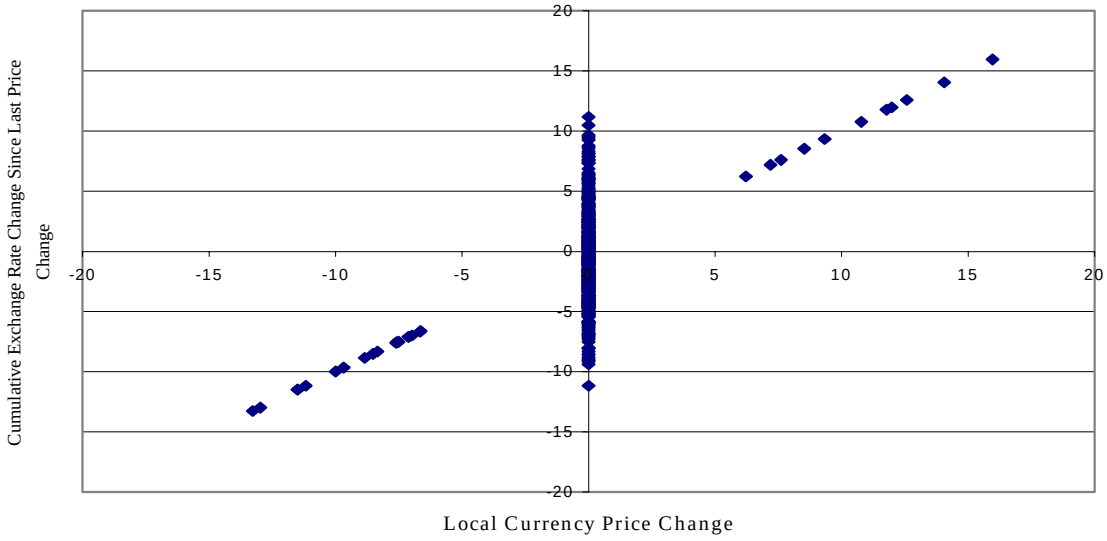
Figure 2: Price Versus Current Exchange Rate Change



estimated passthrough elasticity vis a vis contemporaneous exchange rate movements is less than unitary.

Figure 3 plots the price change under the menu cost model against the cumulative exchange rate change since the last period in which prices were adjusted. The Figure illustrates the crucial difference between short and long run passthrough under menu costs: if the passthrough regression is estimated for a restricted sample including only those periods in which prices are adjusted, the passthrough elasticity is one.

Figure 3: Price Versus Cumulative Exchange Rate Change



Are these interpretation problems more than a theoretical curiosity? The simple simulation illustrates the pitfalls in using aggregate price indices to assess this question: the telltale patterns of Figure 1 are likely to be lost through averaging across multiple goods with different menu costs. Prices for individual products however allow both a direct look at the presence of menu costs and delayed adjustment and, more crucially, permit examining the passthrough elasticity between periods of price adjustments. Below, we present evidence on the importance of menu costs as a partial explanation of imperfect passthrough based on the cover prices of two competing internationally sold magazines, *The Economist* and the European edition of *Business Week*.

Magazine prices have a number of advantages as a study object in international pricing. First, they are, with some qualifications, fairly homogenous products.[7] Second, they are sold in a large number of countries differing along a number of dimensions generally thought to be relevant for strategic pricing to market decisions, including market size, the average rate of local inflation

[7] The qualification is threefold. First, advertising and editorial content differs slightly across destination markets. Second, printing for the Economist takes place (for the destination markets we consider) in the United Kingdom, the Netherlands, Switzerland and the United States. The European edition of Business Week in is printed in only one location, the Netherlands. As the main component of printing cost -the price of newsprint - is a traded commodity with small variations across markets, and as all the printing locations considered are located in countries with comparable

and the degree of bilateral exchange rate variability with the primary production country (the United Kingdom for the *Economist*, the United States for *Business Week*). Third, there are limits to effective arbitrage imposed by the time sensitivity of the product and the dispersion of the distribution network, suggesting that, if desired, the publishers have ample scope for effective price discrimination across markets. The final advantage is availability: both magazines are published weekly, yielding one of very few high frequency price series on differentiated traded products.

In sum, magazine prices satisfy the set of criteria for which one might suspect strategic pricing to market to play a role — a differentiated product with limited arbitrage possibilities facing different competitive situations in its various export markets. Yet there is no free lunch, the focus on a particular product naturally raises the question whether results can be generalized. There is no unambiguous answer, the magazine market has some special features, yet also possesses many of the characteristics often stressed in theoretical analysis of strategic pricing—market segmentation, large strategic competitors, and an important role of market share considerations (via advertising revenues).

The remainder of the paper is set out in four parts. We first outline the alternative models. We then conduct the standard battery of tests, establishing that magazine prices indeed display imperfect passthrough. In the last part of the paper, we turn to tests differentiating between the strategic pricing to market and the menu cost explanations.

2. Alternative Models of Pricing Behavior

In the canonical model of pricing to market [Menon (1995), Goldberg and Knetter (1996)], a firm produces both for its domestic market and for export to n-1 other countries.[8] In each market, the firm may face competition from producers located in its own country; in the foreign market; or a third country. The demand function in country *i* and at time *t* is given by Q_{it} (P_{it}, ϕ_{it}), where Q_{it} is the firm's exports to market *i* and P_{it} is the price expressed in the destination market currency. The

wage levels, the different printing locations are however unlikely to significantly influence production costs. Third, magazines are sold both at newsstands and through subscription; we only focus on the former.

[8] The *n-th* country is defined as the home country. In our case, the site of the main editorial office, the United Kingdom for the Economist, the United States for Business Week.

firm is assumed to be able to prevent resale across markets. ϕ_{it} denotes other factors shifting demand, including the price of competing products. Production costs are incurred exclusively in the home country; in consequence, marginal costs are identical across the destination markets. The maximization problem thus becomes:

(1) $\text{Max } \pi = \Sigma_{i=1..n}[P_{it}Q_{it}(P_{it}, \phi_{it})/E_{it}] - C(\Sigma_{i=1..n}Q_{it}(P_{it,,} \phi_{it}), \Phi)$

Foreign currency profits are translated into home currency profits via the exchange rate E_{it}, defined as units of the destination market currency per unit of the home currency, an increase in E thus constitutes an appreciation of the home currency. C() denotes the cost function, depending on output and on input prices Φ. The first order condition is given by:

(2) $P_{it} = [1+\mu_{it}(E_{it})][dC(Q)/dQ]\ E_{it}$

where μ_{it} denotes the destination market specific markup, which may co-vary with the exchange rate. The pass-through elasticity is then given by:

(3) $[dlog(P_{it})/dlog(E_{it}) = 1 + (dlog[(1+\mu_{it})dC(Q)/dQ])/dlog(E_{it})$

The elasticity thus depends on two factors. First, the change in marginal cost if the exchange rate change has triggered an adjustment of output levels. Second, the response of the demand elasticities determining the markup, depending upon the market structure in the destination country. The generic model of strategic pricing to market is consistent with a wide range of optimal pricing responses (Kasa [1993], Goldberg and Knetter (1997)], including, in the case of constant demand elasticities and constant marginal cost, full passthrough. The information that can be gleaned from a simple passthrough regression is correspondingly limited: a finding of incomplete passthrough is consistent with a wide range of industry structure, a failure to reject full passthrough is not sufficient to reject pricing to market. Empirical tests have hence tended to either impose additional restrictions or to rely on extraneous information on the actual market structure for particular products [Goldberg and Knetter (1995)]. A further problem, a lack of good information on marginal cost, can be overcome if one is willing to make the assumption that marginal costs are

constant across markets. In this case, equation (2) can be divided by its counterpart for the home country to obtain (lower case letters denote logs):

(4) $\text{Log}(P_{it}) = \log[(1+\mu_{it})/(1+\mu_{nt})] + \log(P_{nt}E_{it})$

The associated estimation equation is given by:

(5) $\text{Log}(P_{it}) = \alpha_i + \beta_i \log(P_{nt}E_{it}) + \gamma_i \log(E_{it}) + \varepsilon_{it}$

Under the null of perfect competition and full passthrough the expected parameters are

H_0: $\alpha_i = (1-\beta_i) = \gamma_i = 0 \; \forall$ i=1,...n-1, while strategic local currency price stabilization implies $\gamma_i<0$.

Under menu costs, the profit maximization problem is given by:

(6) $\text{Max } \Pi = \Sigma_{i=1..n} [P_{it}Q_{it}(P_{it},\phi_{it})/E_{it}] - C(\Sigma_{i=1..n} Q_{it}(P_{it},\phi_{it}),\omega) - K(\Delta P_{1t}, \Delta P_{2t}, \ldots \Delta P_{nt})$

where K(.) is an indicator function which captures menu costs of price changes. Menu costs are typically believed to consist of two components, informational costs and administrative costs.[9] If it is assumed that the latter are subject to some economies of scale, than the average cost of changing price decreases in the number of price changes undertaken simultaneously. The information costs are less well understood but are generally thought to depend both on the frequency and on the size of changes [Rotemberg (1982)].

Studies of the implication of menu costs for pricing in the closed economy setting suggest that even modest menu costs can result in an s-S type pricing rule where adjustment of prices will only take place once the difference between the optimal price in the absence of menu cost and the current price passes a threshold.[10] These thresholds can be quite large [Delgado (1991:480)]. Once price adjustment does occur, the price (under the assumption that the nominal exchange rate is

[9] See Cecchetti [1986] specifically on publication prices, Carlton (1986), Rotemberg (1982) and in particular Blinder (1991) for a general survey of the reasons for price "stickiness".

stationary) is reset taking into account the cumulative changes since the last price adjustment [Cecchetti (1986)].

Consider any period, *t*, in which the price in market *i* is *not* changed. We reference the period in which the price was last changed by 0, and assume that at that time, both the home price and the destination market price were changed. Adding and subtracting $[\log(P_{i0})-\log(P_{n0})-\log(E_{i0})]$ to the current relative price RP_{it} yields:

(7) $[\log(P_{it})-\log(P_{nt})-\log(E_{it})] = [\log(P_{it})-\log(P_{i0}]-[\log(P_{nt})-\log(P_{n0}]-[\log(E_{it})-\log(E_{i0})]$

By assumption $\log(P_{it})-\log(P_{i0}) = \log(P_{nt}-\log(P_{n0}) = 0$. Substituting from equation (4) yields the following equation for the common currency relative price (RP_{it}):

(8) $\log(RP_{it}) = [\log(P_{it})-\log(P_{nt})-\log(E_{it})] = [\log(E_{i0})-\log(E_{it})] +\log(1+\mu_{i0}) - \log(1+\mu_{n0})$

Substituting for RP in equation (8) and solving for P_{it} yields the matching testing equation to (5) above:

(9) $\log(P_{it}) = \alpha_{i0} + \log(P_{nt}E_{it}) - \log(E_{it})$

where $\alpha_{i0} = [\log(1+\mu_{i0})-\log(1+u_{n0})-\log(E_{i0})]$. In consequence, if equation (5) were estimated based on this data process, evidence of local currency price stabilization ($\gamma_i<0$) would be found even though firms are acting perfectly competitively (i.e. $(1+\mu_{i0})=\log(1+u_{n0})=1$) when they *d*o set prices.

3. The Data

The dataset used to examine the presence and importance of menu costs consists of the cover prices, in local currency, of two magazines, *The Economist* and of the European edition of Business *Week* for Austria (AUS), France (FRA), Germany (GER), Italy (ITA), the Netherlands

[10] See, inter alia, Sheshinski and Weiss (1977,1983), Iwai (1981), Benabou (1988), Ball and Romer (1989).

(NET), Norway (NOR), Spain (SPA), Sweden (SWE), Switzerland (SWI), the United States (USA) and the United Kingdom (UK), the latter two serving as the reference countries for the Economist and Business Week, respectively. The sample covers the period from January 1973 to December 1995 for *The Economist*[11]; and from January 1980 to December 1995 for *Business Week*. Prices were collected for the first full week of each month. Common currency conversions are based on the IMF's International Financial Statistics (IFS) exchange rate series converted into local currency per Pound Sterling, using the end of month series to match the price data as closely as possible. Local CPI series were likewise taken from the IFS.

Table 1: Basic Statistics

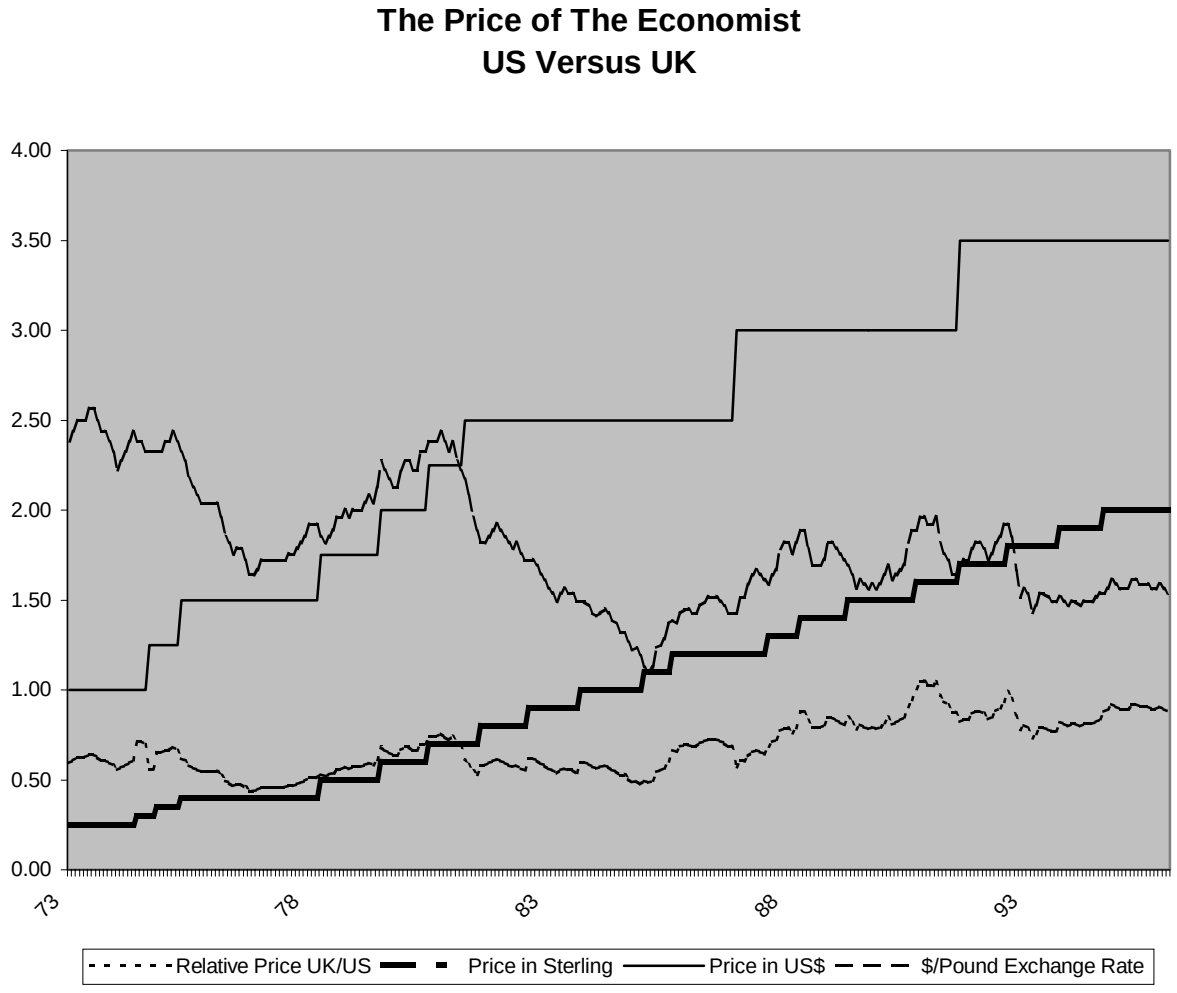
	Relative Common Currency Price Home versus Destination Market			
	Mean	St. Dev.	Mean	St.Dev.
	Economist	Economist	Business Week	Business Week
Austria	0.64	0.10	0.97	0.29
France	0.71	0.09	0.91	0.23
Germany	0.65	0.11	0.74	0.16
Italy	0.66	0.09	0.93	0.10
Netherlands	0.67	0.09	0.84	0.21
Norway	0.70	0.08	0.86	0.10
Spain	0.73	0.10	0.98	0.22
Sweden	0.63	0.08	0.71	0.11
Switzerland	0.63	0.10	0.79	0.17
UK			1.02	0.19
USA	0.69	0.15		

To provide an impression of the data, Figures 4 plots the cover prices of *The Economist* in France and the UK, along with the bilateral exchange rate. The figure reveals suggestive of menu costs: local currency prices remain unchanged for long periods of time before undergoing a jump change, the nominal exchange rate movement at the time of the price change does not differ noticeably from the movement at other times where no price changes were undertaken. Between the adjustment periods, the common currency relative price largely follows the nominal exchange rate.

[11] Except for the Netherlands, Norway, Spain, Sweden and Switzerland, for which availability ends in December 1990.

Table 1 reports the mean and standard deviation of the relative common currency price of the same magazine in the home market (UK for *The Economist*, US for *Business Week*) relative to the destination markets. On average, both magazines are relatively cheaper in the home market. For *The Economist*, the average relative price is tightly bunched in the 60-70% range, with standard deviations around 10%. The distribution for *Business Week* is less tight, average relative prices range from 71% in Sweden to 102% in the UK; the standard deviations are about twice as large as for *The Economist*.[12]

Figure 4:



[12] Price changes display substantial variation, ranging from –20 percent to +58% for *The Economist*, and from –24% to 43% for *Business Week* , with the standard deviation in several cases exceeding the mean. The majority of price changes are in the 3 to 12 percent range.

With these stylized facts as background, we now turn to a more formal examination of pricing behavior for the two magazines.

4. Empirical Tests

We begin by examining whether the relative price RP_{it} is stationary; Table 2 reports Phillips-Perron t (PP-t) and ρ (PP-ρ) statistics and ADF statistics for the individual series (Log (RP_{it}) and for the panel [Pedroni (1995)]. The results do not permit rejection of the unit root null for the individual series, with borderline rejections for the panel. Accordingly, below we report passthrough regressions both in levels and in first differences.

Table 2: Co-Integration Tests

	Economist	Economist	Economist	BW	BW	BW
	PP-t	PP-ρ	ADF	PP-t	PP-ρ	ADF
Austria	-2.00	-7.78	-2.00	-1.97	-4.96	-1.96
France	-2.95	-15.37	-2.94	-1.80	-4.00	-1.79
Germany	-2.29	-8.71	-2.28	-0.62	-1.01	-0.62
Italy	-2.53	-12.04	-2.52	-2.87	-15.75	-2.86
Netherlands	-2.98	-13.25	-2.97	-1.69	-3.97	-1.69
Norway	-2.88	-15.21	-2.87	-1.88	-7.59	-1.76
Spain	-2.81	-14.04	-2.80	-2.49	-12.31	-2.49
Sweden	-2.42	-10.81	-2.42	-1.72	-3.55	-1.72
Switzerland	-2.44	-11.27	-2.43	-1.68	-5.45	-1.67
UK	…	…	…	-1.43	-4.54	-1.42
USA	-2.00	-8.57	-1.86	…	…	…
Panel	-7.68*	-34.13*	-7.77**	-14.16**	-5.08	-5.11**

*,**: Reject null of no cointegration (i.e. non-stationarity of RP) at the 10% and 5% level.

Table 3 reports the results for equation (5), with t-statistics in parenthesis. The results are similar across countries, as well as across the two magazines. Three stylized facts emerge. First, the constants are significant, indicating that (under the assumption that marginal costs are the same

across countries) mark-ups differ across countries. Second, the coefficient on the reference currency price generally differs from unity. Third, there is strong evidence of local currency price stabilization ($\gamma_i < 0$).

Table 3: Exchange Rate Pass-Through Regression: Levels

	Economist					**Business Week**			
	Const.	Log(E_i)	Log($P_{UK}E_i$)	R^2		Const.	Log(E_i)	Log($P_{US}E_i$)	R^2
Austria	3.66	-0.47	0.45	0.96		4.40	-0.65	0.23	0.60
	(41.28)***	(23.30)***	(41.37)***			(24.97)***	(16.24)***	(4.18)***	
France	2.58	-0.88	0.91	0.99		1.08	-1.12	1.42	0.57
	(54.98)***	(40.92)***	(313.36)***			(3.67)***	(19.06)***	(10.78)***	
Germany	1.95	-0.57	0.33	0.96		1.32	-0.65	0.60	0.85
	(53.42)***	(29.41)***	(28.09)***			(39.10)***	(40.67)***	(23.29)***	
Italy	6.91	-1.11	1.26	0.98		0.56	0.12	0.83	0.80
	(14.50)***	(14.47)***	(71.93)***			(1.65)	(1.67)	(16.68)***	
Netherlands	1.67	-0.52	0.57	0.97		1.14	-0.78	0.79	0.57
	(34.28)***	(19.89)***	(46.71)***			(14.66)***	(17.39)***	(13.48)***	
Norway	2.38	-0.78	0.930.93	0.97		1.65	-0.97	1.14	0.86
	(16.42)***	(12.06)***	(102.2)***			(12.31)***	(19.16)***	(32.40)***	
Sweden	2.48	-0.90	1.03	0.94		0.59	-1.25	1.80	0.93
	(18.89)***	(15.42)***	(125.4)***			(6.85)***	(20.63)***	(44.32)***	
Switzerland	1.48	-0.31	0.35	0.82		0.85	-0.85	0.88	0.77
	(26.34)***	(14.02)***	(11.22)***			(19.62)***	(21.13)***	(18.87)***	
Spain	4.71	-0.99	1.15	0.98		1.46	-0.89	1.52	0.67
	(26.08)***	(22.37)***	(91.70)***			(3.54)***	(9.48)***	(18.84)***	
UK	…	…	…	…		-0.68	-1.28	1.20	0.72
						(13.41)***	(15.38)***	(24.71)***	
USA	0.89	-0.47	0.45	0.96		…		…	…
	(59.16)***	(23.29)***	(4.13)***						
Panel	0.44	-0.05	0.87			-0.16	-0.49	1.47	0.99
	(77.46)***	(4.17)***	(141.82)***			(6.67)***	(17.98)***	(54.13)***	

*,**: Significant at the 10% and 5% level.

Table 4 reports the regressions for growth rates, in a form comparable to the existing literature:

$$(9)\ \Delta\log(P_{it}) = \alpha_i + \Sigma_{j=0..k}\,\beta\,\Delta\log(P_{n,t-j}) + \Sigma_{j=0..k}\,\gamma_{ik}\Delta\log(E_{i,t-j}) + \varepsilon_{it}$$

Here the passthrough elasticity at lag k is given by $\gamma(k) = \Sigma_{j=0..k}\ \gamma_{ik}$ and complete passthrough (no local currency price stabilization) implies $\gamma(0) = 1$. Table 4 reports the $\gamma(12)$ coefficients—thus allowing for some sluggish adjustment—for the entire sample period. For *The Economist*, results are also reported separately for 1973-1979 and for 1980-95. The results suggest that even after one year, less than one-half (and typically only a quarter) of the exchange rate movement is passed through to the local currency price.

Table 4: Cumulative Exchange Rate Passthrough: Growth Rates

	Economist							**Business Week**	
	1973-95		**1973-79**		**1980-95**			**1981-95**	
	$\Sigma\gamma_i$	R2	$\Sigma\gamma_i$	R2	$\Sigma\gamma_i$	R2		$\Sigma\gamma_i$	R2
Austria	0.20	0.35	0.00	0.57	0.42	0.30		0.34	0.14
France	0.08	0.34	0.12	0.64	0.03	0.22		0.19	0.15
Germany	0.18	0.24	0.17	0.70	0.29	0.20		0.21	0.30
Italy	0.01	0.33	-0.16	0.53	-0.01	0.15		0.88	0.26
Netherlands	0.05	0.34	0.22	0.65	0.07	0.44		0.21	0.31
Norway	0.28	0.31	0.11	0.50	0.97	0.41		0.05	0.15
Sweden	0.37	0.36	0.22	0.41	0.14	0.43		0.29	0.08
Switzerland	0.31	0.23	0.34	0.47	0.14	0.27		0.59	0.12
Spain	0.52	0.45	0.51	0.47	0.64	0.48		0.03	0.41
UK	…	…	…	…	…	…		0.37	0.24
USA	0.08	0.28	0.48	0.36	0.06	0.16		…	…
Panel	0.18	0.25	0.51	0.47	0.26	0.21		0.33	0.05

The tests presented so far establish the presence of imperfect passthrough but cannot differentiate between the menu cost and the strategic pricing explanations. The next group of tests

explores this whether menu costs play a significant role in addition to strategic pricing to market. We test for the presence of menu costs in a probit model. The dependent variable takes a value of one if a local currency price change is observed in the particular destination market in a particular month, and otherwise takes a value of zero.

To capture dependence on cumulative changes in the forcing variable, we define, for any variable X the percentage change $\Delta X^{\circ}_{t} = (X_t - X_\tau)/X_\tau$ since the previous change in the local currency price at time τ. Under the null of pricing under menu costs, it is the cumulative change ΔX°_{t} rather than the current change, $\Delta X_t=(X_t-X_{t-1})/X_{t-1,}$ that should be relevant for pricing decisions, under standard strategic pricing models, the reverse holds. The incentive to bunch price changes under menu costs if there is a fixed cost of changing prices that can be spread across markets is captured by including the number of price changes in other markets in the same month (OTHER).

In the presence of a common cost shock, bunching would also occur under strategic pricing. We control for this possibility by including the change in the international price of newsprint, P^{NEWS}.[13] To allow for destination market inflation to positive influence the probability of price increases (either through local costs or through an increased relative price of local competing magazines) [Rotemberg (1982), Cechetti (1986)], we include the contemporaneous destination market CPI inflation rate; ΔCPI_{it} and the cumulative change in the destination market CPI since the last price change, ΔCPI°_{it}. Finally, we include an indicator of whether the local currency index of *Business Week* has increased since the last price increase of *The Economist* (and vice versa for the probit on *Business Week* price changes).

Table 5 reports the results. The results are quite strong: the contemporaneous changes of the exchange rate (ΔX_t) does not significantly affect the decision to change prices, while the cumulative change since the last change (ΔX°_{t}) does.[14] Even controlling for common cost shocks, price changes in other markets for the same magazine sharply increase the probability of a price change in the local market, consistent with a menu costs with some fixed element that can be

[13] As a robustness test, we estimate an alternative regression using wages, the WPI and the CPI in the reference country (UK for *The Economist*, US for *Business Week*) as proxies for the common cost shock. The proxies were uniformly insignificant.

[14] The finding is robust to including lagged competitor changes.

distributed across markets. Changes in the local price of goods generally, and of the competitor magazine in particular, also raise the probability of a price change for the two magazines, though both are only significant for *The Economist*.

Table 5: Probit Results

	The Economist	*Business Week*
Constant	-2.47	-2.49
	(15.94)***	(13.09)***
Change: ΔE_t	-0.58	-2.45
	(0.19)	(0.61)
Cumulative change ΔE°_t	1.86	2.82
	(2.53)**	(2.71)**
Change: ΔCPI_t	37.7	17.46
	(2.75)**	(0.98)
Cumulative change: ΔCPI°_t	1.21	0.04
	(0.95)	(0.04)
Change: ΔP^{NEWS}_t	2.01	-1.70
	(1.15)	(0.70)
Cumulative change: $\Delta P^{NEWS\circ}_t$	0.24	(1.29)
	(0.43)	(1.81)**
# of changes in other markets	0.43	0.64
of the same magazine	(14.28)***	(8.75)***
Has competitor magazine changed	0.47	-0.12
price since last price change?	(2.62)**	(0.52)

Dependent variable: 1 if the local currency price has changed this period, 0 otherwise. *Changes in other markets* : number of price changes of the same magazine in other countries. *Changes in competitor prices*: dummy equal to 1 if the price of the competitor magazine (Business Week for the Economist and vice versa) has changed since the last price change.

A different angle on the importance of menu costs is provided by threshold mean reversion regressions. Under the simple menu cost model, price adjustment is delayed until the cost of not adjusting prices (in terms of reduced profits) exceeds the menu cost of changing prices. Menu costs thus generate an adjustment band around the optimal relative price. Within the band, the mean

reversion properties of the relative price are determined by the mean reversion properties of the nominal exchange rate. A broad literature suggests that, at least over the short term, the nominal exchange rate displays at best muted mean reversion, hence one would expect correspondingly limited mean reversion in relative prices within the band under menu cost. Once the relative price breaches the critical level, mean reversion is brought about by the adjustment of the nominal prices given the nominal exchange rate, thus mean reversion outside the band is strong under menu costs. The implication can be tested within the standard threshold mean reversion framework:

$$\text{Log}(RP^*(t))-\text{Log}(RP^*(t-1)) = a + b_0*\log(RP^*(t-1))+ b_1*DU*\log(RP^*(t-1))+ b_2*DL*\log(RP^*(t-1))$$

where RP* is the relative price, DU is a dummy set equal to 1 if RP* is above an upper threshold; and DU is a dummy set equal to 1 if RP* is below a lower threshold. Under simple mean reversion, $b_0<0$, $b_1=b_2=0$: if the relative price is above its mean, it will fall back towards the mean, the speed of reversion is independent of the level of the relative price. Under the menu cost hypothesis, the coefficient on b0 is ambiguous, depending on the mean reversion speed of nominal exchange rates, while b_1, $b_2 <0$: once the threshold is exceeded, nominal prices are reset, reducing the deviation of the relative price from its long run equilibrium.

We estimate the threshold regression in a panel framework. The central value of the relative price for each country is set equal to the sample average[15]; the regression is thus estimated for the de-meaned series of relative prices. The best thresholds are found by a grid search across all feasible levels, using an R^2 criterion.

The standard mean reversion regressions yield significant negative coefficients on the lagged value of the relative price, suggesting that, viewed over the entire sample, mean reversion is indeed present. The grid search reveals that the mean reversion speed is non-linear. For *The Economist*, we find the best thresholds to be almost symmetric, at –0.24 and + 0.25. Adding the threshold effects to the regression leads to a small decline in the b_1 coefficient. The two coefficients measuring the increase in the speed of mean reversion once the relative price breaches the threshold

[15] The alternative is to specify the law of one price as baseline. While relative prices center around one (Table 1), differences in tax regulation, local distribution costs etcetera, can reasonably be expected to generate small differences, we hence prefer the sample mean as the central value of the band.

come in highly significant, and four times larger than the b_1 coefficient. The results for *Business Week* are comparable. The regressions are thus consistent with the implication of the menu cost model that the speed of mean reversion increases sharply once the relative price is above a threshold defined by the cost of changing prices.

$\Delta RP^{Economist}$	=	-0.000	-0.036	RP(-1)					R^2=0.018
		(0.14)	(6.60)**						
$\Delta RP^{Economist}$	=	0.000	-0.027	RP(-1)	-0.124	D^L*RP(-1)	-0.123	D^U*RP(-1)	R^2=0.031
		(0.13)	(4.87)**		(2.70)**	[< -0.24]	(5.13)**	[> 0.25]	
$\Delta RP^{B.Week}$	=	-0.000	-0.027	RP(-1)					R^2=0.014
		(0.75)	(5.00)**						
$\Delta RP^{B.Week}$	=	-0.000	-0.017	RP(-1)	-0.102	D^L*RP(-1)	-0.327	D^U*RP(-1)	R^2=0.062
		(0.74)	(3.11)**		(3.01)**	[< -0.32]		[>0.82]	

The evidence presented so far strongly suggests that menu costs are present, but has little to say on their relative importance. Specifically, we are interested in knowing whether menu costs provide a near-complete explanation of the imperfect passthrough—implying that adjustment is delayed, but is complete once undertaken—or whether it comes atop strategic pricing decisions. The question can be addressed by estimating the passthrough elasticity for a reduced sample consisting only of those months in which prices are in fact changed. If strategic pricing to market played no role, but menu costs did, we would expect to observe approximately complete pass-through between any two periods in which prices are adjusted. In contrast, if strategic pricing to market considerations were important in addition to menu costs, there would be no reason to expect full passthrough of the cumulative exchange rate change.[16]

[16] One caveat arises: if demand elasticities and marginal costs are the same across destination markets, the optimal price under strategic price setting is the same (expressed in common currency) across all destination markets. The identification problem is difficult to avoid, except to note that the conditions for the strategic pricing outcome to match the menu cost outcome are quite stringent

To examine the importance of shifting from contemporaneous to cumulative exchange rate movements, we first regress the monthly change in the ratio of the local currency price of *The Economist* to the Sterling price (and likewise the local currency price of *Business Week* relative to the US$ price) on the monthly change in the exchange rate in a panel setting for the full sample:

$$(10) \quad \Delta\log(P_{it}/P_{nt}) = \beta_0 + \beta_1\Delta\log(E_{it})$$

With unitary pass-through, $\beta_0=0$ and $\beta_1=1$. The results are reported in the top panel of table 6. Consistent with the results reported above, the point estimates of $\beta_1=0.11$ for *The Economist* and $\beta_1=0.03$ for *Business Week* are far from unity. The bottom half of table 6 reports the same regression for the sub sample of observations in which prices are changed, replacing the contemporaneous price and exchange rate movements by their cumulative changes since the last price change:

$$(11) \quad \Delta\log(P_{it}/P_{nt})^\circ = \beta_0 + \beta_1\Delta\log(E_{it})^\circ$$

where, as before, ΔX°_t refers to the change in variable X since the last price change. For *The Economist*, the constant now is insignificantly different from zero, while the coefficient on the cumulative exchange rate changes is four times larger than the coefficient on the contemporary change reported above. The results are even more dramatic for *Business Week*.

A comparison of the two panels suggests that sample selection is crucial in the presence of menu costs. The standard regression of the contemporaneous price change on the contemporaneous change in the exchange rate co-mingles a large number of observations with zero price changes (and hence zero pass-through) with a small number of observations with (possibly quite large) price changes. The estimated pass-through elasticity is the weighted average of these two sub-samples, and may, as illustrated by the simulations presented above, provide a poor guide to the underlying pricing structure. Specifically, the long-term passthrough elasticity may be substantially under-estimated, and mis-interpreted as evidence of strategic pricing to market. For individual price series such as those examined here, it is straightforward to allow for such delayed adjustments to

cumulative changes. For aggregate price indices combining a large number of individual prices with possibly quite different pricing structures, testing for menu costs will be harder; consequently, caution is warranted in equating imperfect passthrough with strategic pricing to markets.

Table 6: Response of Relative Prices to Exchange Rate Movements

	Full Sample			
	β_0	β_1	R^2	N
The Economist	-0.02	0.11	0.01	2280
	(2.30)***	(2.71)**		
Business Week	0.00	0.03	0.00	1440
	(0.47)	(0.97)		
	When Price Changes Occur			
	β_0	β_1	R^2	N
The Economist	-0.01	0.41	0.20	151
	(1.33)	(4.75)***		
Business Week	0.02	0.35	0.20	58
	(1.49)	(3.67)***		

The comparison of the two panels of table 6 also suggests, however, that while controlling for menu costs significantly raises the passthrough elasticity, the point estimates, at 0.41 and 0.35, remain far (and significantly) below unity, suggesting that imperfect passthrough for the present dataset reflects both menu costs and strategic pricing to markets.

5. Conclusions

The standard test for imperfect passthrough is equally consistent with two complementary explanations: temporarily postponed price adjustments due to menu costs; and deliberate deviations from the law of one price reflecting strategic pricing-to-market decisions. The two explanations carry rather different implications: the law of one price retains its long term validity under menu costs—and the standard channels of trade adjustment remain valid, with a delay, while deviations from the law of one price are permanent under most models of strategic pricing.

In the data, strategic pricing and menu cost may well appear together. We looked at a particular micro price-dataset, the cover prices of two magazines, *The Economist* and *Business Week*, to examine whether the evidence is consistent with an important role for menu cost. The standard passthrough regression reveals a small response of local currency prices to exchange rate movements: only 3 percent and 11 percent of the contemporaneous exchange rate movement is reflected in local currency price changes for *The Economist* and *Business Week*, respectively.

The data strongly suggest, however, that strategic pricing to market is only part of the explanation for the imperfect passthrough. While strict discrimination between the two models is impeded by the ability of strategic pricing to markets models to match most pricing patterns under some set of parameters, three features of the data are indicative of an important role for menu costs. First, passthrough in most months is zero, despite exchange rate changes in these months that are not systematically smaller than those observed in the periods in which prices are adjusted. Second, price changes are strongly bunched, suggestive of menu costs with a fixed cost component spread over multiple markets. Third, the telltale pattern of long periods of zero passthrough followed by a single period of (mostly above-unity) passthrough suggests a catch-up of prices to cumulative exchange rate changes.

The catch-up pattern is confirmed by regression analysis. We find that cumulative changes since the last price adjustment are more useful in predicting price changes than are contemporaneous changes. We also find strong support for a threshold mean reversion model of common currency relative prices. Perhaps most striking, the passthrough elasticity increases

sharply if the sample is restricted to those months in which prices are changed, though the elasticity remains well below unity. For this dataset at least, menu costs thus seem to play an important role in addition to strategic pricing decisions.

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