Economics Working Paper 71

Import Pricing, Domestic Pricing and Market Structure*

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Abstract

This paper provides some new empirical evidence on costs, prices and profit margins of US and Japanese exporters, which is relevant for the debate on the puzzles raised by the exchange rate developments of the 1980s: persistent deviations from Purchasing Power Parity, incomplete pass–through, pricing to market behaviour. A model of international duopoly is then proposed to partially explain the evidence. We show that, when exchange rates enter the cost functions, the pass–through of exchange rate changes on prices is not complete and the real exchange rate is no constant. We also provide conditions under which a depreciation of the home currency increases domestic prices and decreases foreign prices (expressed in foreign currency). In general, the impact of the depreciation depends on whether the two goods are perfect substitutes or complements.

1. Introduction

The dramatic swings in the value of the dollar during the 80s represented almost a laboratory experiment, which is an event very rare in economics. Hence, they provide an ideal framework to study pricing and export behaviour of manufacturing firms. During the period of strong dollar in the early 80s, it was observed (e.g. Mann, 1986) that the foreign currency price on manufactured goods sold in the US market tended to be higher than the foreign currency price on goods sold in Japanese and European markets. Prices on the US market did not fall as much as the law of one price would predict in response to the dollar appreciation. Rather, the profit margins of sellers on the US market were increasing. On the other hand, when the dollar underwent a huge devaluation between 1985 and 1987, Japanese and European manufacturing exports to the US market remained fairly constant, with falling prices and a consequent squeeze of profit margins. Therefore, at the end of a cycle, with the value of the dollar basically back where it started, prices and quantities were very different form the levels they had in 1980. The response of manufacturing firms to the exchange rate movements is difficult to explain within the framework of standard models, based on complete arbitrage. Furthermore, firms producing in different countries seem to have reacted in a different way to the appreciation and depreciation of the dollar. According to many observers (cf. for all Ohno, 1990), US firms have tended to pass through fluctuations of the dollar to the foreign currency price of their products, while Japanese and, to a lesser extent, European firms have tended to let profit margins change, keeping the foreign currency price of their products stable. In other words, Japanese (European) firms have absorbed a significant part of the yen (EMS currencies) fluctuations in the 80s in the profit margins, while US firms did not. This implies deviations of relative prices from Purchasing Power Parity (PPP). Persistent deviations from PPP were indeed observed in the 80s and also represent a puzzle within standard arbitrage models (cf. Mann,

1986).

These facts have propelled a very lively debate on the topic of adjustment of trade flows and prices to exchange rate changes. A number of explanations of incomplete pass-through of exchange rate changes on prices and non-linear and asymmetric reactions of trade flows and prices to devaluations (hysteresis) has been put forward.

This paper addresses the issue of international adjustment, with particular emphasis on the pricing behaviour of firms selling in at least two different markets (namely the domestic and one foreign market). Dornbusch (1987) has suggested that models of imperfect competition " à la Cournot" can help explaining the exchange rate-price puzzles. Here I show that a very simple duopoly model of Bertrand competition can explain incomplete pass-through and persistent deviations from Purchasing Power Parity. The paper identifies the main channels through which the exchange rate affects pricing strategies in a static context with symmetric and complete information and analyzes the impact of a devaluation of the nominal exchange rate on real exchange rate.

The outline of the paper is as follows. Section 2 briefly summarizes a number of relevant facts which characterized the 1980s, and presents some new evidence on the developments of prices, costs and profit margins of US and Japanese producers. Section 3 surveys the existing literature. Section 4 presents a game theoretic model of international duopoly, where prices are the choice variable. Section 5 concludes.

2. Some Facts and Related Questions

2.1 The developments of the dollar exchange rate:

2.1.1 First phase: 1978-1985

From 1978 to 1985 the dollar (measured by IMF effective exchange rate against the currencies of 16 industrial countries) rose by 48% (annual average 5%). With respect to the yen the revaluation

was of 37%. From 1980 to 1987[2], US exports suffered from the appreciation, rising at an annual nominal rate of 1.6% (2.1% for non-agricultural exports), while non-oil imports were increasing at a rate of 10.5% a year. In 1987, imports had risen to a level 64 percent above exports (from 11 percent in 1980). Accordingly, the trade deficit rose from $25 billion in 1980 to $160 billion in 1987. In the same period, the current account moved from a surplus of $1 billion to a deficit of $162 billion, equal to 3.6% of US GDP. The external balance of Japan mirrored these developments, with a current account improving for the whole period and peaking at $ 87 billion in 1987 and a trade surplus which, in 1987, reached $96.4 billion.

As Graph 1 shows, during the period 1980-85, US export prices (in dollar) after an initial increase, are fairly stable so that also profit margins of US exporters remain fairly constant (after an initial increase). US import prices (Graph 2) are also fairly stable. Under normal circumstances, however, we would expect the dollar price of foreign (Japanese) goods to fall in a period of dollar appreciation. But foreign exporters seem to have tended to increase their profit margins. And, in fact, there is an upward trend in the developments of mark-ups (also due to falling costs). As Graph 3 clearly shows, Japan export prices in yen are fairly variable, costs of production and profit margins are volatile, with the profit margins reflecting, more or less, the pattern of costs. As can be seen from Graph 4, finally, Japan import prices, which for our purposes can be thought of as prices of US exporters expressed in yen, fluctuate around a more or less horizontal trend but costs of foreign suppliers increase (due to the revaluation of the dollar), so that profits on the Japanese market are decreasing from 1980 to 1985.

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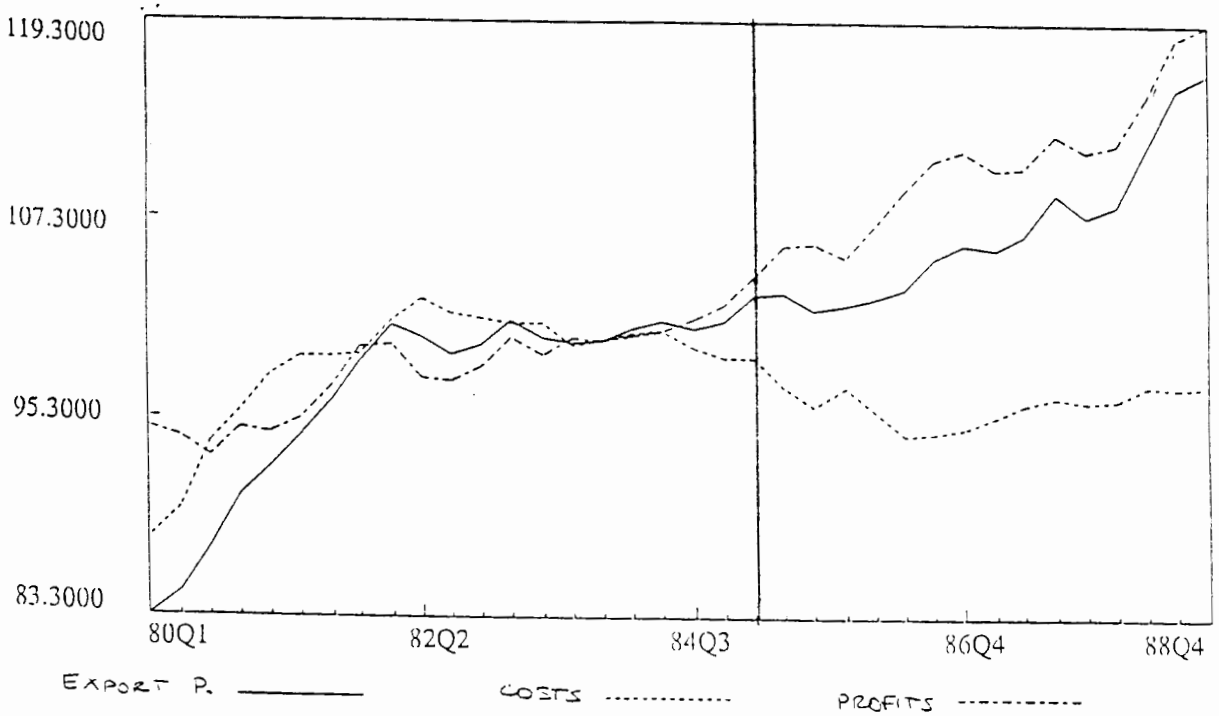
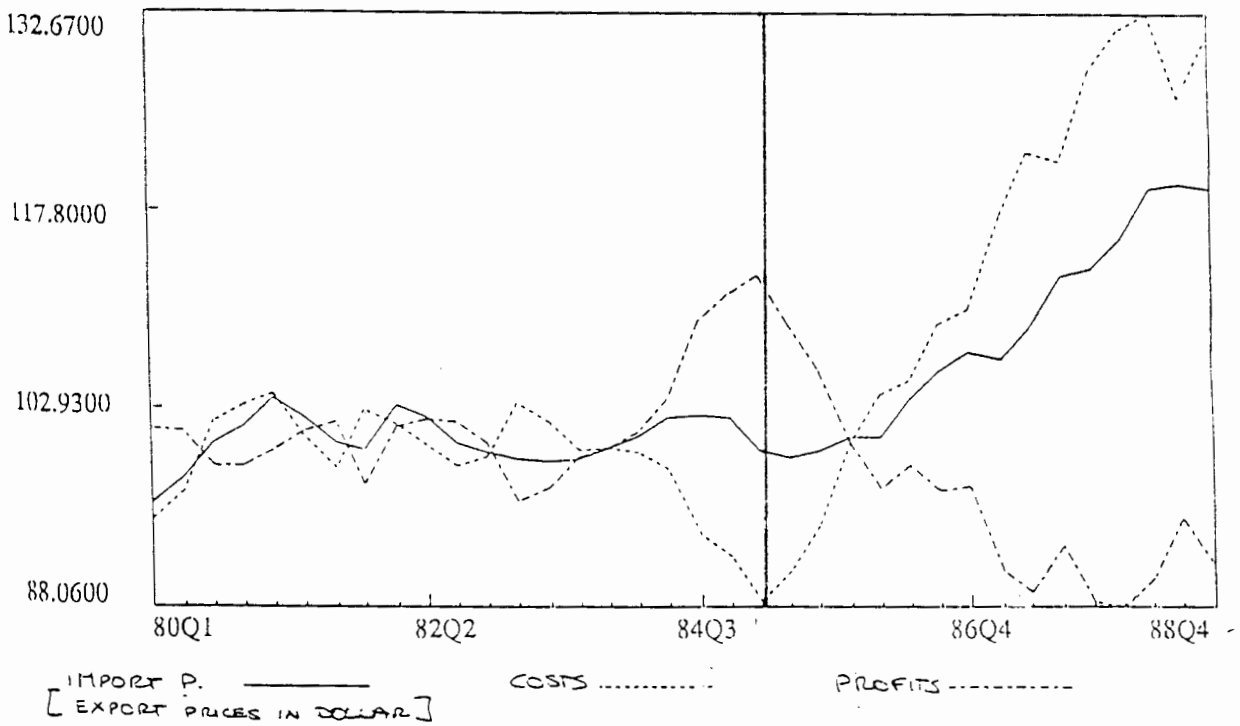
[2] The corresponding trade period, if, following a common practice, a lead of two years is allowed; Cf for instance Bergsten, 1991.

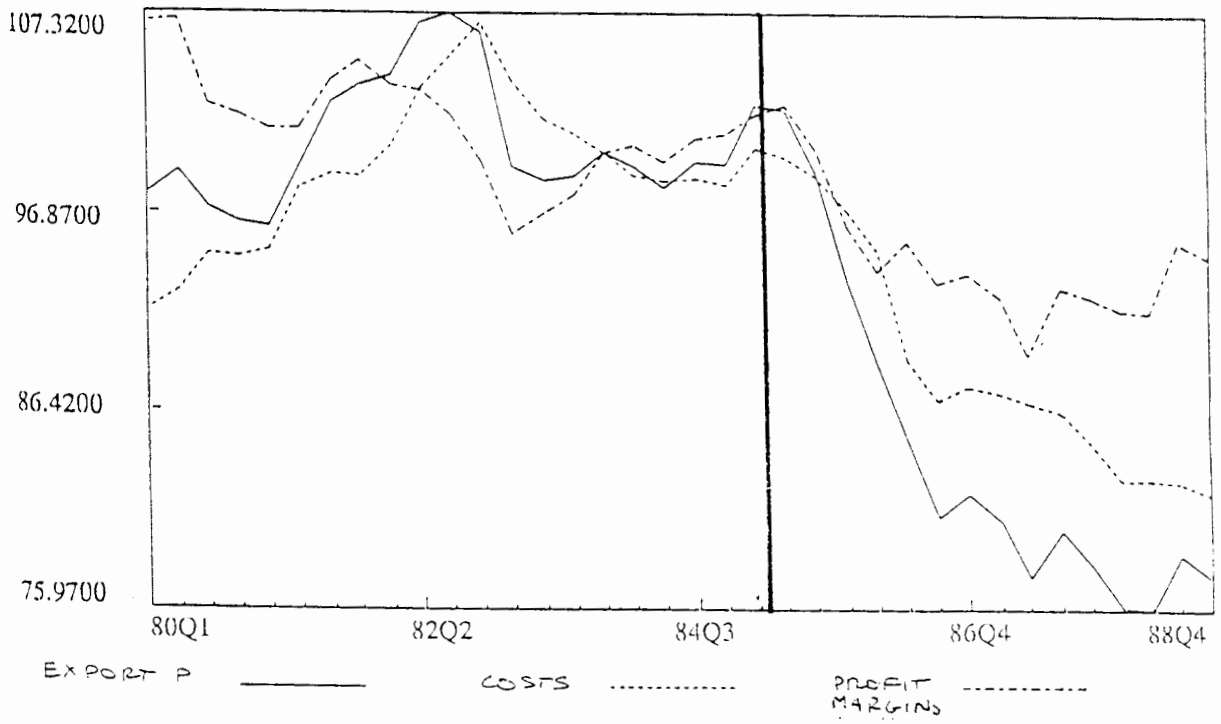
Graph 1: US Export prices, costs and profit margins of US exporters



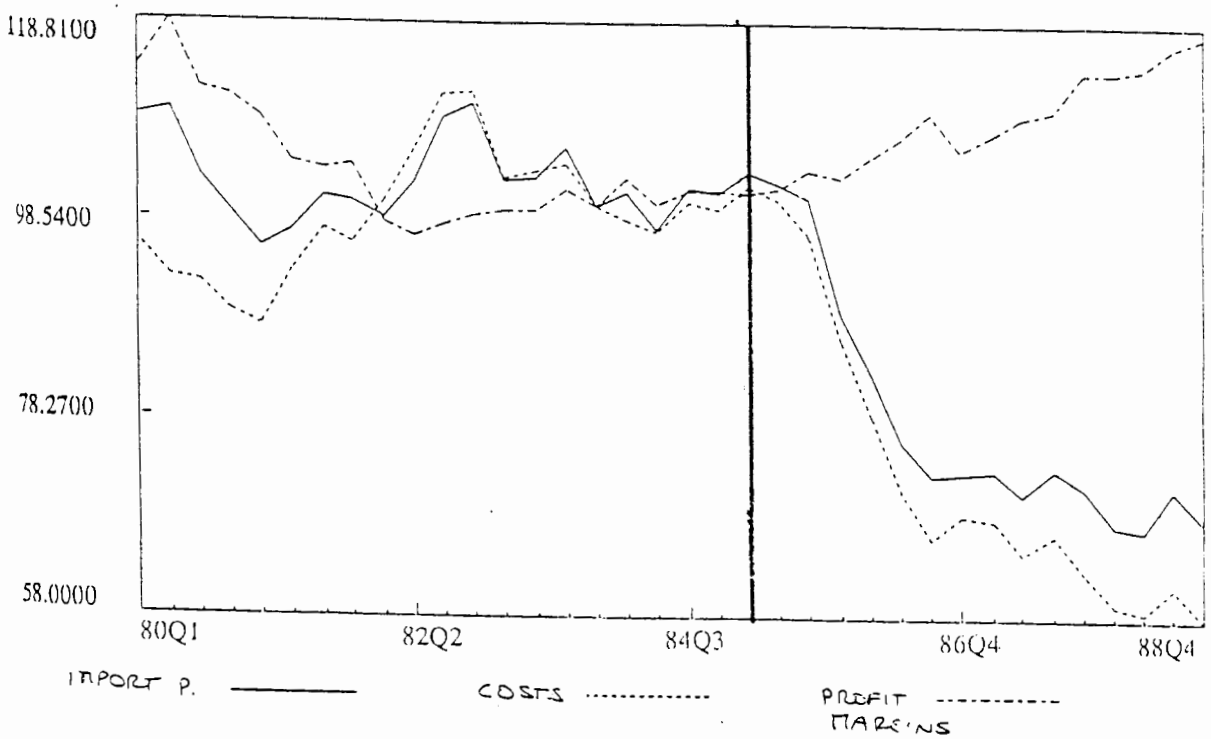
Graph 2: US Import prices, costs and profit margins of foreign suppliers



Graph 3: Japan's Export prices, costs and profit margins of Japanese exporters



Graph 4: Japan's Import prices, costs and profit margins of foreign suppliers



2.1.2 Second phase: 1985-1990

From 1985 to 1987 the dollar fell by 20% with respect to a basket of 16 currencies. But more strikingly, the yen appreciated by almost 99.5%, from 255.5 yen to the dollar in the first quarter of 1985 to 128.1 yen to the dollar (annual average) in 1988. Afterwards, the declining trend of the US dollar was less pronounced, but still downwards. At the end of 1989, therefore, the dollar was basically back to the 1980 levels[3]. US export values rose at an annual rate of 20% during 1987-1989 (allowing again for a two year lead) and non oil imports grew at 7.5%.
From 1987 to 1989, the trade deficit keept increasing and only in 1989 it started to decline and stopped at $115 billion, hardly an impressive adjustment.
The current account followed the same pattern and fell to $110 billion (2.1 percent of GDP) in 1989. The persistence of an external deficit despite the reversals in foreign trade trends reflected the enormous gap between imports and exports, which peaked in 1987.
In Japan, in 1988 trade and current account surpluses stood at $ 95 billion and $ 80 billion respectively, showing no sign of adjustment. The years following the Plaza Agreement (September 1985), hence, did not see any noticeable improvement in the Japanese external balance. In the same way than for the US, only in 1989, the Japanese current account started shrinking, so that, overall, the imbalances showed improvement[4]. The behaviour of prices, costs and profit margins in this period is very interesting and difficult to explain within standard models. Graphs 1 shows that despite the huge depreciation of the dollar

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[3] There is some disagreement about these numbers, which is well summarized in Bergsten, 1991. It mainly concerns "cleaning up the data" from distortions caused by the computer price problems.

[4] The relief was short lived, since in early 91 Japan´s Current Account surplus started once again to increase, even though the bilateral trade with US was not the main cause of this increase.

between 1985 and 1987, US export prices (in dollars) are increasing and with them the profits of US exporters (costs in dollars are slightly decreasing). This pattern is confirmed by looking at export prices in yen (i.e. Japan import prices), shown in Graph 4. These are characterised by a fairly marked decline, less steep, however, than the decline in costs, so that profits of foreign suppliers in Japan (i.e. US producers) are unexpectedly increasing. The movement of the dollar exchange rate, therefore, appear to be reflected in the foreign currency price of US exports. US producers pass-through the exchange rate changes on their prices. In Japan, on the other hand, export prices in yen (cf. Graph 3) decrease substantially. If we think of US import prices as Japan export prices in dollar, and we look at their development in Graph 2, we notice that they increase but less than proportionalely to the exchange rate with a marked decline in profit margins. We can tentatively say that the increase of Japanese export prices, expressed in dollars, suggests that roughly half of the exchange rate variation is accounted for by export prices in dollar and half by export prices in yen (see Ohno, 1990, for a similar empirical finding). Japanese firms, hence, in sharp contrast to US firms, tend to absorb a significant part of the fluctuations in their profit margins[5].

A number of questions arises from the developments of the dollar/yen exchange rate, US and Japan export and import prices, costs and profit margins of firms in these two countries, namely: 1) Did the adjustment process work? or, in other words, to what extent were changes in the dollar/yen exchange rate in the 1980s reflected in changes in trade prices and how did volumes react

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[5] Cf. Graphs 2 and 3 together; neither the yen export price, nor the foreign currency price of Japanese goods reflects entirely the 40% appreciation of the yen, as can be seen from the decreasing profit margins in both markets. Yoshitomi in Bergsten, 1991, calculates the pass through ratio, defined as the ratio of the change in export price in foreign currency to the change in the exchange rate, as 49.7% for the period 1st quarter 1985- end of 1988.

2.1.2 Second phase: 1985-1990

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to these changes, if at all?
2) Did firms price differently in domestic and export markets? Did Japanese firms really behave differently from US firms?
3) Is there a difficulty in reversing changes in trade shares once they have occurred (hysteresis)? And is this a characteristic of the 80s?
In the following, we shall try to answer these questions, with particular attention to the first two. Before, however, we sketch the state of the art and review the different models put forward recently by the literature in the area.

3. A Brief Survey of the Literature

The debate about the possible effects of a devaluation of the exchange rate on trade flows and prices, and their policy consequences, is one of the most lively in international economics. Although this may seem surprising, there is no consensus whatsoever on the effects of a devaluation on trade flow and prices, and, therefore, on the usefulness of a devaluation to improve a current account deficit. It is true that during the 1940s and 1950s there were a series of classic (macroeconomic) papers on the theory of devaluation by Joan Robinson, Haberler, Alexander and Meade that seemed to have reached uncontroversial results: the traditional elasticity approach, in fact, took for granted that currency adjustment shifted relative goods prices. It is also true that all throughout the 70s and 80s, there was extensive and accurate empirical work on the short and medium run determinants of trade flows, with conclusions standing up fairly well to the facts, at least till 1985 (cf. Krugmann, 1992). Yet the issue of the effects of a devaluation on trade flows and prices is an area of high dispute. More precisely, in the early 80s the general impression was that not much more was left to say: a devaluation will affect trade flows (possibly with lags) and will be passed onto prices, so that the law of one price will hold, at least in the long run. However, the rise and fall of the dollar during the

80s destroyed all certainties: persistent deviation from Purchasing Power Parity were detected even in the long run and trade flows seemed not to respond to exchange rate changes, even accounting for lags and J curve effects. This turned the topic of adjustment of trade flows and prices to exchange rate changes again into an "hot and controversial area" (cf. Bergsten, 1991). A number of different explanations of incomplete pass-through[6] of exchange rate on prices and hysteretic[7] behaviour of trade flows based on microeconomic behaviour has then been put forward in the attempt to provide a satisfactory theoretical explanation. A common feature of these models is that there are some departures from perfect competition, which imply incomplete arbitrage and, possibly, some persistence in price/quantities adjustment.

1) A first explanation, mainly concerning incomplete pass-through, is that foreign producers may not be really foreigners, in that some of their costs (advertising, selling, distributing) are in the "local" currency. Hence import prices do not change

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[6] The concept of pass-through is related to the degree to which import prices reflect movement in the exchange rate. The expression "partial pass-through" describes those situations in which a firm increases the foreign currency price of its exports less than the appreciation of the home currency, so that the change in the exchange rate is not passed through completely on prices. The closely linked expression "Pricing to market" (PTM) describes those situations where a firm tries to stabilize its sales abroad by maintaining the export price in foreign currency stable in the face of volatile exchange rates. In other words, a firm "prices to market" if it lowers the price of its exports in domestic currency relative to the price of goods for the domestic market (in this case there is no pass-through of exchange rate changes, since the export price bears the costs of the changes and profit margins are squeezed)

[7] The expression "hysteresis" describes those situations where a temporary shock has a permanent effect. Hysteresis denotes those situations where exports do not react to changes in exchange rates (e.g. firms do not enter markets made profitable by an exchange rate appreciation) or prices do not reflect the appreciation or depreciation of a currency (Baldwin, 1988). In general, it denotes an asymmetric behaviour, characterized by discontinuities.

when exchange rates change, because there is no reason for them to change (cf. Baldwin, 1988 and the graphs above. Import prices and costs of foreign suppliers seem to go hand in hand). This could easily be the case for multinationals. These can use "internal" exchange rates, i.e. a clearing mechanism for intra-firms transactions, which can differ substantially from the true exchange rate and would serve to insulate the pricing decision from the effect of changes in the exchange rates[8].

2) A different explanation, mainly aimed at justifying pricing to market behaviour, relies on the fact that a monopolistic firm, producing in the domestic country but selling in both domestic and exports markets, as long as commodity arbitrage by third parties is ineffective[9], will in general set different prices in the domestic and foreign markets, even when expressed in the same currency. Furthermore, the firm will vary the relative price of exports to domestic goods in response to changes in demand or costs conditions (Marston, 1990). The elasticity of demand for imports may then be reduced by the appreciation of a currency (depending on the functional form of the demand function). If, for instance, the demand is linear (but this applies to a wide range of demand curves including any demand more linear than the constant elasticity curve), a foreign monopolist with constant marginal costs would reduce its local currency price by less than half the change in exchange rate[10].

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[8]As an example, think of subsidiaries having the cooperation of the overseas supplier to defer payment until such time in the future when the devaluating currency has recovered the pre-devaluation value. Of course, under these circumstances, subsidiaries can sell at the pre-depreciation price and have no incentive to change their export prices.

[9]Cf. Krugman, 1987, for evidence of this ineffectiveness as far as car market is concerned.

[10]Consider the example, provided by Marston (1990), of Japanese goods sold in the US market. If the yen depreciates, the price of Japanese goods expressed in dollars falls. But because Japanese firms tend to increase their markups, the pass-through is less than proportional to the depreciation, so that the price

3) A different set of models explains partial pass-through using standard Cournot oligopoly (e.g. Dornbusch, 1987; Krugman, 1987). When markets are segmented, firms own price elasticity falls with an exchange rate appreciation (cf. Dornbusch, 1987). For instance a dollar appreciation will reduce the equilibrium dollar price of traded goods in the US but by proportionately less than the appreciation of the dollar. Hence, an appreciation of the dollar will result in foreign suppliers receiving more for sales to the US market than for sales in other markets. Furthermore, the decline in the home currency price is larger, the more competitive is the industry (i.e. the smaller the markup of prices over marginal costs) and the larger the share of imports in total shares.

4) Dynamic factors in trade adjustment have also been used to explain incomplete pass-through and hysteresis. Dynamics can be on the supply side, if, for instance, non recoverable entry costs exist (cf. Baldwin and Krugman, 1989, Dixit, 1989). In models accounting for these effects, firms behaviour will be characterised by hysteresis bands, i.e. bands of non-activity. Hence, firms will not enter profitable markets nor change prices when the exchange rate moves within the hysteresis band (i.e for relatively small changes). On the other hand, a large enough change in the exchange rate, even if temporary, can raise permanently both the level of exports and the degree of pass-through (cf. Baldwin, 1988; Giovannetti, 1989) and the return of the exchange rate at the pre-shock level won't have any further effect[11].

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in yen must rise. This open a gap between the prices of goods sold in Japan and in the US. If the yen appreciates, on the other hand, export prices in dollars increase, but less than proportionately to the exchange rate, because the yen price of these goods falls. Hence Japanese goods become less expensive abroad than in the domestic market (i.e. they price to market).

[11]This kind of models has been widely used to explain the persistence of the US current account deficit notwithstanding the huge dollar depreciation in the period 1985-89, cf. Baldwin and Krugman, 1989.

5) But dynamics can also be on the demand side. Firms future demand may, in fact, depend on current market shares (Froot and Klemperer, 1989). In this case, foreign exporters will react to a temporary appreciation of the local currency by reducing their local currency prices by less than in the standard static oligopoly framework. In fact, a firm facing an appreciation which it perceives as temporary may limit increases in the price of its exports to maintain market shares for the future. The appreciation increases the value of current local currency profits, expressed in foreign currency, with respect to future local currency profits and gives rise to dynamic demand side effects.

6) Finally, dynamic demand side effects and agents perception of exchange rate dynamics (i.e. whether an exchange rate change is perceived as permanent or temporary) may interact (Sapir and Sekkat, 1993), so that the degree of pass-through is lower the higher the perceived exchange rate instability[12].

This literature embody some "ad hoc" explanations and some simple static model. However, it mainly emphasises the importance of dynamic adjustment. The models accounting for some dynamics either on the supply or on the demand side furthermore share the prediction that the degree of pass-through depends on whether exchange rate movements are perceived as temporary or permanent. A further characteristic shared by the models reviewed (and by most models belonging to this strand of the literature) is their partial equilibrium nature. The study of the general equilibrium implications can prove very interesting[13] but is outside the

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[12] Sapir and Sekkat, 1993, contrast the higher level of pass-through in European markets with the lower level in the US market, by saying that the dollar has been characterised by much more volatile exchange rates and therefore firms tend to consider dollar change temporary and do not react to them.

[13] A paper by Brown, 1990, deals with pass-through in a general equilibrium context. By using a GE computational trade model, Brown finds that exchange rate pass-through appears to be incomplete because the change in relative production costs alters the real equilibrium price structure in the different markets.

scope of this paper. In the following we shall use a simple model of international duopoly to provide a theoretical explanation for the observed persistent deviations of relative prices from Purchasing Power Parity and for partial pass-through. We need to identify the main channels through which the exchange rate affects the pricing strategies of exporting firms. In order to keep the structure of the model simple and get more intuitive results, the domestic firm is assumed to sell its products only on the home market, while the foreign firm produces also to export. This assumption introduces an asymmetry between the duopolists and has some implications for the results of the model, but given the nature of US and Japan (US is a very closed economy, while Japan is export oriented) can be thought of as a feasible representation.

4. A Duopoly Model

The model consists of two firms, one foreign (say Japanese, denoted by the subscript 2) and one domestic (say US, denoted by the subscript 1). Each firm produces a product with labour and raw materials. Firm 2 is assumed to sell its goods on the domestic and foreign markets, while products of firm 1 are sold only on the domestic market. This assumption makes it possible to analyse the competition on a single market separately[14]. For

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A 10% revaluation of the dollar reduces US prices by 2-3% and increases prices in other countries by 0-6%. Hence marked differences in purchasing power parities can occur after a revaluation. The mechanism at work in GE models is, roughly speaking, the following: a dollar appreciation can cause changes in the prices of primary commodities, traded in dollars in international markets, and will therefore change the relative costs of US firms with respect to foreign producers.

[14] Cf. Di Gioacchino and Giovannetti, 1990, for an analysis of competition on two markets. The simplier structure of the current model allows a more complete characterization of the effects of nominal exchange rate changes. However, it does not allows us to directly address the issue of dumping which can arise when a firm discriminate between domestic and export prices, because it concentrate on differences in prices imposed by US and Japanese firms in the US market. Of course, implicitly

simplicity the same Cobb Douglas production functions with constant returns to scale is used for the two firms. The costs functions of the two firms are given by:

$$1a)\ C_1 = K_1 w_1^a (m)^{(1-a)} x_1$$
$$1b)\ C_2 = K_2 w_2^a \left[\frac{m}{e}\right]^{(1-a)} x_2$$

where:
- C_1, C_2 are total costs in domestic and foreign currency,
- K_1, K_2 are constant,
- w_1, w_2 are money wage rates in local currency,
- m is the price of raw materials (expressed in the currency of country 1, say dollars),
- e is the exchange rate (which can be thought of as dollar per yen),
- x_1 is domestic output, x_2 is foreign output sold on the domestic and foreign market.

On the home market (US, i.e. 1), the two firms are faced with symmetric linear demand functions[15]:

$$2a)\ x_1 = \alpha_1 + \gamma_1 p_2 e - \beta_1 p_1$$
$$2b)\ x_2 = \alpha_2 - \beta_2 p_2 e + \gamma_2 p_1$$
$$\alpha_i, \beta_i, \geq 0, \beta_i \geq \gamma_i, i = 1, 2$$

where p_1 is the dollar price and p_2 the yen price.

The profits of the two firms, expressed respectively in the domestic (dollar) and foreign (yen) currency, are given by:

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this issue can be addressed and may be very relevant for policy purposes. It must also be noted that the anti-dumping legislation may affect the pricing policies of firms.

[15] Cf. Singh and Vives, 1984 for a formal derivation of these linear demand functions from quadratic utility functions.

$$3a)\ \pi_1 = [p_1 - K_1 w_1^a m^{(1-a)}]\ [\alpha_1 - \beta_1 p_1 + \gamma_1 p_2 e]$$
$$3b)\ \pi_2 = [p_2 - K_2 w_2^a [\frac{m}{e}]^{(1-a)}]\ [\alpha_2 - \beta_2 p_2 e + \gamma_2 p_1]$$

Starting from this simple set-up, we want to relate the pricing strategies of the two firms on the domestic market (i.e country 1) to markup behaviour. In fact, it is through varying markups that a foreign firm can limit the impact of exchange rate changes on its competitiveness. Our aim then is to analyse what happens to domestic prices, foreign prices and the real exchange rate when the nominal exchange rate changes (e.g. the home currency depreciates), firms take the actions of the rivals as given (Nash), and use prices rather than quantities as strategic variables (Bertrand competition).
Accordingly, each firm sets its own price to maximize profits. From the first order conditions, we get the reaction functions of firm 1 and 2:

$$4a)\ p_1 = \frac{\alpha_1}{(2\beta_1)} + \frac{[K_1 w_1^a m^{(1-a)}]}{2} + \frac{\gamma_1}{2\beta_1} p_2 e = a_1 + b_1 p_2 e$$
$$4b)\ p_2 = \frac{\alpha_2}{(2\beta_2 e)} + \frac{[K_2 w_2^a (\frac{m}{e})^{(1-a)}]}{2} + \frac{\gamma_2}{2\beta_2 e} p_1 = a_2(e) + b_2 [\frac{p_1}{e}]$$

where:

$$a_1 = \frac{1}{(2\beta_1)} [\alpha_1 + \beta_1 K_1 w_1^a m^{(1-a)}],\ b_1 = \frac{\gamma_1}{(2\beta_1)},$$
$$a_2 = \frac{1}{(2\beta_2 e)} [\alpha_2 + \beta_2 e K_2 w_2^a (\frac{m}{e})^{(1-a)}],\ b_2 = \frac{\gamma_2}{(2\beta_2)}$$

and the equilibrium prices p^{*1} and p^{*2}:

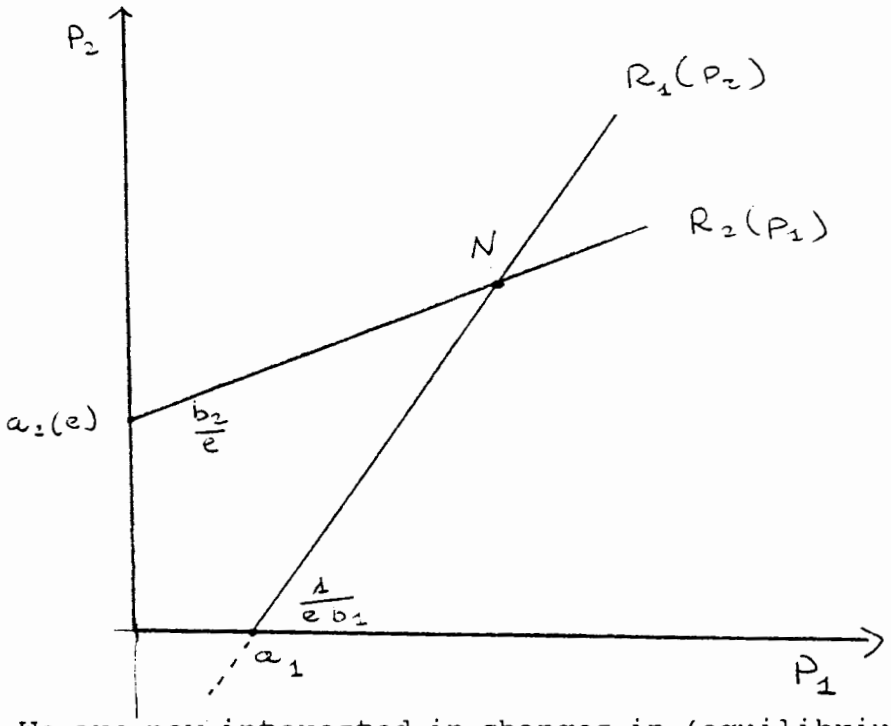
$$5a)\ p_1^* = (1 - b_1 b_2)^{(-1)} (a_1 + b_1 e a_2(e))$$
$$5b)\ p_2^* = (1 - b_1 b_2)^{(-1)} [a_2(e) + \frac{(b_2 a_1)}{e}]$$

Notice that, if raw materials are domestically produced, so that the exchange rate does not enter the cost function of firm 2, the coefficient $a_2(e)$ simplifies to:

$$a_2(e) = \frac{\alpha_2}{2\beta_2 e} + \frac{K_2 (w_2)^{a} m^{1-a}}{2}$$

It is easy to check that, with our assumptions, the system is stable, since the reaction function of firm 1 is steeper than the reaction function of firm 2[16].

Graph 5: Reaction Functions



We are now interested in changes in (equilibrium) prices when the currency of country 1 (US) depreciates (i.e. when the nominal exchange rate increases): it can be easily checked that p_1^*

[16] If goods were perfect substitutes rather than complements, then the reaction functions would be downward sloping. Stability is not affected.

increases while p_2^* decresases[17]. The actual shifts of the reaction functions and equilibrium prices depend on parameters of the demand functions, on the degree of substitution or complementarity between the two goods and on costs (namely the share of labour and raw materials, respectively, a and (1-a)). As can be seen from Graph 5, for the case in which goods are complements[18], a depreciation of the dollar will imply lower foreign prices (p_2 expressed in yen) and higher domestic prices (p_1), which is consistent with the empirical evidence presented above (namely, Graphs 1 and 3 show that in the period 1985-89 the yen price of Japanese exports fell substantially, while the dollar price of US products - Graph 1- increased despite the devaluation). This result depends crucially on the specification of the cost function. In fact, if raw materials are domestically produced, the reaction function of firm 1 does is not affected by changes in the exchange rate.

We can also look at the issue of pass-through from a slightly different perspective: that is, we can see how a nominal exchange rate depreciation affects the real exchange rate. Under the law of one price (or Purchasing Power Parity) relative price levels are independent of the exchange rate when converted in the same currency. The real exchange rate should remain constant (or even be equal to 1, if absolute PPP is assumed). In our setting, the real exchange rate between dollar and yen is the ratio between foreign (Japan) prices expressed in dollars and domestic (US) prices:

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[17] The sign of $\{a_2(e) + e\, a_2'(e)\}$ is positive, while that of $\{ a_2'(e) - b_2\, a_1 / e^2\}$ is negative.

[18] When goods are perfect substitutes both prices decrease after the shock.

$$6)\ RER=\frac{p_2 e}{p_1}$$

At the equilibrium, when goods are complements, we have:

$$7)\ RER=\frac{(ea_2(e)+b_2 a_1)}{a_1+b_1 e a_2(e)}$$

It can be seen from equation 7 that, when the nominal exchange rate depreciates, the real exchange rate reflects the changes. The derivative of the real exchange rate with respect to a change in the nominal exchange rate is, in fact, always positive. Notice that this result is valid both in the case of complements and in the case of substitute goods (even though in the two cases, prices move differently as we have seen above).
This result is in line with the existing empirical evidence[19].
A number of complications can easily be added to the model. For instance the exchange rate could enter the costs functions in some other way, e.g. wages could be indexed on a general price index. Of course, the degree of indexation will play a relevant role, so that the extent of the price change will also depend on the degree of indexation and on the functional form of the relationship between wages and prices. Complications, however, do not add much to the explanatory power of the model (though making it possibly more realistic). That is why, we have confined the analysis to the simpliest possible model. In fact, even this

[19] Cline, 1991, reports for instance 4 different measures for IMF real effective exchange rate for the dollar, and they all depreciate substantially in the period 1985-89.

simple model allows us to account for the fact that foreign (Japanese) firms producing and selling in oligopolistic markets have incentives not to pass through completely the exchange rate changes on prices, so that the prices, expressed in their domestic currency, decrease when the exchange rate revaluates and prices in dollar increase less than proportionately.

5. Conclusions

The issue we addressed in this paper is strictly related to the lack of international arbitrage. We analysed how non competitive firms discriminate between domestic and foreign markets. We have shown that, in a simple model of international duopoly, where firms use a Cobb-Douglas production function with constant return to scale and compete in prices, the impact of an exchange rate shock, say a devaluation of the home currency, will increase the domestic price and decrease the foreign price expressed in their currency. The effect of the depreciation on the equilibrium prices, however, depends on whether goods are perfect substitutes or complements. If goods are perfect substitutes, both prices decrease, while if they are complements domestic prices increase and foreign prices decrease.

We have also shown that the real exchange rate is not constant when the nominal exchange rate changes, but reflects its movements. The paper, therefore, can justify persistent deviations from Purchasing Power Parity[20] as well as the evidence on varying profit margins of exporting firms, provided above.

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[20] For evidence on deviations from PPP in the long run, cf. Giovannetti, 1987 and references reported there. Of course to look at the real exchange rate is only a partial test for Purchasing Power Parity, but a discussion of this issue is outside the nscope of this paper.

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