Pricing to Market versus Menu Costs: Do They Really Con‡ict?

Yunus Aksoy¤

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Abstract

This paper deals with the long lasting debate on the exchange rate shocks and price adjustments in a dynamic programming framework. We present a framework where …rms face menu costs when they decide change their prices in a competitive environment. The main result of the paper is that band of inaction of price changes to exchange rate shocks widens the more competitive a domestic market is. This is a complementary result to both menu cost and Pricing to market debate. We argue that both arguments are correct and do not exclude eachother. Empirical evidence from magazines market is discussed.

1 Introduction

Analysis of nominal price stickiness is frequently at the centre of New-Keynesian economic literature. The question is a very crucial one for the policymakers who often rely on nominal (monetary and exchange rate) instruments to a¤ect demand and supply decisions in the market. A policymaker's attempt to induce both aggregate demand and supply is strictly dependent on the pricing process at the microeconomic level.

Theoretical literature is rich in the sense of proposing price adjustment dynamics. Nowadays, there is a far-reaching consensus that market imperfections are the key elements in understanding sluggish price adjustments with respect to policy and real shocks in the short run. Accordingly, theories o¤er basically two di¤erent explanations to the commonly observed empirical regularity.

First of all, according to (among others) Sheshinski and Weiss (1983) and Danziger (1983) …rms face …xed or variable adjustment costs of price changes. Hence, when policy shocks arrive …rms prefer to wait until the shocks accumulate to a particular threshold and

¤I am grateful to Paul De Grauwe, Marno Verbeek and Frank Verboven for useful discussions. All remaining errors are of course mine. Katholieke Universiteit Leuven, Centrum voor Economische Studien, Naamsestraat 69, B-3000 Leuven, Tel: (+)32.16.326834, fax: (+) 32.16.326796, e-mail: Yunus.Aksoy@econ.kuleuven.ac.be

only than adjust their prices. In other words, prices adjust in discrete time intervals (sS economies).[1]

A second explanation arises from the strategic considerations. Among others Rotemberg and Saloner (1986) focus on strategic aspects of pricing process. Changes in the market structure via entry and exit, degree of competition, product di¤erentiation, all, a¤ect …rms' pricing decisions. Based on these industrial organization foundations prices adjust continuously but di¤erent degrees with respect to policy or real shocks.

International economics also deals with a similar question. Whereas RBC type of international macroeconomics argues for an immediate adjustment of prices w.r.t. exchange rate shocks, empirical evidence widely rejects the hypothesis. In the short run prices either do not adjust at all or the observed adjustment does not completely neutralize the nominal shock. [2] Although open to debate, in the long run there seems to be a one to one relationship between prices and exchange rate changes.

Theoretical literature on pricing decisions of internationally active …rms mainly follows the strategic foundations and imperfect competition. First of all, the bulk of the literature argues in favor of strategic …rm behavior or competitive pressures under exchange rate shocks. The driving force of the incomplete price adjustment are the market failures in the goods markets (Dornbusch (1987), Krugman (1986), competition for market share (Froot and Klemperer (1989) or existence of sunk and maintenance costs Baldwin (1988), Dixit (1989), Baldwin and Krugman (1989)). According to these theories prices continuously adjust however in an incomplete way. Empirical evidence provided by Knetter (1993), Feenstra et al. (1996), Goldberg and Knetter (1999) supports the hypothesis that …rms price to market. However, the pricing to market literature has strong merit about the issue by taking into consideration mark-up adjustment, it fails to account for the adjustment of prices in discrete time intervals. Secondly, the existence of menu costs of multinational …rms gained some attention, however to a limited extent. Delgado (1991) and Knetter (1993) point to the adjustment costs …rm face. The argument relies on the existence of adjustment costs when …rms decide to change prices in accordance with exchange rate shocks. When the exchange rate shock reaches a particular threshold which is determined by the menu costs, …rms adjust their prices. The natural implication of such analysis is that prices do not adjust continuously. However, there are at least three major problems with the theory. In order to create the discontinuous price adjustment, the theory usually has to rely on very high menu costs reaching as much as 50-60%. [3] Secondly, according to this theory, once a particular exchange rate threshold is reached prices adjust completely, which is not necessarily con…rmed by the data.

Essentially, these two theories o¤er two di¤erent explanations of the price puzzle. Both can account for part of the stylized facts but fails to account for the other. The menu cost argument is successful for discontinuity whereas pricing to market argument can account for the incompleteness.

[1] For the analysis of macroeconomic implications of menu costs see among others Blanchard and Kiyotaki (1987).

[2] Empirical research by Knetter (1993), and Goldberg and Knetter(1997,1999).

[3] see e.g. Cecchetti (1986).

In order to make the con‡ict with two streams of analysis more explicit an interesting study by Ghosh and Wolf (1994) is worth to mention. They use the cross-country price data published on the cover pages of the magazine 'The Economist'. They argue that in the presence of menu costs, standard tests to account for pricing to market may yield spurious …ndings.

The distinction between these two concepts is a very crucial one. The existence of pricing to market behavior is a deliberate violation of the Law of One Price and may allow for unfair trade exercises. On the other hand menu costs are able to generate the observed price rigidity and may put obstacles to the frequent adjustment of prices with respect to exchange rate shocks.

Our paper argues that both strategic interactions among international …rms and menu costs are relevant in understanding the pricing process and do not necessarily exclude each other. In an environment where exchange rates are stochastic elements creating uncertainty as concerns future pro…ts, …rms will take care about both aspects. Hence our paper provides a uni…ed framework based on real options theory, where multinational …rms face adjustment costs by altering their prices in an imperfectly competitive environment. Exchange rate shocks are the source of uncertainty.

In order to provide some more intuition of the theory we will present an empirical study. The main di¢culty of analyzing pricing behavior of …rms is data availability. First of all, data should contain information of a single homogeneous good. Any composite price index blurs analysis of the pricing behavior. Secondly, in order to be able to make fair judgement on the individual …rms' pricing decisions one needs high frequency price data (say, weekly or monthly). Low frequency data hides all information about in-between price adjustment exercises. In other to be immune to such criticism we will chose particular goods of a speci…c market. Our empirical analysis will be based on the panel data of two internationally available magazines' cover page prices. We choose the weekly magazine 'Economist' and the magazine 'Business Week'. These di¤erentiated goods did not change their product characteristics over long time periods and quoted in local currencies. They are in some way comparable in terms of their consumer pro…le. With the use of this price data we will try to account for the cross-section time series pricing strategies of these leading magazine publishers.

The paper is organized as follows. Section 2 provides our model of real option theory. In section 3 comparative dynamics are presented. Section 4 provides empirical analysis. Finally Section 5 concludes.

2 A Model of Menu Cost in an Imperfectly Competitive Environment

Our model is a modi…ed version of the models of Dixit (1989) and Delgado (1991). There are n risk neutral …rms active in the domestic market one being foreign origin.

Assumption 1: The exchange rate process is assumed to be exogenous. We assume that

the real exchange rate shock follows a continuous time equivalent of a logarithmic random walk with drift, i.e. a geometric Brownian motion with drift, with constant mean growth rate ® and standard deviation ¾ and is given by[4]

$$dS = \mathrm{®}Sdt + \mathrm{¾}Sdz \tag{1}$$

where dz is the increment of the standard Wiener process and it has the properties of $E(dz) = 0$ and $E(dz^2) = dt$, ® is the drift parameter where ® 2 <: The parameter ¾ represents the exchange rate volatility, ¾ 2 $<_+$.[5]

Assumption 2: We will consider a foreign …rm with a linear production technology. Following Bentolila and Bertola (1990) this …rm has a constant elasticity for demand function, which can be written such that

$$Q_t = P_t^{1=(\mathrm{¹}\ \mathrm{¡}\ 1)} \tag{2}$$

where Q_t denotes the level of production at time t (ignoring inventories), P_t is the price of the good produced at time t and ¹ is the inverse of the mark-up factor. The …rms monopoly power is decreasing when ¹ is increasing. ¹ will serve as the parameter to control for the degree of competition in this market hence foreign …rm's market power in the domestic market.

Assumption 3: The …rm faces constant elasticity of demand function. The ‡ow pro…t function for the foreign …rm in terms of the foreign currency is given by $\mathrm{¼}_t^F = [f_t\ \mathrm{¡}\ S_t\ \mathrm{¤}\ g_t]$; where total revenue function is de…ned as $f_t = P_t\ \mathrm{¤}\ Q_t(P_t; \mathrm{¹})$:

We de…ne total cost function $g_t = C\ \mathrm{¤}\ Q_t(P_t; \mathrm{¹})$: C is the constant marginal cost of production (say, marginal labor costs). S_t stands for the nominal exchange rate at time t indicating that the production costs are incurred at the country where the production takes place.

We impose …rst order conditions for total revenue and total cost functions such that $f' < 0; g' < 0$ and second order conditions are given as $f'' < 0$ and $g'' \geq 0$. [6]

[4] This forms a realistic assumption of the exchange rate processes. For empirical evidence see Meese and Rogo¤ (1983) and Dixit (1989).

[5] In other words, our assumed exchange rate process has independent increments meaning that the probability distribution for the change in the exchange rate over any time interval is independent of any other time interval. (See Dixit and Pindyck (1994) for details.)

[6] In other words, we restrict the idea of strategic interaction. In this set-up increase in the number of competitors simply leads to marginal revenue equals to marginal cost. Oligopolistic competition under demand uncertainty and menu costs (or sunk costs, consumer switching costs) is itself ongoing research. Ideally, one would like to model the pricing outcome via game theoretical considerations. In our case it would mean that we have to calculate the Markov perfect equilibria in the existence of menu costs and exchange rate uncertainty. Incorporating the Markov game is heavily complex and does not allow to interpret the results according to the real option theory yet. For an excellent attempt of incorporating adjustment costs in a dynamic setting of product di¤erentiation and its implied numerical analysis see Pakes and McGuire (1994). An alternative technique for the estimation of the market power is developed by Goldberg and Knetter (1999). They incorporate the concept 'residual demand' in order to estimate the market power in general cases.

Assumption 4: The …rms face linear adjustment costs when altering their prices. In this sense, the decision to change the prices can be considered to some extent irreversible because of the presence of this linear adjustment (menu) costs.[7] We incorporate two types of menu costs in our model. Each …rm faces a …xed menu cost denoted by k (when the …rm increases its price) and l (when the …rm decreases its price) when they decide to change the price of their homogeneous good. We do not make any arbitrary assumptions about the relative size of the menu costs, however they may di¤er.

The …rm chooses its pricing policy to maximize its objective function. In line with Dixit (1989) and Delgado (1991) we …rst write the value function of the foreign …rm active in the domestic market as the expected value of cash ‡ows over the in…nite future as being;

$$V_t(S;P) = \max_{\{P_t\}} E\left[\int_0^{1} e^{-\bar{r}t}[f(P_t) - S_t g(P_t)]\,dt - [k_{dP>0} - l_{dP<0}]\right] \tag{3}$$

Hence, when taking its pricing decisions the …rm takes into consideration the adjustment costs of changing the prices. Obviously when there are no adjustment costs, i.e. $k = l = 0$, …rm maximizes only its current ‡ow of pro…ts. To assure convergence we need that the discount rate used by the foreign …rms ($\bar{r}$) should exceed the constant mean growth rate (α); i.e. $\bar{r} > \alpha$:

2.1 Optimal Stopping

The value function given in equation (3) is continuously di¤erentiable with respect to its …rst argument. It is easy to show that when there is no price change the Bellman equation is satis…ed such that;

$$E(dV/dt) + (f(P) - Sg(P)) = \bar{r}V \tag{4}$$

Over an interval of exchange rate values without price changes the evolution of the value function is given by Ito's Lemma. Hence, extending equation (4) by Ito's lemma we can write;

$$\frac{1}{2}\sigma^2 S^2 V''(S;P) + \alpha S V'(S;P) - \bar{r}V = -(f(P) - Sg(P)) \tag{5}$$

By rearranging we write the ordinary di¤erential equation as being;

$$\frac{1}{2}\sigma^2 S^2 V''(S;P) + \alpha S V'(S;P) + (f(P) - Sg(P)) - \bar{r}V = 0 \tag{6}$$

of which the general solution is the following;

$$V(S;P) = A_1(P)S^{\beta_1} + A_2(P)S^{\beta_2} + \frac{f(P)}{\bar{r} - \alpha} - \frac{Sg(P)}{\bar{r}} \tag{7}$$

where A_1 and A_2 are constants of the integral of solution of equation (6) to be determined. Note that β_1 and β_2 are roots of the fundamental quadratic equation $\pounds = \frac{1}{2}\sigma^2\beta(\beta -$

[7] A desire to reverse the decision requires additional costs.

1) + ®° ¡ ¯ = 0. We know that the roots satisfy $°_1 = \frac{1}{2} ¡ \frac{®}{¾^2} + \sqrt{¡\frac{®}{¾^2} ¡ \frac{1}{2}¢^2 + \frac{2¯}{¾^2}}$; and $°_2 = \frac{1}{2} ¡ \frac{®}{¾^2} ¡ \sqrt{¡\frac{®}{¾^2} ¡ \frac{1}{2}¢^2 + \frac{2¯}{¾^2}}$.[8]

In order to interpret equation (7) we have to manipulate it. Denoting subscript t as the …rst time prices are changed we can write;

$$E(S_t|S_0) = S_t \exp(®t) \tag{8}$$

Therefore we can write;

$$E\int_0^1 (f(P) ¡ S_t g(P)) \exp(¡¯t)dt = \frac{f(P)}{¡®} ¡ \frac{Sg(P)}{¯} \tag{9}$$

Now equation (7) has an interesting interpretation. The last two terms on the right hand side of (7) give the expected present discounted value of keeping prices unchanged forever. On the other hand, …rst two expressions are option values of changing prices. More precisely, $A_1(P)S^{¡°_1}$ is the value of the option to decrease prices and $A_2(P)S^{°_2}$ is the value of the option to increase prices.

Next, let us consider the pricing decision of the foreign …rms in the imperfectly competitive domestic environment. De…ning $(f(P) ¡ I_p g(P))$ the marginal revenue of increasing the price at time t and $(f(P) ¡ D_p g(P))$ the marginal revenue of decreasing the price at time s following must hold at all times when the …rm maximizes equation (3) :[9]

$$V_{p¡1}(I_p) = V_p(I_p) + k \tag{10}$$

$$V'_{p¡1}(I_p) = V'_p(I_p) \tag{11}$$

$$V_{p¡1}(D_p) = V_p(D_p) ¡ l \tag{12}$$

$$V'_{p¡1}(D_p) = V'_p(D_p) \tag{13}$$

Thus, formally we de…ne the value matching and smooth pasting conditions for the upper and lower thresholds of price changes, I_p, D_p following Dixit (1989) and Dixit and Pindyck (1994):[10] If equations (10) to (13) do not hold true at any point in time, this

[8] For an exposition of the derivation of the general solution and fundamental quadratic see Dixit and Pyndick (1994).

[9] De…ne I_p and D_p as the nominal exchange rates at which it becomes for the foreign …rm optimal to change the prices (increase and decrease respectively). In other words, the foreign …rm exercises an option when it decides to change its price for a particular commodity.

[10] Value matching condition simply equates the value of the option to the value of the acquired asset less the exercise price. In our problem this condition states that the …rm equates the gains from changing the price to the menu cost of changing the price. As Dixit (1989) puts it, "if this failed, arbitrage pro…ts would be possible". On the other hand, explanation for smooth pasting condition is borrowed from …nancial economics. It requires not only the values but also the slopes of the two functions to match at the boundary. If this failed, then moving the price would raise the value of the option. For a detailed explanation, see Dixit (1989).

would mean that the foreign …rm is not executing an optimal pricing policy. For reasons of tractability we will de…ne $a = A(P) - A(P-1)$ and $b = B(P-1) - B(P)$ for $P = 1; 2$. Then, we can rewrite value matching and smooth pasting conditions (10) to (13) via substituting the functional form (7) as being;

$$aI_p^{-\gamma_1} - bI_p^{\gamma_2} + \frac{f(P)}{-(\rho)} - \frac{g(P)}{-}I_p + k = 0 \tag{14}$$

$$-\gamma_1 aI_p^{-\gamma_1-1} - \gamma_2 bI_p^{\gamma_2-1} + \frac{f'(P)}{-(\rho)} - \frac{g'(P)}{-}I_p - \frac{g(P)}{-} = 0 \tag{15}$$

$$aD_p^{-\gamma_1} - bD_p^{\gamma_2} + \frac{f(P)}{-(\rho)} - \frac{g(P)}{-}D_p - l = 0 \tag{16}$$

$$-\gamma_1 aD_p^{-\gamma_1-1} - \gamma_2 bD_p^{\gamma_2-1} + \frac{f'(P)}{-(\rho)} - \frac{g'(P)}{-}D_p - \frac{g(P)}{-} = 0 \tag{17}$$

There are four unknowns $a; b; I_p$ and D_p and for equations. Analytical solutions are di¢cult to obtain. Hence in the following section we provide a numerical analysis in order to determine the bounds of band of inaction, i.e. bounds within which the foreign …rm prefers not to change its prices and incurs temporary losses.

3 Comparative Dynamic Analysis

In this section, we will analyze the e¤ects of the menu cost in a imperfectly competitive environment with a simple linear example. Highly non-linear structure of the previously derived general solution constrains us to derive analytical solutions for our analysis. Therefore, we will rely on numerical results based on a simpli…ed linear model. Let us assume that the ‡ow pro…t function is given as $\pi_t = Q_t P_t - S_t Q_t w$: We de…ne the inverse demand function as $Q_t = P_t^{1=(\theta-1)}$; where θ represents the inverse mark-up revealing the nature of the competition and w constant marginal costs of production. Hence we can write the ‡ow pro…t function as being;

$$\pi_t = P_t^{1=(\theta-1)} - S_t P_t^{1=(\theta-1)} w: \tag{18}$$

Next we will introduce some realistic values into our set-up as given throughout equations (14) to (17) and search for numerical solutions for the constants a and b and boundary values I_p and D_p. We aim to show how the band of inaction for price changes is a¤ected by varying degrees of menu costs, competition and exchange rate volatility. Throughout simulations, we e¤ectively …x the values of the parameters $\rho = 0:001; \bar{} = 0:025$ and $w = 1$ which we believe as being realistic approximations (See also Delgado, 1991).

3.1 Size of the Menu Costs

Menu costs are crucial in the determination of the band of inaction with respect to exchange rate shocks. Figures 1 and 2 provide an overview of the evolution of the band of inaction

Figure 1: Menu Costs of Decreasing the Prices and Band of Inaction

with increasing lower and upper level menu costs. In both cases the width of the band of inaction is increasing with the increases in the menu costs. The e¤ect is asymmetric, however. An increase in the …xed cost of price adjustment to increase price level (k) tends to widen the band of inaction upwards, whereas an increase in the …xed cost of price adjustment (l) widens the band of inaction downwards. In other words, existence of adjustment costs are e¤ective in the determination of the inaction space. Hence, higher level of …xed menu costs imply higher value for waiting which is in line with the empirical regularity of infrequent price adjustments and accords with the theoretical prediction of Delgado (1991).[11]

3.2 Competition in the Domestic Market

Results of the numerical analysis for the competition in the domestic market as proxied by the slope of the demand function (^{1}) are depicted in …gures 3 and 4. On the horizontal axis we present the values of the parameter ^{1} from the value 0.1 to 7.0. In other words the …gure depicts the width of band of inaction from the case of a very steep demand curve to a ‡at demand curve unveiling the transition from a potentially high mark-up to a low mark-up. Remember that we use parameter ^{1} as the proxy for the degree of competition foreign …rm faces. Implicit assumption is that in the domestic market we can control for the shifts in the elasticity of demand. Obviously with this assumption we miss some important aspects of the market behavior which could arise from the demand side of the economy. Note that we assume menu costs being present and equal on both sides and being equal to

[11] Note that we …x the opposite menu cost as being 2, and the exchange rate volatility as being 0:001 (equivalent to very low exchange rate volatility).

Figure 2: Menu Costs of Increasing the Prices and Band of Inaction

2 (in Figure 3). In …gure 4 we set k = 5 and l = 2.

The results are quite striking. When the foreign …rm faces less competition in the domestic market (steeper slope) we observe that the size of the band of inaction tends to widen. In other words, the larger our rough proxy for market power is, the less likely our foreign …rm would like to adjust its price with respect to exchange rate shocks. This can be explained as follows: When the foreign …rm has strong market power (high mark-up), it can rather easily adjust its prices with respect to exchange rate shocks (with respect to negative monetary shocks). On the other hand, a tougher competitive environment on the side of the domestic …rms (lower mark-ups) imply a wait and see policy for the foreign …rm. The …rm is willing to accumulate losses for some time period, since it values the option to wait on the high side.

The combination of an existing menu costs with the degree of competition tends to sharpen this result. Basically, band of inaction tends to widen even further with the size of the menu costs. This implies basically that the joint existence of the menu costs and competitive pressures tend to drag the foreign …rms to a long lasting inactive state when they face exchange rate shocks. Prices are more rigid than the level as suggested by Delgado (1991) which neglects competitive pressures. Exchange rate shocks should be large enough to trigger any change in the prices under the presence of menu costs in a competitive environment.

3.3 Exchange Rate Volatility

Exchange rate volatility also a¤ects the pricing decision of the foreign …rm. Figure 5 shows this case for the values of ¾ from 0.001 to 0.070. An increase in the uncertainty parameter ¾ widens the band of inaction of the foreign …rm implying the willingness to accept further

Figure 3: Competition and Band of Inaction (small menu costs)

Figure 4: Competition and Band of Inaction (large menu costs)

Figure 5: Exchange Rate Volatility and Band of Inaction

losses under exchange rate uncertainty. Foreign …rm will be more reluctant to change its price. In other words, option value of waiting is higher under exchange rate uncertainty.

4 Empirical Assessment of the Pricing in the International Business Magazines Market

In the previous section we showed numerically that the degree of competition matters for the pricing decisions of the foreign …rms active in a domestic market when they face exchange rate shocks and have to incur menu costs of changing prices.

The empirical literature on pricing to market has widely neglected the fact that pricing to market is basically a …rm level phenomena. Because of its deliberate nature it contains strategic interaction components (or at least some form of market incompleteness) which induce …rms not to adjust their prices or to adjust in an incomplete way. Hence, essentially any analysis which makes use of aggregate price data is bound to miss important aspects of pricing process. More importantly, any analysis based on aggregate form of data is likely to suggest misleading policy recommendations. In spite of this, scarce availability of …rm level price data led researchers follow this route. A large body of literature focused on aggregate forms of price adjustment processes and tried to provide explanations on the commonly observed price stickiness or incompleteness of price adjustments. (See for an excellent survey of empirical results with such data, Menon (1995)). In this section we will follow a rather di¤erent path and make use of the idea raised by Ghosh and Wolf (1994) and more recently by Goldberg and Knetter (1999) and apply …rm level data.

4.1 Data

For some description of the movements of the prices and exchange rates we will make use of the weekly cross-section time series price data provided on the cover pages of the two popular Economics and Business journals. The Economist and the Business Week. Our price data spans from January 1990 to August 1998. Collected price data cover following countries: for Business Week we use data of cover prices from Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, the UK and the US whereas for the Economist we use data from Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Switzerland, the UK and the US. Data is quoted in terms of local currencies. The Economist is produced in the UK, the US and Hong Kong and Business Week in the US and Ireland. Thus, we will use the incumbents, the UK and the US, as the benchmark countries for our analysis. Weekly nominal exchange rate data is collected from Datastream for the same period.

4.2 Some Descriptive Statistics

The …rst observation is that the prices of these journals are quite rigid. In other words, like other types of normal goods in a low in‡ation environment, prices do not react instantaneously to changes in nominal variables. Some evidence is summed up in Table 4.1.

From Table 4.1, some observations stand out. First of all, columns 1 and 5 indicate that price changes across magazines and across countries are substantially di¤erent. Quoted in local currency, price increase for the entire period reaches as high as 275% in Greece for Business Week (the Economist 122%) and only 16% in Belgium (the Economist 23%). Interestingly, total local price increase of both magazines in Germany and the Netherlands match each other perfectly (31.7% and 27.1% respectively). Secondly, weekly volatility of prices during the 90's lies within the narrow range of 1-3%. This result suggest a substantial decline in price uncertainty as compared to 70's and 80's. (See Ghosh and Wolf, 1994). Furthermore, in line with intuition the volatility of both magazines de…ned in terms of the domestic currency is systematically lower than the volatilities in terms of dollar and pound denomination. This is natural in the sense that the latter captures bilateral exchange rate movements whereas local currency prices follow a very smooth process. Thirdly, standard deviations of price changes during the sample period is systematically higher for Business Week than the Economist, suggesting more frequent price changes of the Economist.

insert here …gures 6 and 7

In Table 4.2, we report the total number of price changes during the sample period for each country.

Basically, Table 4.2 suggests that the Business Week took price change decisions after long time intervals (reaching as many as 3 to 4 years). The natural implication of the case is that the size of the price change executed by the Business Week is larger than the Economist leading to larger standard deviations for the entire time period (see Table 4.1).

Table 1: Summary Statistics: Standard Deviations for Prices and Exchange Rates (January 1990-August 1998)

	Business Week (%)				The Economist				Exchange Rates	
	Δp_i*	Std_i**	$Std_\$$	$Std_£$	Δp_i*	Std_i**	$Std_\$$	$Std_£$	$Std_{\$=i}$	$Std_{£=i}$
Aus	28.6	0.75	-	1.40	25.0	0.44	-	1.31	-	1.885
Bel	16.7	0.59	1.60	1.32	23.1	0.46	1.68	1.31	2.27	5.35
Den	71.1	1.63	2.47	2.02	41.7	0.76	1.79	1.41	.408	.967
Fin	84.0	3.02	-	3.26	56.3	0.84	-	1.58	-	.778
Fra	33.3	1.06	1.93	1.47	40.0	0.56	1.65	1.29	.338	.839
Ger	31.7	0.79	1.86	1.42	31.7	0.67	1.78	1.39	.105	.268
Gre	275.0	3.29	-	3.48	122.2	1.79	-	2.19	-	58.81
Ita	100.0	1.73	2.61	2.08	45.5	0.76	1.76	1.36	194.68	258.68
Net	27.1	0.67	1.76	1.36	27.1	0.45	1.66	1.29	.120	.308
Nor	73.7	1.93	-	2.15	52.2	0.93	-	1.47	-	.767
Spa	52.5	1.08	1.88	1.37	56.3	0.82	1.79	1.41	15.04	24.10
Swe	97.7	2.20	-	2.67	54.2	0.95	-	1.69	-	.969
Swi	33.3	1.06	2.25	1.75	28.3	0.57	1.88	1.48	.120	.255
UK	33.3	0.90	1.88	0.91	60.0	0.95	1.79	0.96	.048	-
US	97.5	2.18	2.30	2.72	31.7	0.97	0.84	1.75	-	.127

i represents local currency. BW stands for the Business Week and EC stands for the Economist.

Table 2: Total Number of Price Changes 01.1990-12.1998

	Aus	Bel	Den	Fin	Fra	Ger	Gre	Ita	Net	Nor	Spa	Swe	Swi	UK	US
Business Week	3	2	3	2	2	3	6	5	3	3	4	4	2	3	5
The Economist	6	5	6	7	8	4	6	6	7	7	7	7	5	6	2

In the next section we will provide an empirical framework in order to account for the …rm speci…c pricing to market phenomena. In particular we will ask what factors determine the probability of the price change.

4.3 Relevance of Menu Costs and Competition

Ghosh and Wolf (1994) tested evidence of pricing to market and the relevance of menu costs using monthly data of the Economist which spans the period January 1973 and December 1990. They …nd systematic evidence of pricing to market using standard OLS tests and at the same time relevance of menu costs. For the pricing to market they estimate the following equation.

$$¢p_{it} = ¢®i + ¯¢p_t + °¢e_{it} + u_{it}$$

where $¢p_{it}$ represents the price change in the destination market, $¢p_t$ is the price change in the UK and $¢e_{it}$ is the change in the nominal exchange rate vis-a-vis the Pound Sterling. Hence, they conclude that the standard OLS tests may just yield spurious …ndings about the international price discrimination in the presence of the menu costs. Their analysis does not take into consideration the potential competitors pricing behavior and does not provide a clear analysis as to which factors determine the foreign …rms pricing decisions.[12]

Simple OLS estimations do not contain su¢cient information on the relevance of the menu costs and the existence of potential competitors. In this section we will ask the question what is the probability of price change within the framework of our theoretical analysis in the previous sections. Therefore, in this section we will conduct a random e¤ects probit model for the panel data and random e¤ect tobit model for the panel data. Probit analysis is useful since we seek factors that in‡uence the probability of the price change of a certain foreign …rm. Following Verbeek (2000) let us start with the latent variable speci…cation

$$y^{¤}_{it} = x^{0}_{it}¯ + ´_{it}: \tag{19}$$

where the disturbance term $´_{it}$~(0; 1) is independent of explanatory variables. Naturally, one has to make an assumption about the joint distribution of the disturbance terms $´_{i1}; :::; ´_{iT}$: Verbeek (2000) shows that assuming error components such that $´_{it} = ®_i + "_{it}$ is feasible but restrictive ($"_{it}$ being independent over time and countries). In order to avoid arbitrary assumptions over the distributions of $®_i; "_{it}$, and hence over $´_{it}$; standard way to start with the analysis is to assume multivariate normal distribution over the disturbance term. Thus, random e¤ects probit model is feasible for our analysis.[13] By de…nition,

[12] They …nd for the time period 1973.1- 1990.12 relevance of both pricing to market and menu costs. We have executed a similar analysis for the pricing to market (both for time series and panel data) and reached qualitatively same conclusions. In other words, we found ° being very close to -1, which indicates that the Economist did not allow to pass through any appreciation of the Pound Sterling to the prices if one neglects menu costs arguments. For reasons of brevity we do not report the results, however these are available upon request.

[13] Thus, we will assume normal joint distribution of $u_{i1}; :::u_{iT}$~(0; 1) over individual countries and $cov(u_{it}; u_{is}) = ¾^2_®; s 6= t$, which is equivalent to saying $®_i$~$N(0; ¾^2_®)$ and "~$NID(0; 1 ¡ ¾^2_®)$: Normalization on the disturbance variances in a particular period implies unit disturbance variance. For a detailed

analysis focuses on the occurrence or non-occurrence of a price change.[14]

4.3.1 The Economist

In this section we will focus on the pricing strategies of the Economist. We set y_{it} as the indicator variable for country i at time t. Hence, we write:

$$y_{it}^{EC\ddagger} = \mathbb{R} + \circ LOP\,Dev_{it} + \pm I_{it}^{BW} + \sum_{k=1} \_k + \acute{}_{it} \qquad (21)$$

y_{it}^{EC} = 1 if there is price increase of the Economist at time t ($y_{it}^{EC\ddagger} > 0$)
y_{it}^{EC} = 0 otherwise

where LOP Dev represents deviations from the Law of One Price (LOP) written as $LOP\,Dev = e_{it} + p_t^{UK} - p_{it}$ where e_{it} is nominal exchange rate of the national currencies vis-à-vis Pound Sterling, p_t^{UK} is the price of the Economist in the UK and p_{it} is the national currency price of the Economist at time t. [15] Deviations from the LOP will serve as our proxy for the menu costs. Naturally, existence of transportation costs implies that the Law of One Price will not exactly hold. However, this is less likely to cause a problem for our estimation since one can easily assume that transportation costs exhibit less variation. If …rms continuously adjust their prices while keeping track of the transportation costs, deviations from the LOP should be more or less constant. Furthermore, a statistically signi…cant accumulated LOP deviation likely reveals the existence of the menu costs. As Ghosh and Wolf (1994) rightly point out, if the menu costs are relevant for the pricing decisions then what matters for the foreign …rms is the further deviation from the LOP and not the transportation cost induced constant deviation from the LOP.

For strategic interactions we use the dp_{ij}^{BW}; price changes of the Business Week in the national currency. This variable will serve as the proxy for one potential competitor of the Economist. As argued earlier, we choose Business Week as only one potential competitor of the Economist. Naturally, there may be other competitors that we neglect. A positive ± indicates that when the competitor adjusts its price, the probability of price adjustment of the Economist increases.

$\_k$'s are dummy variables denoting the regional e¤ects. Subscript k stands for the regions. We categorize regional dummies as being the Core (Austria, Belgium, France,

analysis see Verbeek (2000). See also appendix for a detailed speci…cation of the likelihood function for the random e¤ects model.

[14] Hence it deals with just the binary outcome. When we express the model in probability it will take the following form

$$Prob(dP = 1) = 1 - F\left(-\sum_{k-1} \_k x_k\right) = F\left(\sum_{k-1} \_k x_k\right) = \mathbb{C}\left(\sum_{k-1} \_k x_k\right) \qquad (20)$$

where © is the standard normal cumulative distribution function.

[15] in terms of natural logarithms:

Germany, the Netherlands and Switzerland), South (Greece, Italy and Spain) and Scandinavia (Denmark, Finland, Norway and Sweden) to capture the coordinated price change decisions of the Economist across regions. To avoid perfect collinearity we use the UK as the reference country. As argued earlier the Economist seems to bundle pricing decisions across regions. This may be due to their interest to reduce menu costs (say, one pricing meeting in a certain time period for one region). Without loss of generality we restrict our sample period to quarterly data. Note that we capture all observed changes (also the initial change) in the prices of the Economist and Business Week. Estimation results are reported in Table 4.3.

Table 3: Estimation Results (Random Coe¢cients Probit Model for Panel Data)

	1				2				3			
	est	se	est/se	P[jZj]>z	est	se	est/se	P[jZj]>z	est	se	est/se	P[jZj]>z
®	-1.73	.341	-5.07¤¤	.000	-1.73	.350	-4.95¤¤	.000	-1.71	.351	-4.896¤¤	.000
°	1.09	.460	2.36¤¤	.018	1.50	.538	2.79¤¤	.005	1.51	.539	2.810¤¤	.005
$\pm_t^{dBW}$	-.386	1.238	-.312	.755	-	-	-	-	-	-	-	-
$\pm_{t-6}^{dBW}$	-	-	-	-	5.303	1.29	4.09¤¤	.000	5.33	1.30	4.080¤¤	.000
$\pm_{t-8}^{dBW}$	-	-	-	-	-	-	-	-	-.985	1.72	-.570	568
¸Core	.272	.376	.722	.470	-.038	.400	-.095	.925	-.519	.402	-.129	.897
¸South	.483	.371	1.30	.193	.145	.391	.372	.710	.154	.392	.393	.694
¸Scan	.425	.374	1.14	.255	.099	.392	.254	.800	.094	.393	.238	.811
Partial derivatives of E[y] = F[¤] w.r.t. the vector of characteristics (computed at $\overline{X}$s)												
®	-.403	.074	-5.44¤¤	.000	-.364	.070	-5.21¤¤	.000	-.361	.070	-5.146¤¤	.000
°	.253	.106	2.38¤¤	.017	.315	.110	2.85¤¤	.004	.318	.110	2.878¤¤	.004
$\pm_t^{dBW}$	-.090	.288	-.312	.755	-	-	-	-	-	-	-	-
$\pm_{t-6}^{dBW}$	-	-	-	-	1.12	.282	3.95¤¤	.000	1.11	.284	3.943¤¤	.000
$\pm_{t-8}^{dBW}$	-	-	-	-	-	-	-	-	-.207	.362	-.571	.568
¸Core	.063	.087	.725	.469	-.008	.084	-.095	.925	-.011	.084	-.129	.897
¸South	.112	.086	1.31	.190	.031	.082	.372	.710	.032	.082	.393	.694
¸Scan	.099	.086	1.15	.252	.021	.082	.254	.800	.020	.083	.238	.811

¤¤ denotes signi…cance at the 99% interval, ¤ at the 90% interval.

In Table 4.3 we present both estimation results for random e¤ect probit speci…cation and impled partial derivatives of E[y] = F[¤] w.r.t. the vector of characteristics which are computed at $\overline{X}$s: In estimation 1 (…rst column) we impose only the current values of the independent variables. In estimation 2 (second column), we represent the results with the lagged values of dBW.

A signi…cantly positive $°_{ij}$ coe¢cient indicates that the larger the deviation from the LOP, the Economist will more likely execute price adjustments. According to our interpretation this results strongly points the relevance of the menu costs. The …rm does not continuously execute price changes with respect to exchange rate shocks because of adjust-

ment costs. However, when the deviations from the LOP become substantial, it becomes worthy to change the prices.

Secondly, we do not …nd any signi…cant impact of price changes of the Business Week on the Economist's pricing decisions for the current period. However, when we impose past price changes, and hence 6 periods lag, the coe¢cient becomes signi…cantly positive. This result points to the fact that the Economist does not synchronize its pricing decisions with the eventual competitor Business Week at the current period but with some lags. When the competitor alters its prices the more it becomes likely that the Economist will alter its prices in the near future. Nevertheless, this result should be taken with a high degree of caution, because we do not precisely know whether Business Week is a true competitor or not.

Lastly, there seems to be no signi…cant e¤ect of cost saving behavior (captured by the regional dummies) via bundling the pricing decisions across regions. None of the regional dummies are signi…cant. However, the sign of the estimates for Core countries are negative in the 2nd and 3rd equations.

Partial derivatives tell us a similar story.[16] First of all, a further deviation from the LOP by 1% increases the probability of a price change by a very signi…cant amount, between 0.25 to 0.32%. Secondly, current values of the dBW enter insigni…cantly, however, with a negative sign. When lagged values for the competitor added ($dBW_{t\,i\,6}$) we …nd very strong impact of the competitor price changes on the Economist prices. In other words, when the Business Week changes its price, the probability of price change of the Economist increases by an amount of 1.11. The regional dummies are insigni…cant. However, being a Southern country indicates a higher probability of price change as compared to being a Scandinavian or a Core country.

Estimation results given in Table 4.3 do not provide su¢cient information about the critical value of the deviation from the LOP. In other words, it gives only a rough idea about the relevance of the menu costs. In the following we add dummy variables for di¤erent ranges of LOP deviations. Our speci…cation in order to account for the size of LOP deviations are represented with the following equation.

$$y_{it}^{EC\alpha} = \beta + \pm I_{it}^{BW} + \sum_{k=1} \gamma_k + \sum_{s=1} \mu_s + \varepsilon_{it} \qquad (22)$$

y_{it}^{EC} = 1 if there is price increase of the Economist at time t ($y_{it}^{EC\alpha} > 0$)
y_{it}^{EC} = 0 otherwise

where μ is speci…ed as follows:

[16] An individual coe¢cient in this section is de…ned as the partial derivative of the probability with respect to X_i, evaluated at the mean of the data set and equals to $\hat{}_i P(1 \; i \; P)$, where P is the average probability of observing a price change in the data set as a whole. Here, we also present the asymptotic t-statistics.

if LOP Dev **>** :35, μ_1 = 1, 0 otherwise
if :35 > LOP D **>** :30; μ_2 = 1, 0 otherwise
if :30 > LOP D **>** :25; μ_3 = 1, 0 otherwise
if :25 > LOP D **>** :20; μ_4 = 1, 0 otherwise
if :20 > LOP D **>** :15; μ_5 = 1, 0 otherwise

We present the random e¤ects probit estimation for the panel data in Table 4.4. Not surprisingly we …nd that when the deviation of the LOP exceeds 35%, the probability of observing a price change is signi…cantly high. Lagged competition proxy remains significant. Regional dummies and lower levels of deviations from the LOP are insigni…cant. Marginal e¤ects (partial derivatives) follow the same line of reasoning.

Table 4: Estimation Results for the Pricing Threshold(Random Coe¢cients Probit Model for Panel Data)

	1			
	est	se	est/se	P[jZj]>Z
®	-1.69	.334	-5.06	.000
$\pm_{t\,j\,6}^{dBW}$	2.911	.951	3.063¤¤	.002
¸Core	.140	.380	.368	.712
¸South	.294	.376	.780	.435
¸Scan	.247	.384	.645	.519
$\mu_{LOP\,D>:35}$	.644	.228	2.82¤¤	.005
$\mu_{:35>LOP\,D>:30}$	.200	.308	.648	.517
$\mu_{:30>LOP\,D>:25}$	.206	.307	.671	.502
$\mu_{:25>LOP\,D>:20}$	.456	.343	1.326	.185
$\mu_{:20>LOP\,D>:15}$	.215	.437	.491	.623
Partial derivatives				
®	-.384	.071	-5.401	.000
$\pm_{t\,j\,6}^{dBW}$	.660	.216	3.048¤¤	.002
¸Core	.317	.086	.369	.712
¸South	.066	.085	.782	.434
¸Scan	.561	.087	.646	.518
$\mu_{LOP\,D>:35}$	.146	.051	2.867¤¤	.004
$\mu_{:35>LOP\,D>:30}$	.045	.070	.649	.516
$\mu_{:30>LOP\,D>:25}$	.047	.070	.672	.502
$\mu_{:25>LOP\,D>:20}$	.103	.077	1.332	.183
$\mu_{:20>LOP\,D>:15}$	.049	.099	.492	.623

¤¤ denotes signi…cance at the 99% interval, ¤ at the 90% interval.

Naturally, the random e¤ects probit model does not intend to explain the probability of the rate of price change. For that purpose we will use the simple random e¤ects tobit

model which is essentially very much like a random e¤ects probit model except that the dependent variable is a not a binary one (see Verbeek, 2000). Then, the latent variable speci…cation takes the following form

$$y_{it}^{¤} = x^{0}— + u_{it} \tag{23}$$

where

$$\begin{aligned} y_{it} &= y_{it}^{¤} \text{ if } y_{it}^{¤} > 0 \\ y_{it} &= 0 \text{ if } y_{it}^{¤} = 0 \end{aligned} \tag{24}$$

We assume that the disturbance term is $u_{it} = ®_i + "_{it}$ and all the assumptions for the random e¤ects probit model apply for the random e¤ects tobit model.

The tobit model is interesting for our analysis since one can capture the size e¤ect. However, at the same time we complicate the analysis, since we impose two questions at the same time. The probability of price change and if the probability is high by how much. We present the results in Table 4.5. Addition of the dummy variables for the di¤erent ranges of the LOP deviations signi…es the same direction as the Probit estimates. A deviation above 35% seem to trigger price change. The results for this estimation is presented in Table 4.6.

Table 5: Estimation Results (Random Coe¢cients Tobit Model for Panel Data)

	1				2				3			
	est	se	est/se	P[|Z|>z]	est	se	est/se	P[|Z|>z]	est	se	est/se	P[|Z|>z]
®	-.172	.040	-4.34¤¤	.000	-.166	.042	-3.96¤¤	.000	-.166	.042	-3.96¤¤	.000
°	.103	.051	2.03¤	.042	.154	.060	2.57¤¤	.010	.155	.060	2.59¤¤	.010
$±_{t}^{dBW}$	-.061	.135	-.450	.653	-	-	-	-		-	-	-
$±_{t-6}^{dBW}$	-	-	-	-	.452	.121	3.74¤¤	.000	.451	.121	3.73¤¤	.000
$±_{t-8}^{dBW}$	-	-	-	-	-	-	-	-	-.089	.180	-.492	.623
¸ Core	.108	.039	.276	.783	-.029	.042	-.681	.496	-.030	.042	-.710	.478
¸ South	.047	.038	1.233	.218	.005	.040	.130	.897	.006	.041	.146	.884
¸ Scan	.033	.039	.850	.3952	-.007	.041	-.181	.857	-.008	.041	-.196	.845
Disturbance Std.Dev												
Sigma	.113	.011	10.53¤¤	.000	.112	.013	8.98¤¤	.000	.112	.013	8.98¤¤	.000

¤¤ denotes signi…cance at the 99% interval, ¤ at the 90% interval.

Results for the tobit model, albeit being qualitatively same as the random e¤ect probit model, contain some quantitative di¤erences. First of all, signi…cant variables are still our proxies for the menu costs and lagged values of the prices of the Business Week, the competitor. Regional dummies are still insigni…cant.

Table 6: Estimation Results for the Pricing Threshold(Random Coe¢cients Tobit Model for Panel Data)

	1			
	est	se	est/se	P[jZj]>Z
®	-.164	.038	-4.31	.000
$\pm_{t\,j\,6}^{dBW}$	.276	.097	2.842**	.005
¸Core	-.001	.039	-.019	.985
¸South	.028	.038	.728	.467
¸Scan	.016	.039	.400	.689
$\mu_{LOPD>:35}$	.059	.024	2.431**	.015
$\mu_{:35>LOPD>:30}$	.013	.032	.393	.694
$\mu_{:30>LOPD>:25}$	.012	.032	.376	.707
$\mu_{:25>LOPD>:20}$	.049	.036	1.385	.166
$\mu_{:20>LOPD>:15}$	.011	.047	.244	.807
Sigma	.110	.010	10.564	.000

¤¤ denotes signi…cance at the 99% interval, ¤ at the 90% interval.

4.3.2 Business Week

In this section we will evaluate the pricing strategies of the Business Week. We repeat the speci…cations given for the Economist,here, for the Business Week. Now, however, the Economist is the competitor. We present the estimation results for the random e¤ect probit model in Table 4.7.

First of all, when we add the current values of the change in the Economist price we do not …nd any signi…cant e¤ect of the pricing decision of the Economist on the probability of price change however an addition of the second lag of the Economist price changes we …nd signi…cant positive impact of competitors' pricing decisions. Compared to the results given for the Economist in Table 4.3, this implies an asymmetric consideration of the competitors behavior when deciding for their own price changes. This is not merely surprising. The Business Week adjusts much less frequently its prices as compared to the Economist. Secondly, deviations from the LOP enter signi…cantly positive in the regression implying (according to our interpretation) the relevance of the menu costs. And thirdly, likewise of the Economist equation, we do not …nd a signi…cant impact of the regional e¤ects.

Our tobit results point to the same direction. Signi…cant e¤ects of lagged pricing behavior and menu costs are present and regional e¤ects are insigni…cant.

5 Concluding Remarks

This paper deals with the long lasting debate on the price adjustments with respect to exchange rate shocks. In the …rst part of the paper we derive a rule for the foreign …rm

Table 7: Estimation Results (Random Coe¢cients Probit and Tobit Models for Panel Data: Business Week)

	Probit estimates for BW				Tobit estimates for BW			
	est	se	est/se	P[jZj]>Z	est	se	est/se	P[jZj]>Z
®	-1.062	.265	-4.001¤¤	.000	.025	.010	2.520¤¤	.000
°	1.016	.542	1.872¤	.062	.033	.017	1.884¤	.0596
$\pm_{t\,i\,2}^{dEC}$	.752	.221	3.403¤¤	.001	.203	.095	2.142¤	.0322
¸Core	-.143	.325	-.440	.660	-.004	.012	-.337	.7362
¸South	.031	.311	.098	.922	.010	.012	.868	.3854
¸Scan	-.128	.327	-.390	.696	.007	.012	.568	.5702
Sigma	-	-	-	-	.041	.018	2.27¤	.000
Partial derivatives								
®	-.156	.039	-3.943¤¤	.000	-	-	-	-
°	.149	.079	1.891¤	.059	-	-	-	–
$\pm_{t\,i\,2}^{dEC}$	1.10	.329	3.349¤¤	.001	-	-	-	-
¸Core	-.021	.048	-.440	.660	-	-	-	-
¸South	.005	.046	.098	.922	-	-	-	-
¸Scan	-.019	.048	-.390	.697	-	-	-	-

¤¤ denotes signi…cance at the 99% interval, ¤ at the 90% interval.

active in the domestic market under exchange rate uncertainty. We argue that the existence of the menu costs and competitive pressures leads to wider bands of inaction than argued in the literature so far. In other words, in the presence of menu costs a foreign …rm active in the domestic market is likely to remain in an inactive state, no change in prices, when there is a strong competition on the side of the domestic …rm. This result is in line with the empirical regularities of price rigidity (discontinuous and incomplete price adjustments) found in previous research.

Secondly, we conduct an empirical study based on the product level data. Panel data of internationally available magazines the Economist and the Business Week are chosen for that purpose. A test for the relevance of the menu costs and pricing to market with the use of the limited dependent variables indicates that both elements are important in the derivation of a pricing rule for both magazines. First of all, exchange rate shocks trigger price change if and only if these reach a certain level determined by (among others) the size of adjustment costs to change the prices, i.e. the menu costs. Our probit estimations suggest that this threshold can be as large as 35% deviation from the Law of One Price. Secondly, the pricing behavior of the competitor in the domestic market seems to be relevant albeit with lags. Our examination of the Business Week pricing behavior in the presence of the Economist and pricing behavior of the Economist in the presence of the Business Week suggests that these publishers take into consideration the pricing behavior of their 'potential' competitors after some time periods. We …nd evidence of some asymmetry of the competitor e¤ect. Business Week adjusts its prices much less frequently than the

Economist.

Figure 6: The Economist Prices

6 Appendix

Figure 7: The Business Week Prices