EUI WORKING PAPERS IN ECONOMICS

EUI Working Paper ECO No. 93/18

Exchange Rate Fluctuations, Market Structure and the Pass-through Relationship

Iñigo Herguera

European University Institute, Florence

Please note

As from January 1990 the EUI Working Paper Series is divided into six sub-series, each sub-series is numbered individually (e.g. EUI Working Paper **LAW** No. 90/1).

EUROPEAN UNIVERSITY INSTITUTE, FLORENCE

ECONOMICS DEPARTMENT

EUI Working Paper **ECO** No. 93/18

Exchange Rate Fluctuations, Market Structure and the Pass-through Relationship

IÑIGO HERGUERA

BADIA FIESOLANA, SAN DOMENICO (FI)

Printed in Italy in March 1993
European University Institute
Badia Fiesolana
I – 50016 San Domenico (FI)
Italy

Exchange Rate Fluctuations, Market Structure and the Pass-through Relationship

Iñigo Herguera

European University Institute
Via dei Roccettini
50016 San Domenico di Fiesole
Firenze, Italia

Abstract: Models of imperfect competition have been introduced recently (Dornbusch, 1987, Mann, 1989) in order to explain the behavior of prices in international markets. The Law of One Price does not yield a good explanation of prices in the short and medium term. In this paper market structure, the degree of risk aversion and the aggressiveness in the behavior of the firms are shown to be crucial determinants of the response of import prices to exogenous exchange rate fluctuations (i.e. the pass-through relationship). In a Cournot oligopoly model we let a general number of two different types of firms operate in the industry. As the number of firms in the industry increases or as the expected response of the rivals becomes more aggressive, results get closer to what the Law of One Price predicts.

* I want to thank Christopher Bliss, Ramón Caminal and participants in the ASSET 1992 Meeting, Toulouse, November 1992, in the Seminario de Economía, Universidad Carlos III, Madrid, and in the VIII Jornadas de Economía Industrial, Madrid, September, 1992 for helpful comments and suggestions. Most especially I want to thank Stephen Martin for his encouragement and discussions. Any remaining errors and omissions are solely my responsibility.

1. Introduction

The Law of One Price states that there is perfect arbitrage in commodity trade and that price differentials between homogeneous products in different countries reflect only the existing barriers to trade and the exchange rate. Empirical studies in international trade flows do not, in the short and medium term, support this theory of price behavior (Kravis and Lipsey, 1977; Krugman, 1988)[1]. The main line of criticism regards the perfect competition assumption of the theory. If the Law of One Price were to hold, the pass-through relationship, that is, the way domestic prices change with exchange rate movements, would be one-to-one. This would require that an exchange rate devaluation of the importing country's currency result in a fall of the imported quantity that would in turn drive the equilibrium price of the imported good down in exact proportion to the fall in the exchange rate. The direct implication for the exchange rate pass-through is that we should observe a one-to-one relationship between any change in the exchange rate and the domestic price of the imported good.

It has been empirically found, though, that the pass-through relationship, tested for different levels of aggregation, is not equal to one (the absolute version of the Law of One Price) and is not constant over time (the relative version of the Law). Not only are exchange rate changes not reflected one-to-one in the domestic prices of imported goods, but evidence has also been found that changes in certain variables are passed on incompletely into domestic prices. Feenstra (1988) has studied the pass-through of exchange rates on the one side, and of import tariffs on the other, and found that the way that tariffs and exchange rates were passed into the domestic import price had similar lag structures.

The empirical observation that import prices adjust incompletely to exchange rate changes gives support to the hypothesis of imperfect competition in international trade. In fact in the last three decades the

[1] In both articles the main objective was to test the relative version of the Purchasing Power Parity doctrine.

greatest growth in international trade has taken place in intra-industry trade, i.e. international trade in imperfectly competitive markets where the interactions among firms influence the behavior of prices and quantities traded. In a seminal article Dornbusch (1987) proposed the introduction of models of imperfect competition, coming from the industrial economics literature, to explain pricing behavior in international markets. In the rest of the paper I follow this tradition and extend some basic results, by introducing a specific form of uncertainty in order to study price adjustment when different types of imperfect competition are assumed.

2. An oligopoly model of trade with uncertainty and risk averse firms

2.1. Context and scope

The literature on the pass-through relationship has had a short but intense life. Dornbusch (1987) introduced the idea of analyzing the behavior of prices at a disaggregated level when the exchange rate fluctuates by introducing various forms of imperfect competition in the markets, linking in this way two literatures: that of Industrial Organization (IO) and of international trade. Afterwards, Bertola (1987), Mann (1989), and Knetter (1990) used the IO framework to study the behavior of prices in international markets. Krugman (1987) applied a general Cournot oligopoly model to explain the "pricing to the market" policy and the price differentials between different countries of the same good. Giovannini (1987) explained deviations from Purchasing Power Parity with the introduction of three elements: (1) exchange rate surprises, (2) price-staggering and (3) ex-ante price discrimination. In order to study the price discrimination element we need to use models of imperfect competition. Mann (1989), using a general specification of demand functions and modelling exchange rate uncertainty with the first two moments of the distribution of exchange rate changes, introduced the idea that risk aversion on the part of the firms as well as of consumers matters. In this section I start from the general specification used by Mann (1989) and extend it in a number of ways. In Sections 1 and 2, specific linear demands for the case of quantity setting firms are introduced, a general number of firms is modelled allowing two different types of rivals that might have different strategic behaviors: exporters and domestic producers. A special form of product differentiation is introduced: goods produced in different locations (i.e. countries) are regarded by consumers as different varieties of the same good . The conjectural variations approach is used in Section 3 to study different types of competition assumed by each rival and their implications for the pass-through relationship: the adjustment in prices and quantities traded after exchange rate uncertainty is introduced. Finally in Section 4 I study the difference between economic exposure and exchange rate pass-through in the context of international oligopolies.

2.2 The invoicing currency, the source of risk and exchange rate the pass-through

Before setting out the model, we need to specify the source of risk. Given that exporters make an ex-ante decision, i.e., they set the price (or the quantity) before the exchange rate is known, each firm has the choice of invoicing its contracts on its own currency or in the destination market's currency. If the (say, German) exporter quotes the price of the goods in the foreign (destination, i.e. the US) country's currency then it will be facing a "price risk", since the final price, or unit revenues, will depend on the realization of the exchange rate[2]. In this case the equilibrium price will be affected by the relative risk aversion of the exporter, since it is the exporter who faces an uncertain home currency price (in DM). On the other hand if the exporter invoices the contracts in its home country's currency then he will face a "quantity risk" because the final demand will depend on the realization of the exchange rate. In this case the final destination market price (in US$) is uncertain and the consumer's risk aversion matters as well.

When uncertainty is introduced in an oligopoly model the choice of the strategic variable has two main implications: (a) it affects expected profits, and (b) the choice of the strategic variable together with the invoicing currency of the contract determine the source of risk of the firm. Klemperer and Mayer (1986) have shown that if an additive demand shock is introduced in an oligopoly model, the firm

[2] The distinction in the invoicing currency is based on Mann (1989).

will be better off if it chooses quantities rather than prices as the strategic variable when there are decreasing returns to scale and should choose prices when there are increasing returns to scale. If there are constant marginal costs, both strategic variables yield the same expected profits. Furthermore, the choice of strategic variable affects the source of risk for the firm. If competition is of the Cournot type, the firm faces random unit revenues, as will happen if Bertrand competition is assumed and the firm quotes its prices in the destination market's currency. Table I gives a summary of the interactions between these three elements.

To model exchange rate uncertainty I introduce a stochastic multiplicative shock into the export (foreign) demand for the oligopolist in the lognormal form:

$$E = \mu e^{\sigma\varepsilon} \qquad (1)$$

with $\varepsilon \sim (0,1)$

Table I: the choice of the strategic variable, the invoicing currency and the source of risk(P and P* are the home and foreign currency denominated prices respectively)

Strategic variable	Invoicing currency	Uncertainty
Prices	foreign	P (unit revenues)
	domestic	Quantity (P*)
Quantities		P (unit revenues)

The exchange rate e includes a stochastic shock, has mean μ and constant variance σ^2. The disturbance term ε is white noise. By using a Taylor series expansion[3] it is possible to obtain the approximation

[3] Expanding the random distribution around the mean value $\mu = 0$, applying the substitution theorem and checking that the series converges to zero after the third term in the expansion, we obtain the approximation.

$$E = \mu e^{\sigma\varepsilon} \approx \mu (1 + \sigma \varepsilon)$$

that can be used directly in the demand function[4].

There are two types of firms: (1) n_1 exporters, firms based in country h that export to market f (denoted by the subscript i), and (2) n_2 domestic producers (denoted by j); firms based in country f that produce only for home consumption.

In the case of price or unit revenues risk faced by the exporter and when the perceived (inverse) demand curve in the destination market is assumed to be linear, we have

$$P^i_{hf} = \alpha - \beta \left(\sum_{i=1}^{n_1} x^i_{hf} + \omega \sum_{j=1}^{n_2} x^j_{ff} \right) \qquad i = 1,\ldots n_1 \qquad (3.a)$$

$$P^j_{ff} = \alpha - \beta \left(\sum_{j=1}^{n_2} x^j_{ff} + \omega \sum_{i=1}^{n_1} x^i_{hf} \right) \qquad j = 1,\ldots n_2 \qquad (3.b)$$

where α is the demand intercept, β is the slope of the (inverse) demand curve and ω is the degree of product differentiation between the h-country and the f-country varieties ($0 < \omega < 1$). If $\omega = 0$, h-country and f-country varieties are independent in demand. When $\omega = 1$, they are perfect substitutes. An implication of the demand system (3.a) and (3.b) is that h-country varieties are perfect substitutes one for another and likewise for f-country varieties.

2.3. An international oligopoly model with risk averse firms

We assume that each firm is risk averse, which we model with the use of an objective function that has two parts: the expectation of profits minus a loss function that depends on the degree of risk aversion of the exporter,

---

4 The approximation is valid only for a certain range of the parameters of the distribution, which is equivalent to working with small values of the variance of the random distribution. This approximation allows us to linearize the multiplicative random demand shock and simplifies greatly the algebra afterwards.

$$\max_{x_{hh},\, x_{hf}} \quad \Gamma = E(\Pi^i) - \delta\sqrt{Var(\Pi^i)} \qquad (4)$$

where x_{hh} and x_{hf} is production for the home and the export (foreign) market respectively, and δ is the Arrow-Pratt measure of (absolute) risk aversion, $\delta = u(\Pi)''/u'(\Pi)$. E(.) and Var(.) are the expectations and the variance operators. Our cost function is of the form: $C_i(x_{hf}+x_{ff}) = c\, x_{hf} + c\, x_{ff}$. By assuming constant returns to scale and Cournot competition we are in fact segmenting the home and the export markets: each firm takes two output decisions, one for each market. That is, the firm sees each country as a different market and there is no arbitrage among markets. This *separation property* has important implications[5]. The firm also is able to choose the strategic variable it wants to set in each market.

With constant marginal costs, the profits for firm 1 of country h in the export market (f) are[6]

$$\Pi^i_{hf} = \left[\alpha - \beta\left(\sum_{i=1}^{n_1} x^i_{hf} + \omega \sum_{j=1}^{n_2} x^j_{ff}\right)\right] \mu(1+\sigma\varepsilon)\, x^1_{hf} - c\, x^1_{hf} \qquad (5)$$

Profits are measured in units of the h-country currency. Substituting these expressions into the objective function (4), and maximizing we obtain the first order conditions for each firm, which in turn yield the firm's reaction functions, one for each market. We can solve the system of reaction functions and finally obtain the Nash-Cournot equilibrium.

In equilibrium, all exporting firms will produce the same output and all domestic firms will produce the same output. Imposing this symmetry on the reaction functions, we obtain a system of condensed

---

5 This property depends on the particular form of the pay-off function, even though in our context this is implied by the constant marginal costs together with the Cournot behavioral assumptions.

6 The first subscript (i = f,h) denoting the country of origin (and production) and second subscript (j = h,f) indexes the destination country.

reaction functions that can be solved for equilibrium outputs in market f:

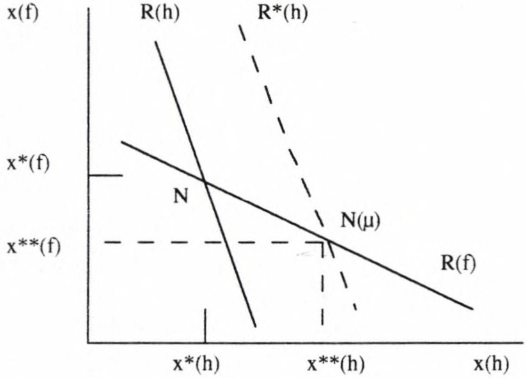
$$\begin{pmatrix} n_1+1 & \omega\, n_2 \\ \omega\, n_1 & n_2+1 \end{pmatrix} \begin{pmatrix} x^i_{hf} \\ x^j_{ff} \end{pmatrix} = \begin{pmatrix} \alpha - z \\ \alpha - c^* \end{pmatrix} \qquad (6)$$

where $$z(c,\mu,\sigma) = \frac{c}{\mu(1-\delta\sigma)}$$

When $n_1 = 1$ and $n_2 = 1$, we have the special case of duopoly, one exporter and one domestic producer. This is illustrated in Figure 1, for the case of perfect substitutes (ω=1) in Figure 1.

Initially the Nash-Cournot equilibrium is depicted in Figure 1 in N where the reaction functions R(h) and R(f) cross. After an appreciation of the destination market's currency, the reaction function of the exporter, R(h), shifts north-east in proportion to [(c/(2β)], to R*(h) and the reaction function of the domestic producers stays where it was, at R(f). The new Nash-Cournot equilibrium lies at N(μ), where the exporter produces a higher output, (x**(h) > x*(h)) and the domestic producer reduces the optimal production plan (x**(f) < x*(f)). Even though the domestic firm does not directly face exchange rate uncertainty, its equilibrium quantity traded does change after an appreciation of its currency.

Figure 1: an appreciation of the foreign market currency and the Nash-Cournot equilibrium



Solving (6) simultaneously, we obtain the Nash equilibrium outputs. These are the noncooperative equilibrium best response outputs for h-firms and f-firms. For the representative exporter, x_{hf}^{i} , we obtain the Nash-Cournot equilibrium quantity

$$x_{hf}^{i} = \frac{\alpha[1 + n_2(1-\omega)] + c^*\omega\, n_2 - (n_2+1)\, z}{\beta\left[N + 1 + n_1 n_2 (1-\omega^2)\right]} \qquad (7)$$

where $N = n_1 + n_2$ and c^* and $z = (c/\mu(1-\delta\sigma))$ are the marginal costs schedules for the two types of firms: constant schedule for the home producer and a function of the first two moments of the random distribution for the exporter.

If we allow for different values of the risk aversion coefficient of each firm, or for the value of the first two moments of the distribution of exchange rate changes to differ among countries, equilibrium prices will differ among the two markets. This is not price discrimination policy by the firm, but the result of ruling out arbitrage among the different markets where the firm operates and the fact that each firm is facing different elasticities of demand in each market.

This result, called *pricing to the market* by Krugman (1987), Knetter (1989, 1991) and Mann (1989) is a direct implication of the segmented markets hypothesis in an oligopolistic model. We can see this result from the first order condition of the representative exporter when it faces the shipping decision: how much quantity to send to each market (its home one, h, or the destination market, f).

The equilibrium prices, in terms of deviations from marginal costs, are:

$$P^{i}_{hf} - z = \frac{(1+n_2)(\alpha - z) - \omega\, n_2(\alpha - c^*)}{A} \qquad (8.a)$$

and $$P^{j}_{ff} - c^* = \frac{(1+n_1)(\alpha - c^*) - \omega\, n_1(\alpha - z)}{A} \qquad (8.b)$$

where $A = N + 1 + n_1 n_2(1 - \omega^2)$.

From equation (7) we can see that the first two moments of the exchange rate distribution (μ, σ) affect the equilibrium as expected: the variance (σ^2) and the absolute risk aversion coefficient (δ) negatively affect the quantity sold by each firm facing the shock. The uncertainty as represented by the first two moments, *has an asymmetric effect in the optimal strategy of each type of firm*, affecting in opposite directions the equilibrium quantities traded: the exporter increases the quantity traded after a unit increase in μ, and the domestic producer reduces the quantity of equilibrium but in smaller amount than the initial increase in the exporter's quantity.

To reach an expression for the pass-through relationship (in prices) we notice that the moments of the random distribution affect the equilibrium quantity and price via the random marginal costs schedule of the exporter, $z(c, \mu, \sigma)$. From the Nash equilibrium price of the industry, we compute

$$\left(\frac{\partial P_{hf}}{\partial \mu}\right) = \left(\frac{\partial P_{hf}}{\partial z}\right)\left(\frac{\partial z}{\partial \mu}\right) \qquad (9)$$

In our case we have linear demands and cost schedules, and we find that $(\partial P_{hf}/\partial z) > 0$ and $(\partial z/\partial \mu) < 0$, so that the pass-through relationship is negative. In terms of the parameters of the model, we evaluate expression (9)

$$\frac{\partial P_{hf}}{\partial \mu} = \frac{-z}{\mu}\left(\frac{B}{n_2 + 1 + B}\right) < 0$$

where $B = n_1 + n_1 n_2 (1 - \omega^2)$. The pass-through has a negative sign because it reflects the effect on the domestic price of a unit increase in the mean of the exchange rate (i.e. an appreciation of the destination market's currency), and hence it models a positive shock for the exporter.

There are two different effects when an appreciation (or devaluation) occurs: (1) a *substitution effect*: the market becomes more (less) attractive due to the reduction in the marginal costs schedule. We can directly see this effect in the Nash-Cournot equilibrium, by differentiating the equilibrium quantity with respect to μ and checking the resulting expressions are positive; and the (2) "income effect"[7] or rather *a decreasing risk aversion effect*: the increment(decline) in demand in home currency units makes the firm increase (decrease) its quantity sold to the foreign market and it will be willing to take up more risk. This amounts to a movement north-east along the concave utility function of the firm. The further from the origin, along the utility function, the smaller the relative risk aversion coefficient for the firm.

3. The pass-through relationship and market structure

The pass-through relationship in prices, i.e. the way the import domestic price changes with changes in the exchange rate, can be derived from the Nash equilibrium. We can decompose the pass-through in two parts: the *pass-through for the expected value of the exchange rate (μ)*:

$$\frac{\partial P_{hf}}{\partial \mu} = \frac{-z}{\mu} \eta \qquad (10)$$

---

7 As Katz, Paroush and Kahana called it.

and the *pass-through for the volatility* part of the exchange rate (σ)

$$\frac{\partial P_{hf}}{\partial \sigma} = \frac{z\,\delta}{(1-\delta\sigma)^2}\; r_i \qquad (11)$$

where $r_i = (n_i/(n_1 + n_2 + 1))$ is the relative number of firms of type i in the industry. Both expressions are obtained for the case of perfect substitutability among the varieties in trade (ω = 1). The pass-through of the volatility has the opposite sign as the one for the trend of the exchange rate because exporters we assumed are risk averse. The pass-through for the volatility depends on the degree of risk aversion of the firms (δ): this expression reflects the way that an oligopolies will pass into the final equilibrium price the increased volatility in exchange rates.

Proposition 1: *an increase in the expected value of the exchange rate (i.e. in μ) causes a decrease in the (Nash-Cournot) equilibrium price of the industry. The reduction in the equilibrium price (i.e. the pass-through relationship) is an increasing function of the level of marginal costs and a decreasing function of the total number of firms in the industry(N). Since we distinguish between exporters (n_1) and domestic producers(n_2), we can conclude also that the higher the number of exporters, the higher the pass-through will be.*

To show the first part of this proposition, we just check the two effects working in the determination of the pass-through relationship: (1) the effect of a higher expected exchange rate in the marginal cost schedule, $(\partial z/\partial \mu)$, and (2) the effect of a change in the marginal cost schedule on the equilibrium price, $(\partial P_{hf}/\partial z)$. The total effect is $(\partial P/\partial \mu) = (\partial P/\partial z)(\partial z/\partial \mu)$. We have that, in our case with linear schedules, $(\partial P/\partial z) > 0$, which together with $(\partial z/\partial \mu) < 0$ implies that $(\partial P/\partial \mu) < 0$.

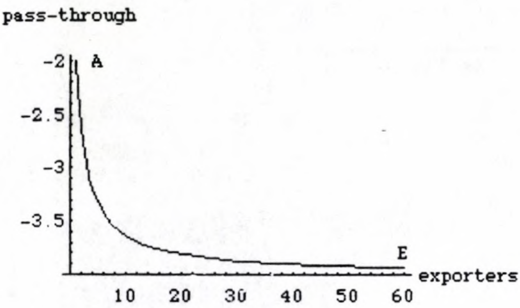
The reduction in the equilibrium price will be bigger the higher the number of exporters in the industry relative to home producers. We want to compute, $(\partial/\partial n_1)*(\partial P/\partial \mu)$, which we decompose into, $(\partial/\partial n_1)*(\partial P/\partial z)*(\partial z/\partial \mu)$. We obtain that, $(\partial/\partial n_1)*(\partial P/\partial z) < 0$, and $(\partial z/\partial \mu) < 0$, so that the total second derivative is defined only for positive values .

The relative number of each type of firm (whether exporters or home producers) determines the degree of the pass-through relationship. We have two different effects working in the opposite direction depending on whether we increase the number of exporters (n_1) or the number of domestic producers (n_2) in the destination market.

If we include only one exporter ($n_1 = 1$, $n_2 = 0$, and $r_1 = 1/2$), we obtain the monopoly pass-through, which takes the value (c/2). As we increase the number of exporters (n_1) (keeping constant the number of home producers), the pass-through increases with n_1 and the upper limit of the pass-through is the level of marginal cost (c). Increasing the number of home producers (n_2) drives the pass-through to zero. Clearly then, as we increase the number of rivals that don't face directly the exchange rate uncertainty relative to the number of exporters, the impact of exchange rate changes will be smaller in the industry equilibrium.

In Figures 2 and 3, the pass-through relationship ($\partial P/\partial \mu$) is shown when both the number of exporters and the number of domestic producers increases. In the vertical axis we draw the pass-through values, and these two figures are drawn for the following parameter values: $c = 4$, $\beta = 0.5$. Two different schedules are obtained: the first one, AE, is the adjustment of the industry price when the number of exporters is let to increase (from 1 to 30), keeping the number of domestic rivals fixed(at 1). In Figure 3 the schedule AD describes the pass-through relationship when the number of domestic producers is allowed to vary.

Figure 2: the pass-through when the number of exporters increases, when $c = 4, \mu = 1, \sigma = 0$ and $n_2 = 0$, where $N = n_1 + n_2$.

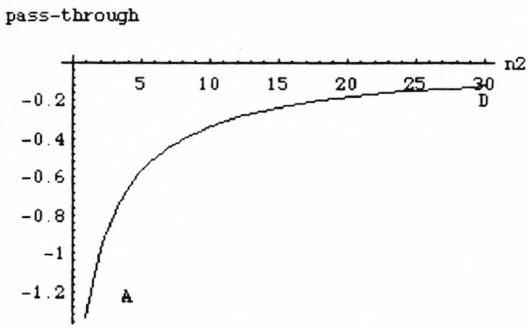


In the schedule AE, *as the number of exporters* (n_1) *increases, the reduction in the industry price* due to the positive shock of the exchange rate *increases as well*, until it reaches the level of marginal costs (set at 4). The pass-through is shown to be negative in this case, because a unit increase in μ is a positive shock (i.e. an appreciation of the foreign market's currency) for the exporter and this drives the price closer to marginal cost level.

The schedule AD, in Figure 3, shows how the pass-through decreases with increasing number of domestic producers (n_2), until it approaches zero(keeping $n_1 = 1$).

Hence with Cournot competition the pass-through relationship will be determined by the absolute number of each type of firms in the industry as well as by the relation exporters/home producers in the industry: home producers tend to reduce the influence of exogenous exchange rate changes into the domestic price level, and foreign producers tend to increase the pass-through in the equilibrium price.

Figure 3: the pass-through when the number of domestic producers increases(n_2), when $n_1 = 1$, $c = 4$, $\mu = 1$, $\sigma = 0$.



From the equilibrium quantity traded for each firm, by taking the partial derivative with respect the expected value of the exchange rate (μ), we obtain the pass-through in quantities, at the Nash-Cournot equilibrium, of a unit change in the equilibrium exchange rate. Calling $r_2 = (n_2)/(N+1)$, i.e. the relative number of home producers, and assuming for now that $\omega = 1$, we have

$$\frac{\partial x^i_{hf}}{\partial \mu} = \left(\frac{\partial x^i_{hf}}{\partial z}\right)\left(\frac{\partial z}{\partial \mu}\right) = \frac{z}{\beta \mu}\left(r_2 + \frac{1}{N+1}\right) \qquad (12)$$

which is the optimal pass-through in quantities for the exporting firm after a unit change in the expected exchange rate value, evaluated at the Nash equilibrium. Three variables are relevant in explaining the pass-through in quantities: (1) *market structure*: (the second term in (12)), i.e. the relative number of domestic firms in the industry and the inverse of the total size of the market; the higher the number of domestic rivals, the smaller the perceived elasticity of demand for each firm in the industry: the pass-through, then, will be smaller; (2) *the level of marginal costs* (c), which determines the upper limit of the pass-through when the number of exporters goes to infinity, and (3) the

---

Table II: the pass-through (Pt) for (μ,σ^2) in the Nash equilibrium of the industry with different market structures, when $\omega=1$ and i=h,f.

Pt for the expected value	for the volatility
$\left.\frac{\partial P}{\partial \mu}\right\|_{\substack{\mu=1\\ \sigma^2=0}} = -c\, r_1$	$\left.\frac{\partial P}{\partial \sigma^2}\right\|_{\substack{\sigma^2=1\\ \mu=1}} = \frac{c\,\delta}{(\delta-1)^2} r_1$
$\left.\frac{\partial x_{hf}}{\partial \mu}\right\|_{\substack{\mu=1\\ \sigma^2=0}} = \frac{c}{\beta}\left(r_2 + \frac{1}{N+1}\right)$	$\left.\frac{\partial x_{hf}}{\partial \sigma^2}\right\|_{\substack{\sigma^2=1\\ \mu=1}} = \frac{-c\,\delta}{\beta\,(\delta-1)^2}\left(r_2 + \frac{1}{N+1}\right)$
$\left.\frac{\partial x_{ff}}{\partial \mu}\right\|_{\substack{\mu=1\\ \sigma^2=0}} = \frac{-c}{\beta}\, r_1$	$\left.\frac{\partial x_{ff}}{\partial \sigma^2}\right\|_{\substack{\sigma^2=1\\ \mu=1}} = \frac{c\,\delta}{\beta\,(\delta-1)^2}\, r_1$

Since we are in a quantity setting model, the individual adjustment takes place via quantities. From expression (12) we saw that the adjustment in quantities for each firm is a decreasing function of the number of exporters and an inverse function of the number of domestic rivals. The picture we obtain, Figure 4, graphs the opposite adjustment to that obtained when studying the pass-through in prices (Figures 3 and 4). Graphing on the horizontal axis the number of exporters and of home producers (n_1, n_2), the schedule BE describes the pass-through in quantities when the number of domestic rivals is fixed at 1, and the number of exporters is let to increase, that is, it is the limit as

$$\lim_{n_1 \to \infty} \left(\frac{\partial x_{hf}}{\partial \mu} \right) = 0$$

The individual pass-through is a decreasing function on the number of exporters. The schedule BD, on the other hand, describes the individual adjustment in quantities by the representative exporter when the number of domestic rivals increases (and the number of exporters is fixed, $n_1 = 1$):

elasticity of demand and the degree of substitutability of the varieties in trade (ω).

Proposition 2: *an increase in the expected (equilibrium) exchange rate μ will cause the exporter to increase the optimal quantity sold in the destination market in proportion to the ratio (c/β). The optimal adjustment depends directly on the relative number of domestic rivals (r_2) in the industry.*

We have that at the Nash equilibrium, $x_{hf}(n_1,n_2,z(.))$, so that a change in the expected exchange rate affects the optimal quantity traded via the marginal costs term $z(.)$. We need to find the sign of $(\partial x_{hf}/\partial \mu)$, and we can divide this expression into two terms, $(\partial x_{hf}/\partial z)$ and $(\partial z/\partial \mu)$. It is easy to find that, $(\partial z/\partial \mu) < 0$, and that $(\partial x_{hf}/\partial z) < 0$, so that $(\partial x_{hf}/\partial \mu) > 0$. Applying the chain rule we can compute the sign of $(\partial/\partial n_2)*(\partial x_{hf}/\partial \mu)$, and obtain that the second derivative is positive which tells us that the higher the relative number of domestic rivals in the industry (r_2), the higher also the individual pass-through in quantities for each exporter will be.

Developing the analysis in the opposite market (the home one), it is easy to see that the prices (expressed in a common currency) of the same variety in both markets will differ[8].

Proposition 3: *a unit increase in the volatility of the exchange rate (in, σ), leads to an increase in the equilibrium price and a decrease in total quantity traded in the industry (see Appendix).*

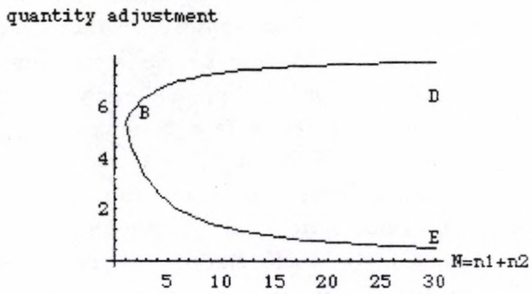
In Table II, expressions for the two measures of the pass-through relationship are given in terms of the first two moments of the distribution of the exchange rate changes and of the market structure variables.

8 Different optimal quantities sold in each market can lead also to different equilibrium prices, even though other market structure variables might be identical in both locations. This would be understood as "pricing to the market" and not as price discrimination. For empirical tests on this, see Knetter (1991).

$$\lim_{n_2 \to \infty} \left(\frac{\partial x_{hf}}{\partial \mu} \right) = \frac{c}{\beta}$$

The pass-through is an increasing function of the number of domestic producers due to the no entry/exit in the industry hypothesis.

Figure 4: the pass-through in quantities when the number of exporters and the number of domestic rivals increase (for $c = 4$, $\omega = 1$ and $\beta = 0.5$)



So far we have seen how market structure variables and the risk aversion on the part of the exporters influence the adjustment of prices an quantities to exogenous shocks. The other determinant of this adjustment comes next: it is the expected type of competition to be played by the rivals.

4. The pass-through relationship under different types of competition

In order to study the sensitivity of the pass-through relationship with respect to different types of competition played by the firms we introduce next conjectural variations parameters. We develop in the section the approach for the case of homogeneous goods with an indeterminate number of two different types of competitors in the industry: the home producers and the exporters. We find that under Cournot competition, the higher the number of firms in the industry, the closer the pass-through will tend to the competitive outcome, i.e. the Law of One Price. Bertrand conjectures imply a constant and more competitive price adjustment than Cournot conjectures for any market structure and the collusive case shows important implications for price adjustment when exchange rate uncertainty.

The idea with the conjectural variations approach is to capture the indirect effect of a change in one firm's strategic variable on the rival's strategic variable level with a parameter that enters the first order condition of the representative exporter. Call the conjectural parameter $\lambda_i = (\partial x_{ff}^j / \partial x_{hf}^i)$.; it reflects the way the rival (firm j in market f) reacts to a change of the firm's (firm i in market f) strategic variable, x_{hf}^i. With the conjectural variations approach we can model different aggressiveness in the expected response of the other firms in the industry (i.e. collusion among one type of firm) not easily modelled otherwise. The representative exporter faces a foreign inverse demand curve: $P_{hf}(x,x) = P^*_{hf}(x_{hf},x_{ff})E$, where E is the bilateral exchange rate. The firm maximizes profits in each market, the home and the foreign one, and because of constant returns to scale technology, it can separate the optimization problem in each market. In the foreign market (subscript f) its profit function can be expressed as: $\Pi_{hf}^i(x_{hf},x_{ff}) = P_{hf}(x_{hf},x_{ff})\, x_{hf}^i\, E - C_i(x_{hf})$. If we introduce, as before, the possibility of risk averse firms, we can use the objective function in (4). Substituting the profit expression into (4) we arrive at the first order conditions for the exporter as

$$[n_1 + 1 + (n_1 - 1)\lambda + \omega\, n_2\, k]\, x_{hf} + \omega\, n_2\, x_{ff} = \frac{\alpha - z(\mu,\sigma)}{\beta} \qquad (13.a)$$

$$\omega\, n_1\, x_{hf} + [n_2 + 1 + (n_2 - 1)\lambda + \omega\, n_2\, k]\, x_{ff} = \frac{\alpha - c^*}{\beta} \qquad (13.b)$$

where $\lambda = (\partial x_{hf}^k / \partial x_{hf}^i)$ and $k = (\partial x_{ff}^j / \partial x_{hf}^i)$ are the conjectural variation parameters that reflect the belief of firm i of country h with respect the expected response of its rivals (those of the exporters and the domestic firms, respectively) in the foreign market(indexed by f). We let this parameter to vary across firms.

From the first order conditions we obtain the reaction curves for each firm in each market. Solving them yields the Nash equilibrium from which we can derive expressions for the pass-through relationship under different conjectures. We consider the following type of beliefs on the part of the firms:

a. when $\lambda=0$ that reflects the *Cournot conjecture*: each firm assumes that its rivals will not react to any change in its own strategic variable so that the indirect effect term is equal to zero. We can see in expression (15) that the Cournot behavioral assumption implies that the additional term in λ is equal to zero, and the first order conditions now become the same as in the case we studied before in Section 2.

b. when $\lambda=1$, the *collusive conjecture*: which reflects the belief of the part of the firm that market share matters, since each change in its own strategic variable is believed to be matched by the rivals. The indirect (or strategic) effect here is at its maximum. With this conjecture the firm believes that it can affect total industry output but not its on market share.

c. when $\lambda= -1$, that represents *Bertrand conjectures*, in that it resembles the price competition case. Each change in the strategic variable will be matched by the rival. This conjecture makes sense if we think of the firms as competing in prices. When linear demands and constant marginal costs, Bertrand conjectures are also consistent conjectures, in that this conjecture is equivalent to the optimal response of the rivals at the equilibrium defined by the conjecture itself[9].

[9] Whereas Cournot and the collusive conjectures are not consistent conjectural equilibria, but we study them in order to gain insight into the different aggressiveness in the behavior that they imply. On consistent conjectural variations, see Bresnahan (1981).

Table III: the pass-through in prices and quantities with different conjectures ($\omega = 1$)

Pass-through:	Cournot	Bertrand	Collusion
$\left.\frac{\partial P}{\partial \mu}\right\|_{\substack{\mu=1 \\ \sigma^2=0}} =$	$-c\, r_1$	$\frac{-c}{2}\, n_1$	$\frac{-c}{2}\left(\frac{n_1}{N}\right)$
$\left.\frac{\partial x_{hf}}{\partial \mu}\right\|_{\substack{\mu=1 \\ \sigma^2=0}} =$	$\frac{c}{\beta}\left(r_2 + \frac{1}{N+1}\right)$	$\frac{c}{2\beta}\left(\frac{n_1-2}{N-2}\right)$	$\frac{c}{2\beta N}\left(1+\frac{n_2}{N}\right)$

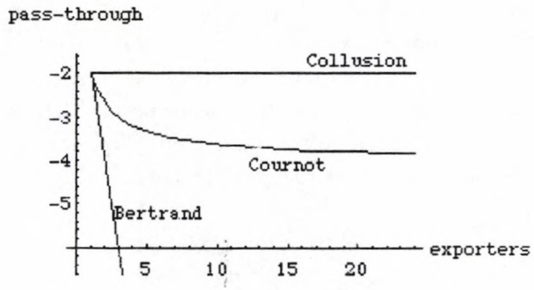
So far we have introduced a general (but fixed) number of rivals in both markets (the domestic and the foreign one). When free entry is allowed only the competitive behavior (i.e. conjecture) will be a consistent conjectural equilibrium. We focus here only on the three conjectures mentioned above when the number of exporters and of domestic rivals is fixed (but can be very large).

4.1 The pass-through relationship

In Figure 5 the different pass-through elasticities are graphed. The picture is drawn for the special case when goods are perfect substitutes, no domestic producers ($n_2 = 0$) and constant marginal costs schedules (for the graph fixed at the level $c = 4$). As the number of exporters increases, all three different adjustments in the equilibrium price tend towards the full pass-through, i.e. the equilibrium price in the industry will reflect the whole change in marginal costs due to the exchange rate movement, as under perfect competition.

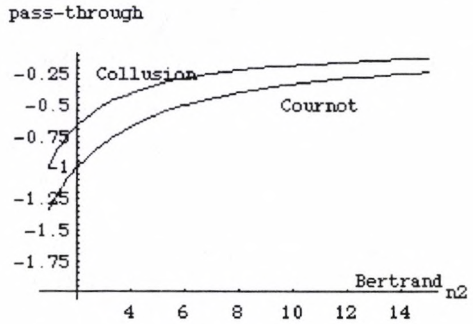
The picture changes as soon as we introduce a variable number of domestic rivals. Since domestic forms do not face directly the exchange rate changes, an increase in the number of domestic producers implies that in the limit the price adjustment to an exchange rate shock will be negligible, which is what happens with all of the different types of behavior modelled as the number of domestic firms increases.

Figure 5: the pass-through after a unit increase in the equilibrium exchange rate (c = 4, $n_2 = 0$ and $\omega = 1$)



From both Figures (5 and 6) we can see that the exchange rate adjustment depends on the relative number of the different types of firms in the industry. For all of the three conjectures introduced, exporters, on the one hand, tend to make the adjustment in prices closer to what the Law of One Price predicts (full pass-through), and domestic producers, on the other hand, tend to reduce the impact of exchange rate changes in the industry price.

Figure 6: the pass-through when the number of domestic rivals increases(n_1=1)



4.2. The adjustment in quantities

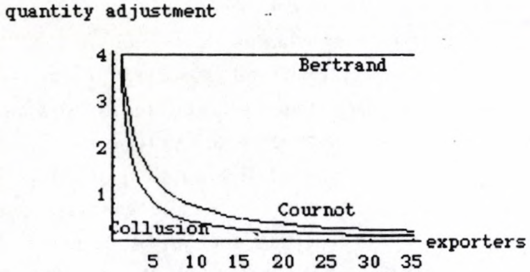
The other side of the adjustment process is the quantity pass-through. In Figure 7 is depicted the quantity adjustment with different aggressiveness in the expected response of the rivals. The constant pass-through corresponds to the Bertrand case, in which case it does not matter the number of exporters in the industry: the adjustment in quantities is constant and equal to the level of marginal costs ($c = 4$). This is the reflection of the more competitive behavior modelled with Bertrand beliefs: there is no strategic effect and each exporter behaves as under perfect competition. This can be interpreted as the Bertrand paradox in our context.

When no domestic rivals are incorporated we find that the collusive pass-through *declines faster* that the Cournot equilibrium price adjustment when the number of exporters increase. The reason for this is clear if we take into account the specific linear demands that we use: under collusion, and in order to keep the change in the equilibrium price constant (at $-c/2$), i.e. the same pass-through as under monopoly, the market share of each individual exporter must decline at a faster rate than under Cournot, and the individual mark-up (our measure of pass-through in quantities) decreases with an increasing number of exporters due to the fact that the demand elasticity increases with the export volume.

If we increase the number of domestic rivals ($n_2 > 0$) we find that now the relative number of each type of firm in the industry becomes the crucial determinant of the sign and degree of the pass-through elasticity when Bertrand and collusive beliefs are introduced, as shown in Figure 8.

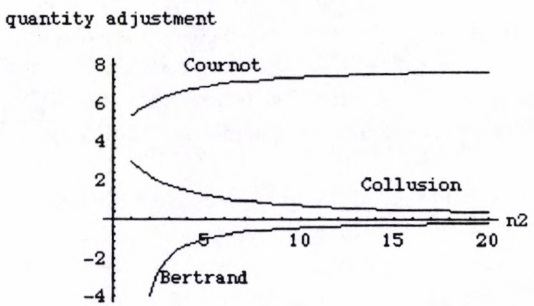
Under Cournot conjectures as the number of domestic producers (n_2) increases, the pass-through in quantities converges to zero, as happened also for the case when only exporters served the whole destination market. The interesting case is when Bertrand conjectures are introduced, since then the adjustment takes place in the negative quadrant (in Figure 8). If a unit increase in μ comes as a positive shock to the exporter, this can only be explained by the fact that under Bertrand conjectures the relative number of domestic producers determines the sign of the adjustment in quantities.

Figure 7: the adjustment in quantities when Bertrand, Cournot and collusive conjectures are held among the exporters (for the case when $c = 4$, $\omega = 1$, $\beta = 0.5$ and $n_2 = 0$)



In terms of expected competitive responses, Bertrand supposes a more aggressive behavior than Cournot and in turn this models a still more aggressive behavior than under the collusive conjecture.

Figure 8: quantity pass-through for different conjectures ($\omega = 1$, $\beta = 0.5$, $c = 4$ and $n_1 = 1$)



5. Exchange rate risk and economic exposure: the role of strategic behavior

When the exchange rate appreciates (increase in μ), there are two effects influencing the behavior of the foreign firm: (1) as the per unit price in foreign currency increases, the revenues increase as well for the exporter: the *direct effect*, and (2) after an appreciation, the exporter will change the quantity supplied to the destination market, and given that the goods are strategic substitutes, the home producer will reduce its market share. This *indirect effect* is the channel through which the home producer(s), even though it is not facing the exchange rate fluctuations directly, is affected also by them. To account for the two effects is crucial the assumption of strategic substitutes in determining the final equilibrium outcome of the industry. It is also easy to see that the higher the number of firms in the industry, the smaller this indirect effect will be. We can see these two effects in the following way: lets express the profit function of the exporter as, $\Pi_{hf}(x_{hf}) = \Pi(x_{hf}(e), x_{ff}(x_{hf}))$, that is, the optimal quantity shipped to the export market depends on the exchange rate (e). We can now express the first order condition as

$$\left(\frac{\partial \Pi^i_{hf}}{\partial e}\right) = \underbrace{\left(\frac{\partial \Pi^i_{hf}}{\partial e}\right)}_{A} + \underbrace{\left(\sum_{j=1}^{n_2} \frac{\partial \Pi^i_{hf}}{\partial x^j_{ff}}\right)}_{B} \underbrace{(k)}_{C} \underbrace{\left(\frac{\partial x^i_{hf}}{\partial e}\right)}_{D}$$

A > 0 is the direct effect, and BCD the indirect effect. Since the goods are strategic substitutes, we have that B < 0, since ex-post, C $(k = (\partial x_{ff}/\partial x_{hf})) < 0$, and we know that D > 0 (an increase in e means an appreciation of the home currency), then we have that the indirect effect will be overall positive, which strengthens the direct positive effect in A.

It would be different if the goods were strategic complements: in which case the term in B will be bigger than zero, also C > 0, but $(\partial x_{hf}/\partial e) < 0$ and the overall effect will be negative. In fact, as Mishra and Sundaram (1989)[10] point out, for conjectures other than Cournot, the first order condition will be based on the total derivative of profits with respect to the quantity, rather than the partial derivative, which is enough in the Cournot case if we consider that the Cournot behavioral assumption implies that $[\partial x_{ff}/\partial x_{hf}] = C = 0$ and hence the

[10] For this point also Bulow, Geanakoplos and Klemperer (1985).

perceived marginal profit for firm i from reacting to the exchange rate change will consist of the direct effect alone, leaving BCD = 0.

The distinction between exchange rate risk and economic exposure now becomes clear: exchange rate risk implies a random unit revenue, due to the volatility in the export foreign price, and economic exposure is the effect that the variations in the unit price have on the equilibrium profits of the firm. In oligopoly, and because of the strategic interdependence among the firms, the exposure is higher than under perfect competition. The direct effect accounts for the exchange rate risk, in the profits level, that has a direct relationship with the price fluctuation. As long as the indirect effect, BCD >0, the economic exposure will be higher, than the direct effect alone.

In oligopoly the uncertainty affects the level of profits more than under perfect competition, and as the number of competitors tends to infinity, the indirect effect tends to zero, and the only remaining influence of the exchange rate change will be the direct one, $\partial\Pi/\partial e$. Von Weizsäcker and Von Ungern (1989)[11] have studied the optimal hedging policies for an oligopolist when facing exchange rate uncertainty. In a similar model they concluded that the hedging policy, defined only at the Nash-Cournot equilibrium and for the expected value of the exchange rate, will be of magnitude bigger than twice the Nash-Cournot quantity. The hedging in this model that each firm performs, is by selling(buying) foreign currency in the futures (perfect) market at an expected price.

6. Conclusions

In an international oligopolistic model with exchange rate uncertainty, we have seen how volatility can affect total amount of goods traded depending on the risk aversion attitude of the firms, the market structure and the degree of product differentiation of the varieties in trade.

In determining the sign and the degree of the pass-through relationship it is important to take account not only of market structure elements but also the more or less aggressive response expected from the rivals. We have shown how by increasing the number

---

[11]Von Weizsäcker and Von Ungern (1989).

of participants in the industry or by assuming a more aggressive response among the firms competing in an international market with uncertainty, results get closer to the Law of One Price.

More empirical evidence at a desegregated level is necessary in order to gain insight into other elements that might be influencing the behavior of international prices, and more specifically, the sluggishness in the response of prices to exchange rate movements in the short and medium term. Market structure variables, and types of competition can explain only part of this price inertia.

Appendix

*Derivation of the pass-through expressions

In our oligopoly model with the multiplicative shock in the demand functions, we defined the objective function of the risk averse exporter as

$$\max_{x_{hh},\, x_{hf}} \quad \Gamma = E(\Pi^{i}) - \delta\sqrt{Var(\Pi^{i})}$$

where we introduced in the quantity setting case a multiplicative random shock into the inverse linear demand functions facing each firm of the form

$$E = \mu e^{\sigma\varepsilon} \qquad \text{where} \quad \varepsilon - (0,1)$$

that we could approximate by Taylor expansion by

$$E = \mu\, e^{\sigma\varepsilon} \approx \mu\,(1+\sigma\varepsilon)$$

Our profit expression is,

$$\Pi^{i}_{hf} = \left[\alpha - \beta\left(\sum_{i=1}^{n_1} x^{i}_{hf} + \omega \sum_{j=1}^{n_2} x^{j}_{ff}\right)\right] \mu(1+\sigma\varepsilon)\, x^{1}_{hf} - c\, x^{1}_{hf}$$

Maximizing the objective function for each exporter and each domestic producer, we obtain a system of n1 + n2 first order conditions, as

$$x_{hf}\left[2 + \left(\frac{\partial \sum_{i=1}^{n_1-1} x_{hf}}{\partial x_{hf}}\right) + \omega\left(\frac{\partial \sum_{j=1}^{n_2} x_{ff}}{\partial x_{hf}}\right)\right]\beta = \alpha - \frac{c}{\mu(1-\delta\sigma)} - \beta \sum_{i=1}^{n_1-1} x_{hf} - \beta\,\omega \sum_{j=1}^{n_2} x_{ff}$$

From this system of first order conditions we obtain the reaction functions for each rival in terms of the domestic rivals and of the exporters.

We can now apply the symmetric firms hypothesis and get the condensed reaction functions, that is, a reaction function for the i-th exporter in terms only of the domestic rivals as

$$\begin{pmatrix} n_1+1+(n_1-1)\lambda+\omega\, n_2\, k & \omega\, n_2 \\ \omega\, n_1 & n_2+1+(n_2-1)\lambda+\omega\, n_1 k \end{pmatrix}\begin{pmatrix} x^i_{hf} \\ x^j_{ff} \end{pmatrix}=\begin{pmatrix} S_{hf} \\ S_{ff} \end{pmatrix}$$

where $\lambda = (\partial x_{hf}{}^k/\partial x_{hf}{}^i)$ and $k = (\partial x_{ff}{}^j/\partial x_{hf}{}^i)$, $S_{hf} = (\alpha-z)/\beta$, $S_{ff} = (\alpha-c^*)/\beta$, and $z = (c/(\mu(1-\delta\sigma))$. Let Det be the determinant of the matrix on the left hand side. Note that for $\lambda = k = 0$, and $\omega = 1$, Det = N + 1. From here by inverting the matrix on the left hand side and after some manipulation we find the Nash-Cournot equilibrium, x^*_{hf} and x^*_{ff} :

$$\begin{pmatrix} x^{i*}_{hf} \\ x^{j*}_{ff} \end{pmatrix}=\frac{1}{\beta\,\mathrm{Det}}\begin{pmatrix} [n_2+1+(n_2-1)\,\lambda+\omega\, n_1\, k][\alpha-z] & \omega\, n_2\,(\alpha-c^*) \\ [n_1+1+(n_1-1)\,\lambda+\omega\, n_2\, k][\alpha-c^*] & \omega\, n_1\,(\alpha-z) \end{pmatrix}$$

Writing the condensed reaction functions in terms of deviations from marginal costs,

$$\begin{pmatrix} P_{hf}-z \\ P_{ff}-c^* \end{pmatrix}=\beta\begin{pmatrix} S_{hf} \\ S_{ff} \end{pmatrix}-\beta\begin{pmatrix} n_1 & \omega\, n_2 \\ \omega\, n_1 & n_2 \end{pmatrix}\begin{pmatrix} x^*_{hf} \\ x^*_{ff} \end{pmatrix}$$

and substituting into the system (A.4) the Nash-Cournot equilibrium quantities, x^*_{hf} and x^*_{ff} obtained in (A.3), we finally get the market clearing prices, P^*_{hf} and P^*_{ff}. The expressions for equilibrium price are complex; they have been obtained with the help of the software Mathematica. As a special case, when $k = \lambda = 0$ (i.e. Cournot conjectures), we obtain

$$P^i_{hf} = \frac{\alpha\left[n_2(1-\omega)+1+\omega\, n_2\, c^* + z\, n_2\,(1+A)\right]}{N+1+n_1 A}$$

and $$P^j_{ff} = \frac{\alpha\left[n_1(1-\omega)+1+c^* n_2(1+A)+z\,\omega n_1\right]}{N+1+n_2 B}$$

where $A = n_2(1 - \omega^2)$ and $B = n_1(1 - \omega^2)$.

From the Nash equilibrium we can check that, $z = z(c,\mu,\sigma,\delta)$, $x_{i2} = x(c^*,z(.),n_1,n_2)$, and $P = P(n_1,n_2,z(.))$. Any change in any of the two moments of the random distribution affects the Nash equilibrium via z(.).

From the Nash equilibrium we can derive different expressions for the pass-through relationship, in prices or in quantities, by taking the appropriate derivative. After some manipulation we obtain expressions in Table IV. Second derivatives re used to get the speed of adjustment of the equilibrium price to exchange rate changes with respect to the market structure and the degree of product differentiation in the industry.

II. Proof of Proposition 3

As before, we just need to check that $(\partial P_{hf}/\partial z) > 0$, and that $(\partial z/\partial \sigma) > 0$, so that the total effect is positive, $(\partial P_{hf}/\partial \sigma) > 0$, for the first part. To prove that total quantity traded declines with more volatility, we have that $(\partial x_{hf}/\partial \sigma) < 0$ and that $(\partial x_{ff}/\partial \sigma) > 0$, and we only need to check that

$$\left|\frac{\partial x_{hf}}{\partial z}\right| > \left|\frac{\partial x_{ff}}{\partial z}\right|$$

which is true always since in our case this condition reduces to $[(n_2 + 1)/n_2] > 1$.

References

Bertola, Giuseppe, 1987 :"Short and long term reactions to exchange rate changes", mimeo, MIT.

Bresnahan,T. 1981 :"Duopoly models with consistent conjectures", *American Economic Review*, vol.71, Dec.no.5.

Dornbusch, R.1987 :"Exchange rates and prices", *American Economic Review*, vol. 77, no. 1, March.

Feenstra, R. 1987:"Symmetric pass-through of tariffs and exchange rates; an empirical test for the US industry", NBER Working Paper, no. 2453.

Giovannini, A. 1987, :"Exchange rates and traded goods prices", *Journal of International Economics*, February.

Katz, E., Paroush, J. and Kahana,N. 1982, :"Price uncertainty and the price discriminating firm in international trade", *International Economic Review*, vol. 23, no.2, June.

Klemperer, P. and Mayer, M. 1986:"Quantity vs. Price competition: the role of uncertainty", *Rand Journal of Economics*, Vol. 17, No. 4.

...................,Geanakoplos, J. and Bulow, J.:"Multimarket oligopoly: strategic complements and substitutes", *Journal of Political Economy*, vol. 93.

Knetter, M.1989, :"Price discrimination by US and German exporters", *American Economic Review*, Vol. 17, March.

..........., 1991, :"International comparisons of pricing to market behavior", Dartmouth College, Dept. of Economics Working Paper, no. 91/4, New Hampshire.

Kravis, I. and Lipsey, R. 1977 :"Export prices and exchange rates", NBER Working Paper, no. 182.

Krishna, K. 1990, :"Export Restraints with imperfect competition", NBER Working Paper, no. 324, January.

Mann, C. 1989:"The effects of exchange rate trends and volatility on export prices: industry examples from Japan, Germany and the US", Weltwirtschaftsliches Archiv/Review of World Economics, Heft 3, Band 125.

...............,1986 :"Prices, profit margins and exchange rates", *Federal Reserve Bulletin*, June.

Mishra, V. and Sundaram, A. 1989:" Exchange rate pass-through and economic exposure: a review", mimeo, Dartmouth College, Dept. of Economics, Hannover, NH.

Von Weizsäcker, C.C. and Von Ungern-Sternberg, T.1991: "Strategic foreign exchange management in oligopoly", *Journal of Industrial Economics*.

EUI
WORKING
PAPERS

EUI Working Papers are published and distributed by the
European University Institute, Florence

Copies can be obtained free of charge
– depending on the availability of stocks – from:

The Publications Officer
European University Institute
Badia Fiesolana
I-50016 San Domenico di Fiesole (FI)
Italy

Please use order form overleaf

Publications of the European University Institute

To The Publications Officer
European University Institute
Badia Fiesolana
I-50016 San Domenico di Fiesole (FI)
Italy

From Name . . . .
Address. . . . .
. . . .
. . . .
. . . .
. . . .

❒ Please send me a complete list of EUI Working Papers
❒ Please send me a complete list of EUI book publications
❒ Please send me the EUI brochure Academic Year 1993/94
❒ Please send me the EUI Research Report

Please send me the following EUI Working Paper(s):

No, Author . . . .
Title: . . . .
No, Author . . . .
Title: . . . .
No, Author . . . .
Title: . . . .
No, Author . . . .
Title: . . . .

Date . . . .

Signature . . . .

Working Papers of the Department of Economics Published since 1990

ECO No. 90/1
Tamer BASAR and Mark SALMON
Credibility and the Value of Information Transmission in a Model of Monetary Policy and Inflation

ECO No. 90/2
Horst UNGERER
The EMS – The First Ten Years
Policies – Developments – Evolution

ECO No. 90/3
Peter J. HAMMOND
Interpersonal Comparisons of Utility: Why and how they are and should be made

ECO No. 90/4
Peter J. HAMMOND
A Revelation Principle for (Boundedly) Bayesian Rationalizable Strategies

ECO No. 90/5
Peter J. HAMMOND
Independence of Irrelevant Interpersonal Comparisons

ECO No. 90/6
Hal R. VARIAN
A Solution to the Problem of Externalities and Public Goods when Agents are Well-Informed

ECO No. 90/7
Hal R. VARIAN
Sequential Provision of Public Goods

ECO No. 90/8
T. BRIANZA, L. PHLIPS and J.F. RICHARD
Futures Markets, Speculation and Monopoly Pricing

ECO No. 90/9
Anthony B. ATKINSON/ John MICKLEWRIGHT
Unemployment Compensation and Labour Market Transition: A Critical Review

ECO No. 90/10
Peter J. HAMMOND
The Role of Information in Economics

ECO No. 90/11
Nicos M. CHRISTODOULAKIS
Debt Dynamics in a Small Open Economy

ECO No. 90/12
Stephen C. SMITH
On the Economic Rationale for Codetermination Law

ECO No. 90/13
Elettra AGLIARDI
Learning by Doing and Market Structures

ECO No. 90/14
Peter J. HAMMOND
Intertemporal Objectives

ECO No. 90/15
Andrew EVANS/Stephen MARTIN
Socially Acceptable Distortion of Competition: EC Policy on State Aid

ECO No. 90/16
Stephen MARTIN
Fringe Size and Cartel Stability

ECO No. 90/17
John MICKLEWRIGHT
Why Do Less Than a Quarter of the Unemployed in Britain Receive Unemployment Insurance?

ECO No. 90/18
Mrudula A. PATEL
Optimal Life Cycle Saving With Borrowing Constraints: A Graphical Solution

ECO No. 90/19
Peter J. HAMMOND
Money Metric Measures of Individual and Social Welfare Allowing for Environmental Externalities

ECO No. 90/20
Louis PHLIPS/
Ronald M. HARSTAD
Oligopolistic Manipulation of Spot Markets and the Timing of Futures Market Speculation

* Working Paper out of print

ECO No. 90/21
Christian DUSTMANN
Earnings Adjustment of Temporary Migrants

ECO No. 90/22
John MICKLEWRIGHT
The Reform of Unemployment Compensation:
Choices for East and West

ECO No. 90/23
Joerg MAYER
U. S. Dollar and Deutschmark as Reserve Assets

ECO No. 90/24
Sheila MARNIE
Labour Market Reform in the USSR: Fact or Fiction?

ECO No. 90/25
Peter JENSEN/
Niels WESTERGÅRD-NIELSEN
Temporary Layoffs and the Duration of Unemployment: An Empirical Analysis

ECO No. 90/26
Stephan L. KALB
Market-Led Approaches to European Monetary Union in the Light of a Legal Restrictions Theory of Money

ECO No. 90/27
Robert J. WALDMANN
Implausible Results or Implausible Data? Anomalies in the Construction of Value Added Data and Implications for Estimates of Price-Cost Markups

ECO No. 90/28
Stephen MARTIN
Periodic Model Changes in Oligopoly

ECO No. 90/29
Nicos CHRISTODOULAKIS/
Martin WEALE
Imperfect Competition in an Open Economy

***

ECO No. 91/30
Steve ALPERN/Dennis J. SNOWER
Unemployment Through 'Learning From Experience'

ECO No. 91/31
David M. PRESCOTT/Thanasis STENGOS
Testing for Forecastible Nonlinear Dependence in Weekly Gold Rates of Return

ECO No. 91/32
Peter J. HAMMOND
Harsanyi's Utilitarian Theorem:
A Simpler Proof and Some Ethical Connotations

ECO No. 91/33
Anthony B. ATKINSON/
John MICKLEWRIGHT
Economic Transformation in Eastern Europe and the Distribution of Income*

ECO No. 91/34
Svend ALBAEK
On Nash and Stackelberg Equilibria when Costs are Private Information

ECO No. 91/35
Stephen MARTIN
Private and Social Incentives to Form R & D Joint Ventures

ECO No. 91/36
Louis PHLIPS
Manipulation of Crude Oil Futures

ECO No. 91/37
Xavier CALSAMIGLIA/Alan KIRMAN
A Unique Informationally Efficient and Decentralized Mechanism With Fair Outcomes

ECO No. 91/38
George S. ALOGOSKOUFIS/
Thanasis STENGOS
Testing for Nonlinear Dynamics in Historical Unemployment Series

ECO No. 91/39
Peter J. HAMMOND
The Moral Status of Profits and Other Rewards:
A Perspective From Modern Welfare Economics

* Working Paper out of print

ECO No. 91/40
Vincent BROUSSEAU/Alan KIRMAN
The Dynamics of Learning in Mis-Specified Models

ECO No. 91/41
Robert James WALDMANN
Assessing the Relative Sizes of Industry- and Nation Specific Shocks to Output

ECO No. 91/42
Thorsten HENS/Alan KIRMAN/Louis PHLIPS
Exchange Rates and Oligopoly

ECO No. 91/43
Peter J. HAMMOND
Consequentialist Decision Theory and Utilitarian Ethics

ECO No. 91/44
Stephen MARTIN
Endogenous Firm Efficiency in a Cournot Principal-Agent Model

ECO No. 91/45
Svend ALBAEK
Upstream or Downstream Information Sharing?

ECO No. 91/46
Thomas H. McCURDY/
Thanasis STENGOS
A Comparison of Risk-Premium Forecasts Implied by Parametric Versus Nonparametric Conditional Mean Estimators

ECO No. 91/47
Christian DUSTMANN
Temporary Migration and the Investment into Human Capital

ECO No. 91/48
Jean-Daniel GUIGOU
Should Bankruptcy Proceedings be Initiated by a Mixed Creditor/Shareholder?

ECO No. 91/49
Nick VRIEND
Market-Making and Decentralized Trade

ECO No. 91/50
Jeffrey L. COLES/Peter J. HAMMOND
Walrasian Equilibrium without Survival: Existence, Efficiency, and Remedial Policy

ECO No. 91/51
Frank CRITCHLEY/Paul MARRIOTT/
Mark SALMON
Preferred Point Geometry and Statistical Manifolds

ECO No. 91/52
Costanza TORRICELLI
The Influence of Futures on Spot Price Volatility in a Model for a Storable Commodity

ECO No. 91/53
Frank CRITCHLEY/Paul MARRIOTT/
Mark SALMON
Preferred Point Geometry and the Local Differential Geometry of the Kullback-Leibler Divergence

ECO No. 91/54
Peter MØLLGAARD/
Louis PHLIPS
Oil Futures and Strategic Stocks at Sea

ECO No. 91/55
Christian DUSTMANN/
John MICKLEWRIGHT
Benefits, Incentives and Uncertainty

ECO No. 91/56
John MICKLEWRIGHT/
Gianna GIANNELLI
Why do Women Married to Unemployed Men have Low Participation Rates?

ECO No. 91/57
John MICKLEWRIGHT
Income Support for the Unemployed in Hungary

ECO No. 91/58
Fabio CANOVA
Detrending and Business Cycle Facts

ECO No. 91/59
Fabio CANOVA/
Jane MARRINAN
Reconciling the Term Structure of Interest Rates with the Consumption Based ICAP Model

ECO No. 91/60
John FINGLETON
Inventory Holdings by a Monopolist Middleman

* Working Paper out of print

***

ECO No. 92/61
Sara CONNOLLY/John MICKLEWRIGHT/Stephen NICKELL
The Occupational Success of Young Men Who Left School at Sixteen

ECO No. 92/62
Pier Luigi SACCO
Noise Traders Permanence in Stock Markets: A Tâtonnement Approach. I: Informational Dynamics for the Two-Dimensional Case

ECO No. 92/63
Robert J. WALDMANN
Asymmetric Oligopolies

ECO No. 92/64
Robert J. WALDMANN /Stephen C. SMITH
A Partial Solution to the Financial Risk and Perverse Response Problems of Labour-Managed Firms: Industry-Average Performance Bonds

ECO No. 92/65
Agustín MARAVALL/Víctor GÓMEZ
Signal Extraction in ARIMA Time Series Program SEATS

ECO No. 92/66
Luigi BRIGHI
A Note on the Demand Theory of the Weak Axioms

ECO No. 92/67
Nikolaos GEORGANTZIS
The Effect of Mergers on Potential Competition under Economies or Diseconomies of Joint Production

ECO No. 92/68
Robert J. WALDMANN/ J. Bradford DE LONG
Interpreting Procyclical Productivity: Evidence from a Cross-Nation Cross-Industry Panel

ECO No. 92/69
Christian DUSTMANN/John MICKLEWRIGHT
Means-Tested Unemployment Benefit and Family Labour Supply: A Dynamic Analysis

ECO No. 92/70
Fabio CANOVA/Bruce E. HANSEN
Are Seasonal Patterns Constant Over Time? A Test for Seasonal Stability

ECO No. 92/71
Alessandra PELLONI
Long-Run Consequences of Finite Exchange Rate Bubbles

ECO No. 92/72
Jane MARRINAN
The Effects of Government Spending on Saving and Investment in an Open Economy

ECO No. 92/73
Fabio CANOVA and Jane MARRINAN
Profits, Risk and Uncertainty in Foreign Exchange Markets

ECO No. 92/74
Louis PHLIPS
Basing Point Pricing, Competition and Market Integration

ECO No. 92/75
Stephen MARTIN
Economic Efficiency and Concentration: Are Mergers a Fitting Response?

ECO No. 92/76
Luisa ZANCHI
The Inter-Industry Wage Structure: Empirical Evidence for Germany and a Comparison With the U.S. and Sweden

ECO NO. 92/77
Agustín MARAVALL
Stochastic Linear Trends: Models and Estimators

ECO No. 92/78
Fabio CANOVA
Three Tests for the Existence of Cycles in Time Series

ECO No. 92/79
Peter J. HAMMOND/Jaime SEMPERE
Limits to the Potential Gains from Market Integration and Other Supply-Side Policies

* Working Paper out of print

ECO No. 92/80
Víctor GÓMEZ and Agustín MARAVALL
Estimation, Prediction and Interpolation for Nonstationary Series with the Kalman Filter

ECO No. 92/81
Víctor GÓMEZ and Agustín MARAVALL
Time Series Regression with ARIMA Noise and Missing Observations Program TRAM

ECO No. 92/82
J. Bradford DE LONG/ Marco BECHT
"Excess Volatility" and the German Stock Market, 1876-1990

ECO No. 92/83
Alan KIRMAN/Louis PHLIPS
Exchange Rate Pass-Through and Market Structure

ECO No. 92/84
Christian DUSTMANN
Migration, Savings and Uncertainty

ECO No. 92/85
J. Bradford DE LONG
Productivity Growth and Machinery Investment: A Long-Run Look, 1870-1980

ECO NO. 92/86
Robert B. BARSKY and J. Bradford DE LONG
Why Does the Stock Market Fluctuate?

ECO No. 92/87
Anthony B. ATKINSON/John MICKLEWRIGHT
The Distribution of Income in Eastern Europe

ECO No.92/88
Agustín MARAVALL/Alexandre MATHIS
Encompassing Unvariate Models in Multivariate Time Series: A Case Study

ECO No. 92/89
Peter J. HAMMOND
Aspects of Rationalizable Behaviour

ECO 92/90
Alan P. KIRMAN/Robert J. WALDMANN
I Quit

ECO No. 92/91
Tilman EHRBECK
Rejecting Rational Expectations in Panel Data: Some New Evidence

ECO No. 92/92
Djordje Suvakovic OLGIN
Simulating Codetermination in a Cooperative Economy

ECO No. 92/93
Djordje Suvakovic OLGIN
On Rational Wage Maximisers

ECO No. 92/94
Christian DUSTMANN
Do We Stay or Not? Return Intentions of Temporary Migrants

ECO No. 92/95
Djordje Suvakovic OLGIN
A Case for a Well-Defined Negative Marxian Exploitation

ECO No. 92/96
Sarah J. JARVIS/John MICKLEWRIGHT
The Targeting of Family Allowance in Hungary

ECO No. 92/97
Agustín MARAVALL/Daniel PEÑA
Missing Observations and Additive Outliers in Time Series Models

ECO No. 92/98
Marco BECHT
Theory and Estimation of Individual and Social Welfare Measures: A Critical Survey

ECO No. 92/99
Louis PHLIPS and Ireneo Miguel MORAS
The AKZO Decision: A Case of Predatory Pricing?

ECO No. 92/100
Stephen MARTIN
Oligopoly Limit Pricing With Firm-Specific Cost Uncertainty

* Working Paper out of print

ECO No. 92/101
Fabio CANOVA/Eric GHYSELS
Changes in Seasonal Patterns: Are They Cyclical?

ECO No. 92/102
Fabio CANOVA
Price Smoothing Policies: A Welfare Analysis

***

ECO No. 93/1
Carlo GRILLENZONI
Forecasting Unstable and Non-Stationary Time Series

ECO No. 93/2
Carlo GRILLENZONI
Multilinear Models for Nonlinear Time Series

ECO No. 93/3
Ronald M. HARSTAD/Louis PHLIPS
Futures Market Contracting When You Don't Know Who the Optimists Are

ECO No. 93/4
Alan KIRMAN/Louis PHLIPS
Empirical Studies of Product Markets

ECO No. 93/5
Grayham E. MIZON
Empirical Analysis of Time Series: Illustrations with Simulated Data

ECO No. 93/6
Tilman EHRBECK
Optimally Combining Individual Forecasts From Panel Data

ECO NO. 93/7
Víctor GÓMEZ/Agustín MARAVALL
Initializing the Kalman Filter with Incompletely Specified Initial Conditions

ECO No. 93/8
Frederic PALOMINO
Informed Speculation: Small Markets Against Large Markets

ECO NO. 93/9
Stephen MARTIN
Beyond Prices Versus Quantities

ECO No. 93/10
José María LABEAGA/Angel LÓPEZ
A Flexible Demand System and VAT Simulations from Spanish Microdata

ECO No. 93/11
Maozu LU/Grayham E. MIZON
The Encompassing Principle and Specification Tests

ECO No. 93/12
Louis PHLIPS/Peter MØLLGAARD
Oil Stocks as a Squeeze Preventing Mechanism: Is Self-Regulation Possible?

ECO No. 93/13
Pieter HASEKAMP
Disinflation Policy and Credibility: The Role of Conventions

ECO No. 93/14
Louis PHLIPS
Price Leadership and Conscious Parallelism: A Survey

ECO No. 93/15
Agustín MARAVALL
Short-Term Analysis of Macroeconomic Time Series

ECO No. 93/16
Philip Hans FRANSES/Niels HALDRUP
The Effects of Additive Outliers on Tests for Unit Roots and Cointegration

ECO No. 93/17
Fabio CANOVA/Jane MARRINAN
Predicting Excess Returns in Financial Markets

ECO No. 93/18
Iñigo HERGUERA
Exchange Rate Fluctuations, Market Structure and the Pass-through Relationship

* Working Paper out of print