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TRADE HYSTERESIS IN MARKETS WITH ASYMMETRIC INFORMATION ABOUT PRODUCT QUALITY

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1. INTRODUCTION

The sharp and lengthy appreciation of the US dollar in the early 1980's generated a huge trade deficit in the US. The return of the dollar to more normal levels has not reduced the magnitude of the deficit to the levels that prevailed before this appreciation. In particular, the volume of imports has shown little response to the downward movement in the exchange rate (1).

In the classical model of trade, trade flows are related to the value of the exchange rate, so this model fails to explain the behavior of US imports after the depreciation of the dollar in early 1985.

One plausible explanation to this phenomenon is to question the validity of the law of one price. Dornbusch (1985) and Krugman (1986) have argued that, under the assumption of imperfect competition in import markets or adjustment costs in the commercialization process, it is possible that foreign suppliers to the US market do not adjust the dollar price of their exports to the full extent of the depreciation of the dollar. Under these circumstances the lack of response of imports

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(1) For example, the dollar has depreciated sharply with regard to the yen, but sales from Japan to the US have continued rising steadily more than a year after the depreciation took place.

would only be apparent, since what would have been happening is that import prices have not increased significantly despite the magnitude of the appreciation.

Another explanation given by Baldwin (1986) and Baldwin and Krugman (1986), is that a large and sustained appreciation of the dollar can generate changes in the structure of the tradable sector of the economy. This structural change would cause a permanent modification in the relationship between trade flows and the exchange rate. Their argument is the following: if a foreign firm has to incur a sunk cost in order to enter the domestic market, there would be a discrepancy between the exchange rate that encourages the firm to enter and the one that causes it to exit from a particular market. The exchange rate that occasions entry would be higher that the one that provokes exit. This is because the relevant costs of operation are smaller for a firm that is already in the market than for a firm that is outside the market and will therefore have to pay the sunk cost of entry.
This asymmetry in the entry and exit decision makes it possible that a given appreciation may cause foreign firms to enter a market, a situation that is not necessarily reversed by the return of the exchange rate to the original level. If foreign firms face significant sunk costs associated with the decision to enter, a high degree of "hysteresis" in the response of trade flows to exchange rate movements is plausible.

The purpose of this paper is to show that the existence of asymmetric information regarding the quality of foreign goods can also generate

hysteresis in the behavior of imports. The basic idea is that a temporary appreciation can generate a significant modification in the set of information that consumers have regarding the quality of foreign goods. This structural change could induce a dynamic change in import demands that cannot be reversed when the exchange rate goes back to its original level.

In the last 20 years many countries have had an accelerated process of technological development in industries where the US was formerly the leader. This technological catch-up has resulted in a sustained improvement in the cost-quality trade-off for foreign producers relative to the US. This is why it has become possible for foreign manufacturers to produce at competitive costs goods of similar or even better quality than their US counterparts.

This process has increased the potential number of products that can be introduced into the US market. If these goods are "experience goods," goods whose quality can be determined after purchasing, the number of foreign goods present in the US market and the dynamic behavior of the demand for these imported goods will depend decisively on the history of exchange rate movements. In particular, a temporary appreciation of the magnitude of the one that ocurred with the US dollar in the period 1980-85 could generate a permanent upward shift in the demand for imports that cannot be reversed by the return of the dollar to its previous level.

The first case we analyze is when a temporary appreciation causes foreign firms to enter the domestic market, but they do not exit when

the exchange rate returns to its original level. This case is similar to the one considered by Baldwin and Krugman (BK), although the mechanism that causes the asymmetry in the entry and exit decision is different - ie., the irreversible gain in consumer recognition and respect for the quality of the good during the period of apperciation. In this case we have a situation where there are two equilibriums (steady states) in the import market, one in which the foreign firm has a low reputation and zero sales in the domestic market, and another with high reputation and positive sales. An exchange rate shock may cause the market to move from the zero-imports steady state to an equilibrium with positive imports. What generates hysteresis is the fact that the return of the exchange rate to the original level does not shift the equilibrium of the market to its original steady-state position with zero imports, since the exchange rate shock causes a permanent change in the information set of consumers.

The second case we consider is when a transitory appreciation generates lasting effects on sales of imported goods that were already in the market, with whose quality consumers are still becoming acquainted. In other words, we ask how the path of imports of goods in transition between the two aforementioned equilibriums is affected by a transitory exchange rate appreciation.

The third case developed in this paper is an extension of the first one to a situation in which imports are trapped in a low-reputation low-demand equilibrium. In this case there are multiple equilibriums with positive levels of imports and hystereses in the behavior of imports

ill not be associated with entry of new imports, as in the first case, ut with a jump from a low level of imports equilibrium to a new steady tate with a higher reputation for quality and higher level of imports s a consequence of an exchange-rate shock.

To develop the first two cases we model the effect of product quality n consumer demand following the general approach developed by Shapiro 1982). The basic assumption of the model is that the quality of ertain goods is unobservable before purchase; consumers learn the true uality of the good after purchase (experience goods). The demand faced y suppliers will depend on the expectation that consumers have about he quality of the good being supplied. Consumers adjust their xpectation about quality in an adaptative fashion.
n mature industries, where the suppliers have been in the market for a hile, the expectations about quality are likely to be correct, if there ave been enough opportunities for consumers to learn and diffuse nformation about the quality of the products. For foreign firms that ant to introduce new products to the market the situation will be ifferent. The consumers have not previously experienced the good, so, heir expectations about quality will be formed a priori. This xpectation is likely to be incorrect. We will analyze cases in which he consumer's initial expectation understates the true quality of the roduct and the reverse case, in which the true quality is overstated. t is possible to show that for industries where there are potential mports whose quality is underestimated by domestic consumers, a ignificant appreciation will generate the entry of foreign imports that

will not be eliminated when the exchange rate returns to its original level.

An appreciation that induces the entry of imported goods will set in motion a process of learning by consumers that will generate a dynamic shift in the demand for imports. The foreign firms exporting high-quality products will likely gain in reputation over time, while firms producing low-quality products will lose it. When the exchange rate returns to its original level, the high-quality firms will face an improved demand curve, so it may be profitable for them to stay in the market. The low-quality firms will face an even lower demand curve, so they will leave the market when the exchange rate goes back to its previous level. In conclusion, only the understatement of quality generates hysteresis in imports; the reverse case produces only transitory effects.

This model also allows us to conclude that the exchange rate needed to get rid of the newly introduced imports will be lower the bigger and the longer the initial appreciation. This is not the case in the BK model, where there is a unique exchange rate that generates exit in a sector once entry of imports has ocurred.

Making the assumption that the speed of learning depends at any point in time on the amount of sales, it is shown that a transitory appreciation will affect the future path of imports that are still in the process of gaining or losing reputation. An appreciation will generate a multiplicative shift in marginal revenue, which under standard assumptions will increase sales and hence speed up the

accumulation or depletion of reputation. Once the appreciation is over, the level of reputation will be higher or lower than it would have been with an unaltered exchan ge rate, depending on whether quality was under or overstated. In general we will see that the effect of increasing reputation on the level of sales of goods already in the market is ambiguous. Under the assumptiom that marginal revenue is very responsive to reputation, a temporary appreciation will generate an increases in imports after the shock.

To develop the third case, in which we could have different steady states with positive imports, the aforementioned model is modified by assuming some non-convexities in the learning process, for example, by introducing a minimum level of sales above which learning can take place. The idea of the existence of a threshold or some kind of increasing returns in the process of diffusion of information is mentioned in the empirical literature on industrial organization. In particular, Sherer (1980) considers this possibility in his analysis of the effectiveness of advertising. If in conjunction with the diffusion process there is a process by which people leave the group of informed buyers (forget) and the rate of exit declines with the size of the informed population, then the whole learning process will have the threshold mentioned above and multiple equilibriums with positive imports can be obtained.

2. The Model

To model a market in which consumers have imperfect information about a product's quality, we adapt the general formulation presented by Shapiro (1982). In this paper, we assume that the foreign producer is introducing a good whose level of quality was established in the past and for which the cost of changing the quality is extremly high (1). For simplicity 's sake we consider an industry where there is a single foreign firm that supplies an experience good and acts as a monopolist. The introduction of strategic interaction with domestic firms complicates the analysis, without altering the conclusions of the monopolistic case.

Consumers at any point in time have expectations about the quality of goods. The process of learning implies adjustment of expectation of quality toward the true level. The initial expectation of quality for a newly introduced imported good will depend in a complex way upon the past experience of consumers and upon the signals that the good conveys.

We will assume that the consumer does not know the cost structure of the foreign producer, so that prices and sales cannot be considered by consumers a signal by which to infer quality (2).

The inverse demand function faced by the potential suplier at time t

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(1)In Shapiro's paper, the firm chooses the level of quality instead.
(2)For models of markets with experience goods that consider this signaling problem, see Klein and Leffer (1981) and Milgrom and Roberts (1986).

a:

$$P(t) = P(x(t),R(t))$$

where x(t) is the supply of the good to the domestic market at time t, R(t) the expectation about the quality of the product being delivered by the firm at time t (reputation), and P(t) the price expressed in domestic currency.

The cost for the foreign of operating in the domestic market, expressed in terms of its home currency, is given by:

$$C(x) = cx + C$$

where C is a fixed cost associated with the operation in the domestic market(it is not a sunk cost, namely the firm could avoid it
When the firm is operating in the market, its operational profits, measured in its home currency, are given by:

$$\Pi(t) = p(x(t),R(t))x(t)E(t) - cx - C$$

where $\Pi(t)$ is operating profits and E(t) is the exchange rate that translates domestic prices into foreign currency.

Consumers adjust their expectations according to the following process:

$$\dot{R} = f(x,R,q)$$

The foreign firm will thus solve the following problem of maximizing the present value of profits:

$$\text{Max} \int_0^{\infty} e^{-rt} [p(x(t),R(t))E(t) - cx - C]dt$$

subject to

$$\dot{R} = f(x,R,q), \text{ and } R(0) = R0$$

Setting up the standard Hamiltonian to solve this dynamic problem:

$$H = \Pi(x,R) + \&f(x,R,q)$$

where & is the usual current shadow price associated with the state variable R.

In order to assure uniqueness in the optimal choice of sales as a function of R, and to have a smooth convergence toward a self-fulfilled expectation of quality, the Hamiltonian has to be concave in the decision variable. This requires that the operational profits and the expectation-adjustment function be locally concave on x. Notice that the assumption of $f(x,R,q)$ concave on x imposes a special kind of learning process. In particular, it rules out the existence of a threshold level of sales below which consumers do not learn. The implications of relaxing this assumption will be analyzed in section 5 of this paper.

In the next two sections we assume that the learning function meets the following conditions:

$f(x,R,q)$ and $fx(x,R,q) > 0$ for $R<q$,

$f(x,R,q)$ and $fx(x,R,q) < 0$ for $R>q$,

Reputation increases when the expectation of quality is less than true quality, and vice versa. We also assume:

$f(x,q,q)=0$, hence $fx(x,q,q)=0$ and $fq(x,q,q)=0$,

$f(0,R,q)=0$, hence $fx(0,R,q)=0$ for all R.

That is, the learning process stops when consumers learn the true quality of the good, and there is no learning with zero sales to the domestic market.

The necessary conditions for an optimal solution are:

$$E(t)[dMR/dx] = c - \&fx \qquad (1)$$

$$-\{E(t)[dP/dR]x + fR\} = \dot{\&} - \&r \qquad (2)$$

where MR represents marginal revenue. The shadow variable & is unambiguosly positive, because increasing reputation always raises profits.

The interpretation of condition (1) is straightforward: if $R < q$, marginal revenue is less than marginal cost in the amount &fx, which is positive. In other words, if the expectation of quality by consumers understates the true quality of the good, the firm will want to increase sales above the monopoly level for a given R. This is because there is a dynamic benefit associated with increasing sales, consisting in the speeding up of the learning process, which will generate an upward shift in the demand curve.

If $R > q$, the value of fx is negative, in which case the marginal revenue will be above marginal cost and the firm will want to restrict sales in relation to the monopoly level in order to delay the process of running down reputation.

If the exchange rate approaches some asymtotic value, it is possible to determine the steady-state conditions by setting $\dot{R} = 0$ and $\dot{\&} = 0$. The former implies that either $q = R$ or $x = 0$, and the latter that $\& = (E(dP/dR)x^*)/r$, where x^* represents the steady-state monopolistic level of sales. When the learning process has stopped, the firm operates at

the monopolistic level of sales and expectations are self-fulfilled (1).

In order to get a close-form solution for the first-order conditions, it is assumed that fR is constant and that R reaches q when t goes to infinity. Integrating forward the differential equation for the shadow price &, we get:

$$\&(t) = \int_t^{\infty} E(s)(dP/dR)x(s)e^{-(r-fR)(s-t)}\,ds$$

The marginal valuation of reputation is equal to the present discount value of all additional sales in the future due to a marginal increase in reputation.

Substituting the value for &(t) in the equation (1) we get:

$$MR(R(t)) = -fx\left\{\int_t^{\infty} E(t)(dP/dR)x(t)e^{-(r-fR)(s-t)}\,ds\right\} \qquad (3)$$

At any point in time the monopolist sets sales in such a way that marginal revenue (MR(R(t)) equals the marginal cost of selling to the domestic market less the extra benefit generated by the positive effect that additional sales have on reputation (2).

It is worth mentioning that the path of imports for a given exchange rate can either increase or decrease over time. Let us analyze the case in which R(t) < q. Independent of the assumptions about expectations, the derivative of &(t) with regard to time is negative; fx is positive

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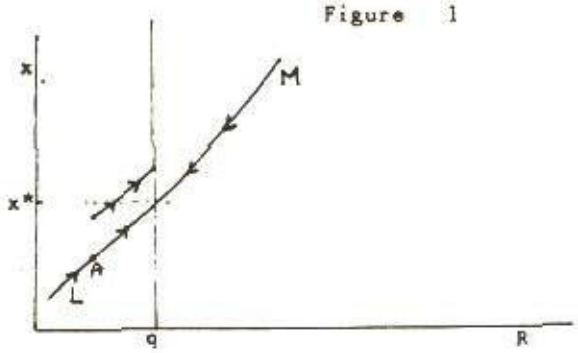
1) Note that even in the steady state the shadow value & is positive, since increasing reputation always raises profits. This is so, independent of the fact that f(x,q,q) = 0.

2) Note the similarity of this solution with the solution to the optimal production decision when there exists learning by doing in the production process. If W denotes the state variable 'experience,' and the marginal cost of production depends on W, the solution to the latter problem is: $MR = c(w) - c(w)xe \quad ds$

over the transition and becomes zero when R approaches its steady-state value; accordingly, the right-hand side of the equilibrium condition (3) increases over time. If marginal revenue depended only on sales, imports would decline over time. However, marginal revenue also depends on the level of reputation, so it will rise over time. With both sides of the equation augmenting over time, the behavior of imports will depend on the relation between the derivative with regard to R of marginal revenue compared with the same derivative of fx&(t). If the effect of rising reputation on marginal revenue dominates, imports will increase over time. Nevertheless, in general the sign of the slope of the path of imports is ambiguous under either assumption about expectations.

In Fig. 1 we depict the phase diagram that represents the dynamic system presented above, assuming that the effect of reputation over marginal revenue is the dominant factor in determining the path of imports.

Figure 1



Depending on whether the initial reputation is above or below the true quality of a given product, the volume of sales will approach the steady state by path L or M in Fig #1.

The steady-state level of imports x^* is affected by any permanent change in the exchange rate because it will modify the marginal revenue. The path of imports during the transition is also affected by any movement in the exchange rate. A permanent increase in the exchange rate will raise both the shadow value of reputation and marginal revenue, so there will be a jump in the level of imports from point A to B in Fig 1. From this point on, imports will converge to a new steady state, following a path that lies above the original one. The jump in imports will also speed up the learning process, which will take less time to reach the new steady state.

3. Hysteresis Due to Asymmetries in the Firm's Entry and Exit Decision

Let us call $V(E(t),q,R0)$ the solution to the dynamic optimization problem presented above, where q is the exogenously given quality of the good, R0 the initial expectation of quality, and E(t) an exogenously given exchange-rate path. The higher the initial reputation the greater the present value of future profits when the optimal policy has been followed ($dV/dR0 = \lambda(0) > 0$). If $V(E(t),q,R0)$ is positive at time 0 the firm will start exporting to the domestic market, otherwise the firm will stay out of the market.

We define EI as the exchange rate that leave the firm indifferent as to whether it wants to export or stay out of the market; EI is such that $V(EI,q,R0) = 0$.

In order to show the existence of an asymmetry in the entry and exit

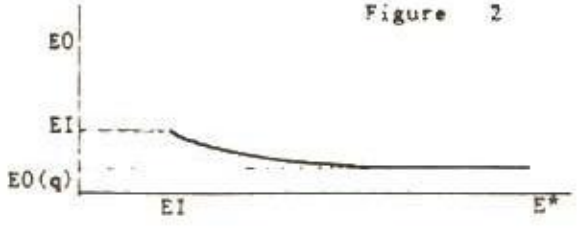
decision for foreign producers that generates hysteresis in the flow of imports, we develop the following thought experiment. Assume that the exchange rate has been unchanged at the level EI (i.e., imports in the industry we are analyzing are zero). Unexpectedly, at period t0 the exchange rate appreciates to a level E* and stays there for an interval t. The function V evaluated at t0 with the new exchange rate path will be unambiguosly positive. The firm will decide to enter the market. Two different cases have to be analyzed: first the case in which initial reputation is below the actual level of quality and second the reverse. Only in the first case, when quality is underestimated, are we going to have hysteresis in the behavior of imports. When the firm starts exporting to the domestic market $x > 0$, so $f(x,R) > 0$; the consumer starts learning about the true quality of the good and the reputation of the firm increases over time. At time $t0 + \Delta t$, when the period of appreciation is over, $R(t0 + \Delta t) = R0 + \int_{t0}^{t0+\Delta t} f(x(s),R(s))ds > R0$, therefore $V(EI,q,R(t0+\Delta t)) > 0$, i.e., the firm stays in the market when the exchange rate returns to its original level and imports will be positive in the future even though the exchange rate has returned to its original level.

The opposite case does not generate hysteresis: if the people overestimate the true quality of the good $f(x,R) < 0$ and $R(t0 + t) = R0 + \int_{t0}^{t0+\Delta t} f(x,R)ds < R0$, therefore $V(EI,q,R(t0 +\Delta t))$ will be less than zero and the firm will not operate when E(t) returns to its original level EI. In this case the appreciation generates transitory imports, the firm enters, runs down its reputation, and then leaves the market.

The previous analysis shows that, as far as the entry and exit decision are concerned, the effects of understating and overstating quality are not symmetrical: only the former generates hysteresis. This means that the hysteresis in the behavior of imports generated in the sectors where a product's quality is underestimated will not be canceled out by those sectors in which quality is overstated.

Before turning to the analysis of hysteresis on existing imports we want to discuss briefly how the exchange rate required to restore the original equilibrium depends on the magnitude and length of the appreciation. Call E0 the exchange rate that will cause exit of the firm after an appreciation of the exchange rate to a level E^*, for a length of time t. This exchange rate is defined implicitly by $V(E0, R(t0 + \Delta t), q) = 0$. If $R0 < q$ then $R(t0 + \Delta t) > R(t0)$, and since $V(EI, R(t0), q) = 0$ it follows that $E0 < EI$. To restore equilibrium it is necessary to depreciate the exchange rate beyond its original level. The magnitude of the depreciation depends on the length of the appreciation and its magnitude. The bigger the gain in reputation during the appreciation period the bigger the magnitude of the depreciation required to get rid of recently introduced imports.

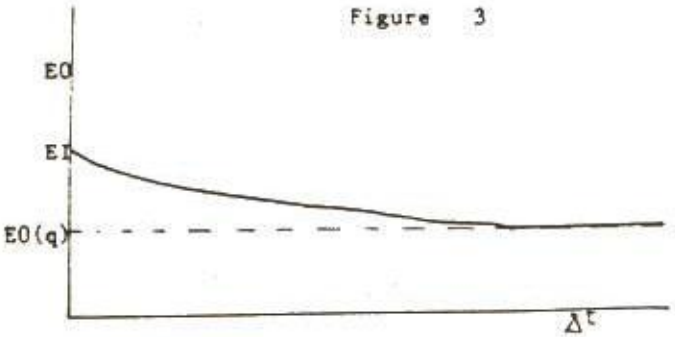
Figure 2



In Figs. 2 and 3 we depict the relationship between E0 and E^* and

also between E0 and Δt. The bigger E^* is the higher marginal revenue will be and the larger the level of imports during the appreciation. Since reputation improves on instantaneous imports, the level of reputation will increase with E^*. Similarly, for a given E^* a bigger Δt implies accumulation of more imports and thereby increased reputation. If the appreciation is large or prolonged enough the system will reach a steady state where R = q, and there will be a unique exchange rate E0(q) that will induce exit. E0(q) will be defined implicitly by V(E0(q),q,q)= 0.

Figure 3



The basic mechanism that generates hysteresis in the BK model is the gap the entry fee creates between the exchange rates that induce entry into and exit from a given industry by a foreign firm.

Our model also generates a gap between the exchange rates that induce entry and exit, but the difference is that the exchange rate that causes the firm to leave the market depends on the characteristic of the exchange-rate shock. In the BK model, EI and E0 are given constants that depend on the magnitude of the sunk cost. Here E0 is a function of the history of exchange rate movements; in the particular example we developed above it is a function of E^* and t.

4. Hysteresis on Existing Imports in Process of Gaining Reputation

In the model we developed in section 3, exchange-rate shocks may also have lasting effects on goods that were introduced to the domestic market sometime in the past, provided that consumers are still learning about the true quality of the good. For instance, during a transitory appreciation, the level of sales to the domestic market is unambiguously increased, hence the effect of the exchange-rate shock is, in the case where R < q, to raise the value of the state variable R, as against to the situation with a stationary exchange rate. The converse effect will result when quality is overstated.

An analysis of the effect of increasing reputation on the path of imports is similar to the discussion in section 2 regarding the slope of the path of import over time. Increasing reputation accelerates the transition toward the steady state. Therefore, depending on whether imports increase or decrease over time, the consequences of a temporary appreciation on the level of imports could go either way. In order to see the factors influencing the path of imports, we implicitly differentiate the equilibrium condition for the firm (equation (1)) with regard to R to get an expresion for dx/dR:

$$dx/dR = \frac{-d(fx\delta)/dR - dMR/dR}{dMR/dx + fxx + fx\, d\,/dx}$$

The assumption of concavity for the Hamiltonian on the control variable guarantees that the denominator is less than zero. Thus, the sign of dx/dR depends on the sign of the numerator. Consider the case where $R < q$: the first term in the numerator represents the change in the dynamic

benefit of expanding sales when there is a marginal growth in reputation, while in the steady state this dynamic benefit is zero. Since during the transition this dynamic benefit is positive, it should decline over time; that is, d(fx&)/dR is negative. The second term in the numerator dMR/dR is positive, hence the sign of the numerator is ambiguous. Conceptually, the analysis is the following: if the level of reputation is very responsive to the volume of sales, and reputation has a considerable effect on demand, the monopolist will have a large incentive to overexpand sales initially. As the expectation of quality approaches true quality, the effect of rising sales on reputation is attenuated, and the monopolist has an incentive to reduce sales over time. Nevertheless, there is also a direct effect of reputatio on marginal revenue that acts in the opposite direction, tending to raise imports over time. Depending on what effect dominates, the consequence of a temporary appreciation on imports whose quality is understimated will be either an increment or a drop in imports. This is an issue that can only be elucidated empirically. However, we tend to think that in the majority of experience goods the effect on marginal revenue will be dominant, so that the result of a temporary appreciation will be a lasting upward shift in imports.

In the case where quality is overstated, the effect of a transitory appreciation is also ambiguous, albeit of opposite sign than in the case when quality is understated. That is, in order to have an upward shift in preexisting imports of experience goods it is necessary that in the majority of the cases quality be understated and that marginal revenue

be very sensitive to the expectation of quality by consumers. The idea that in general the quality of imports is initially understated is consistent with the pattern of technological development shown by US competitors, as was discussed in the introduction to this paper.

5. Learning with a Threshold Level of Imports

To analyze the possibility of hysteresis in imports as a result of the existence of multiple equilibriums with positive imports we introduce the idea that the process of diffusion of information presents some kind of threshold level above which learning can take place. We present a very simple model of learning, which to some extent captures this concept. The model is a very stylized representation of the learning process that actually takes place in real markets; more realistic models would complicate the dynamic without changing the basic conclusion of this analysis, - that the existence of multiple equilibrium in the level of imports is very likely when there is imperfect information about product quality, and hence an exchange-rate shock could modify radically the relationship between exchange rate and import flows.

Let consumer preference be represented by an indirect utility function:

$$U = 1 + kq - P$$

where k is the marginal valuation of quality of consumer type k and P

the price that consumers pay for the good. There is a distribution of k given by dF(k). A consumer type k will buy one unit of the good if k > (P - 1)/q , where q is the quality expected by the consumer.

Every period, N individuals enter the population of potential consumers.

Of this N consumers M are informed about the true quality of the imported good q*; the remaining N-M are not informed and assume that the quality of the good is q. Each consumer stays in the population of potential buyers for one period only (1).

We will assume that the price of the imported good in terms of foreign currency P* is given exogenously. This is a plausible assumption if there are many foreign firms producing the good with the same level of quality. This assumption is made for simplicity's sake and it is not essential to the result. The domestic price of the good is P = P*E where E is the exchange rate.

The demand for imports at time t, XMt is given by:

$$XMt = Mt\{1 - F((P^*E-1)/q^*)\} + (Nt - Mt)\{1 - F((P^*E-1)/q)\}$$

Rearranging terms:

$$XMt = Mt\{F((P^*E-1)/q) - F((P^*E-1)/q^*)\} + Nt\{1 - F((P^*E - 1/q)\} \quad (4)$$

Note that the coefficient on Mt would be positive or negative depending on whether q* is less or greater than q(quality is over- or

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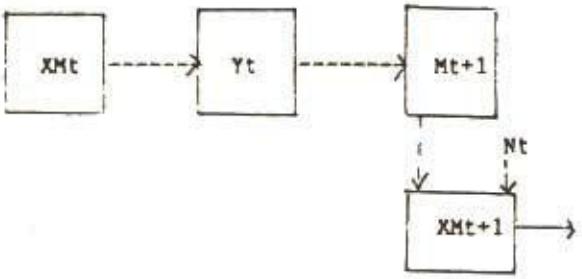
(1) The model assumes that there are no repeated purchases of the good; nfi din in the theory of population dynamics lead us to believe that the introduction of repeated purchases will increase the number of equilibriums and the persistence of imports (see Clark(1976)).

underestimated).

Figure 4



Now we turn to a description of the dynamic process by which the informed population evolves over time. The model is based on the flow chart shown in Fig. 4. The people who buy the imported good at period t, XMt, learn about the true quality of the good. These people transmit information regarding the true quality of the good to other people. We assume that of the total population that will potentially buy the good in period t+1, only Yt will receive the message in period t. The number of the next period's potential buyers who receive the message is assumed to be proportional to the amount of people who buy the good in the current period; i.e., $Yt = \alpha XMt$ (implicitly it is assumed that Yt is always small compared to N). Of the people who receive the message not everybody will retain it until the next period. In other words, not everybody who receives the message will be enrolled in the informed population: some of them will forget, therefore Mt+1 will be less than Yt. Once the relationship between Mt+1 and Yt is determined, we obtain Mt+1 as a function of XMt Hence, replacing this in equation (4) we get the dynamic demand for imports.

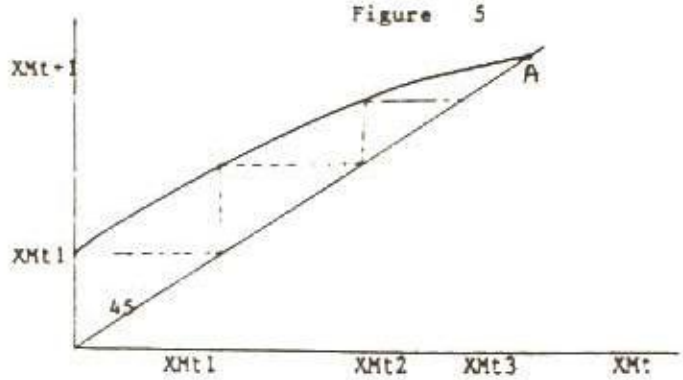
Call h the function that relates XMt to Mt+1, namely Mt+1 = h(XMt). Hence the dynamic demand function becomes:

$$XMt+1 = Mt[1 - F(P^*E - 1/q)] + h(XMt)[F(P^*E - 1/q) - F(P^*E - 1/q^*)]$$

This is a non-linear first-order difference equation on XM. The characteristic of the dynamic of imports depends on the shape of the h function. If h is a function increasing on its argument, positive for any XMt > 0 and concave, the dynamic process that derives from this equation is similar to the one presented in section 2. That is, there would be a unique steady state with positive imports.

In Fig. 5 we present a dynamic demand which has an h function with the characteristic mentioned above. If an imported good is introduced at time zero, imports will increase over time, following, for example, the sequence XMt1, XMt2, XMt3,... converging toward point A.

Figure 5



This model is the discrete time analog of the model developed in section 2 of the paper. It is interesting to ask what kind of forgetting process will generate a function h consistent with a unique equilibrium with positive imports. In Appendix 1 it is shown that one

of the conditions to get a dynamic import demand function like the one shown in Fig. 3.5 is that the proportional rate of forgetting increases with the size of the population that receives the message. This means that in order to get a dynamic of imports with multiple equilibriums with positive imports one has to search for a forgetting process that displays the opposite characteristic. That is, the difussion process should have a rate of forgetting that decreases with the size of the population that receives the message (1).
The assumption that the relative rate of forgetting declines with the size of the population that receives the message does not seem an implausible assumption about the effectiveness of the diffusion process.

If K(t) denotes the number of people who retain the message at time t, the rate of forgetting can be defined by the differential equation(in continous time):

$$dK/dt = -@(K)$$

A declining proportional rate of forgetting @(K)/K is implied by a concave rate of forgetting @(K). Consequently, in order to illustrate the possibility of hysteresis in imports due to the existence of multiple equilibriums in the diffusion process, we have chosen a specific functional for @(K), which is concave on K:

$$@(k) = -bK^{1/2}, \quad b>0.$$

Integrating this differential equation between 0 and T, and defining

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(1) There is an analogy between the analytic structure of this model and discrete metered models developed by biologists to analyze population dynamics. See, for example, Clark(1976), Beverton and Hall(1958).

K(T) = Mt and K(0) = Yt-1, we get:

$$Mt = \sqrt{(Yt)^{1/2} - c}$$

where c is a constant equal to (1/3)bT. This means that the dynamic import demand becomes:

$$XMt+1 = \sqrt{(\alpha XMt)^{1/2} - c}\ [F(P^*E-1/q) - F(P^*E-1/q^*)] + N(1 - F(P^*E- 1/q)$$

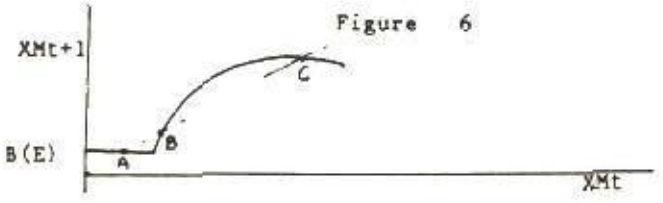
or

$$XMt+1 = A(E)\sqrt{(\alpha XMt)^{1/2} - c} + B(E)N$$

where A(E) = [F(P*E-1/q) - F(P*E-1/q*)] and B(E) = (1 - F(P*E - 1/q)

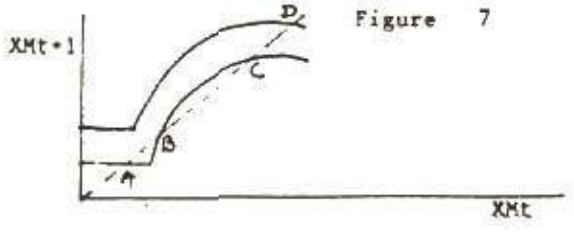
We start analyzing the case in which quality is understated. If q < q* then A(E) is positive, hence the graph of XMt vs XMt-1 will be as shown in Fig. 6

Figure 6



In the situation depicted in the graph there are three equilibriums, two of which are stable(A and C), the third unstable(B). If at time zero imports of the good are introduced, the level of sales will stay at point A. An appreciation will shift the curve up, since A'(E) and B'(E) are positive. In Fig. 7 we see a possible location for the demand schedule after an appreciation of the domestic currency.

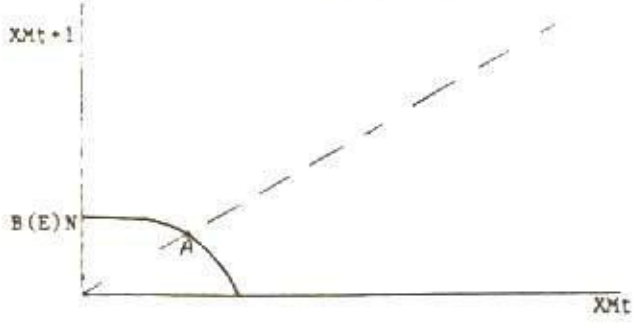
Figure 7



After the appreciation has taken place, imports will start rising in discrete steps. If the exchange rate remains at this level for a while, imports will eventually reach a new steady state at (D). The return of the exchange rate to the original level will cause the level of imports to move toward the steady state represented by point C in the graph. This level of imports is higher than at the original equilibrium at A. Therefore, it has been shown that an exchange-rate shock can cause a permanent upward shift in the level of imports by moving the economy from one equilibrium to another. In order to return to the original steady state there must be an overshooting depreciation that moves the curve below the 45-degree line for a significant period of time.

Now we turn to the case in which quality is overstated. In this case $A'(E) < 0$ and the graph for the dynamic import demand is shown in Fig. 8

Figure 8



There is a unique equilibrium at point A. so in this case we cannot observe hysteresis as a consequence of shifts in the equilibrium level of imports, as was the case for the model in which quality was understated.

6. Conclusions

In this paper we have argued that the history of exchange-rate movements could play a significant role in determining the current relationship between trade flows and the exchange value of domestic currency. While other authors have made this argument before, based on supply-side considerations, we have focused on demand-side hysteresis.

In particular, if a significant proportion of the goods imported to the US are experience goods, a temporary appreciation of the US dollar could cause a considerable upward shift in import demand due to an additional accumulation of goodwill by foreign goods. In the models developed in this paper, goodwill represents an objetive variable; the extent to which consumers are aware of the true quality of the good.

First, we showed that the existence of potential imports over which consumers have understated expectations of quality generates an asymmetry in the entry and exit decision for the foreign producer; this asymmetry depends on the history of exchange-rate movements. A temporary appreciation of domestic currency can make it convenient for the foreign firm to enter the market, and sales to the domestic market will set in motion a learning process by consumers that will improve the image of the good. When the appreciation is over the firm will have gained a reputation for being a high-quality producer, and the demand schedule faced by the firm will therefore be higher than it would have been without appreciation. With the improved demand curve it may be

convenient for the firm to stay in the market, even if the exchange rate has fallen below the original level.

We also considered the case of imports whose quality was overstated by consumers. In this case a transitory appreciation that causes entry of these goods will only have a transitory effect on imports, since once the appreciation is over the level of reputation will be lower than otherwise. We also argued that given the technological catching-up of US competitors it is reasonable to expect consumers underestimate the true quality of newly imported goods.

Second, we analyzed the case of products that were imported prior to the appreciation but that are in transition, with consumers still learning about the quality of the good.

The effect of a transitory appreciation on imports about which consumers are still learning is ambiguous. If the path of imports is increasing over time, a temporary appreciation will heighten imports. Otherwise, they will drop as a consequence of the exchange-rate shock. We presume that in most of the cases of experience goods the effect of reputation on marginal revenue is strong enough to outweigh the incentive to overexpand sales at the beginning of the product cycle. If this is the case, and for most of the imported experience goods quality is understated, a transitory appreciation will produce an abiding increase in imports.

Third and last, we considered the case in which foreign suppliers can be initially trapped in a low-reputation, low-demand equilibrium. In

this situation an exchange-rate shock can move the market from a low demand equilibrium to a high-demand equilibrium, modifying sustantially the relationship between the exchange rate and import levels.

The implications of this paper for the current discussion in the US on the extent of depreciation necessary to reduce the trade deficit is evident. If we couple the supply-side hysteresis of the kind proposed by BK paper with the demand-side hysteresis addressed in this paper, we may expect a considerable overshooting in the depreciation of the exchange rate in order to restore the pre-shock balance of trade equilibrium.

Another conclusion that can be derived from this model is that a modest amount of transitory export promotion on the part of foreign governments could have a very significant influence in the long-run prospects for exports in the case of experience goods.

In this framework, in particular, a temporary export subsidy is equivalent to a transitory appreciation that could move the export market from the underable low-demand equilibrium to a healthier high-reputation, high-demand equilibrium. In a sense, this is an argument for government intervention that has similarities with the infant industry's argument for protection. A government intervention aimed at shifting the equilibrium in the export market will only be socially desirable when there are some other distortions that cause discrepancies between the private and social return on investment.

Appendix 1

The function h that relates XMt with Mt+1 (Mt+1 = h(XMt)) is:

i) Concave.

ii) Increasing.

iii) Strictly positive for any XMt > 0

Provided that the following conditions are met:

i) The rate of forgetting @(K) is convex.

ii) The first-order differential equation

$$dK/dt = -@(K) \qquad (1)$$

satisfy the Lipchiz-continuity condition.

iii) $\lim_{M_{t+1} \to 0} \int_{M_{t+1}}^{Y_t} 1/@(K)\,dK = \infty$, where Mt+1 = K(t +T) and Yt = K(t).

Proof.

The Lipchitz-continuity condition (see Clark(1976)) states that the first-order differential equation like equation (1) possesses at most one solution curve K(t) for a given initial condition. This means that for two different initial conditions at t0, K1(t0) = Y1t0 and K2(t0) = Y2t0, where Y1 = Y2, the two curves K1(t) and K2(t) will never intersect for any t. This implies that for Y1t0 > Y2t0, then K1(t0 + T) = M1t0 + 1 is bigger than K2(t0 + T) = M2t0 + 1. This is equivalent to showing that the function h is increasing on XMt, since Yt = αXMt.

The interval of time T between the moment that the consumers receive the message and the moment that they are recruited to the informed population can be expressed as:

$$T = \int_{M_{t+1}}^{Y_t} 1/@(K)\,dK \qquad (2)$$

In order for Mt+1 to be positive for any positive Yt(which is equivalent to saying that h(XMT) > 0 for any XMt >0), it is required that:

$$\lim_{M_{M+1}\to 0} \int_{M_{M+1}}^{Y_t} 1/@(K)\,dK = \infty$$

Namely, to have a solution for Mt+1 we need in equation (2) that T be a given constant. Mt+1 will be zero for a positive Yt only when T is undefined.

Finally, differentiating equation (2) with regard to Yt, we get:

$$1/@(Yt) - 1/@(Mt+1)\ dMt+1/Yt = 0 \text{ or}$$

$$dMt+1/dYt = d(Mt+1)/d(Yt)$$

Hence,

$$\frac{\partial}{dMt+1/dYt^2} = \frac{[@'(Mt+1) - @'(Yt)]@(Mt+1)}{@(Yt)^2}$$

If @ is convex, Then for Mt+1 < Yt we obtain that @(Mt+1) - @(Yt) < 0, and dMt+1/dYt < 0. The function h is concave and there exists a unique equilibrium in the level of imports.

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