NBER WORKING PAPER SERIES

HYSTERESIS IN IMPORT PRICES: THE BEACHHEAD EFFECT

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Working Paper No. 2545

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 1988

I gratefully acknowledge the comments and suggestions of Paul Krugman, Avinash Dixit, Gene Grossman, Jeff Sachs, Rob Feenstra, Ron Jones, Alan Stockman, Steve Ambler, Sue Collins, Cathy Mann, Harry Foster, Nils Gottfries, Assar Lindbeck, Rich Lyons, Jim Levinshon, Alberto Giovannini, and Bill Helkie. The research reported here is part of the NBER's research program in International Studies. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research. Support from The Andrew W. Mellon Foundation is gratefully acknowledged.

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ABSTRACT

International economists typically assume that temporary real exchange rate shocks can have only temporary real effects — and no effect at all on the underlying structure of the economy. This paper shows that even in a simple "off-the-shelf" industrial organization model, this assumption is unfounded; if market-entry costs are sunk, exchange rate shocks can alter domestic market structure and thereby have lasting real effects. In other words, a sufficiently large exchange rate shock can cause hysteresis in import prices and quantities. This simple idea has strong implications for exchange rate theory (Baldwin and Krugman 1986 shows this), for trade policy (Dixit 1987a discusses this), and for the estimation of trade equations as the present paper shows.

To show that the theoretical point is not just empirically empty theorizing, we present evidence which suggests that the recent dollar overvaluation is an example of a hysteresis-inducing shock. To this end we demonstate that the pass-through relationship shifted in a manner that is consistent with the nature and timing of the market structure changes predicted by the model. In particular, we find evidence that the structural break occurred during the rising dollar phase rather than in 1985 as is commonly asserted. A direct test of the model is not performed due to data limitations.

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INTRODUCTION

International economists typically assume that temporary real exchange rate shocks can have only temporary real effects — and no effect at all on the underlying structure of the economy. For instance, in the well–known Dornbusch (1976) overshooting model, a one time money stock increase leads to a temporary real depreciation. However, in the long run the shock is assumed to be neutral, i.e., to have no real effects. In the empirical trade literature, researchers implicitly assume that their trade volume and price equations are stable through time. In particular, they ignore the possibility that exchange rate shocks might themselves cause structural breaks in the equations.

This paper shows that, even in a simple "off–the–shelf" industrial organization model, this assumption is unfounded; if market–entry costs are sunk, exchange rate shocks can alter domestic market structure and thereby have persistent real effects. In other words large, temporary exchange rate shocks may result in hysteresis in import prices and quantities.[1] This simple idea has strong implications for exchange rate theory (Baldwin and Krugman 1986 shows this), for trade policy (Dixit 1987a discusses this), and for the estimation of trade equations as the present paper shows.

Moreover, to show that the theoretical point is not just empirically empty theorizing, this paper presents evidence which suggests that the recent dollar overvaluation is an example of a hysteresis–inducing shock. The real US dollar exchange rate (based on wholesale price data) rose about 20 percent in the 18 quarters leading up to 1985:1, and fell almost as much in the subsequent ten quarters. This dollar cycle has had rather puzzling effects on import prices. The appreciation lowered real import prices, and the depreciation has partially forced them back up. However since the early 1980s, import prices appear to have been below the level predicted by the historical relationship. This paper formally shows that the pass–through relationship (of real exchange rates to real import prices) has indeed shifted in the 1980s, and that the nature and timing of the shift is consistent with the market structure changes predicted by the model. A direct test of the model is not performed due to data limitations.

The notion that large exchange rate changes have a qualitatively different impact on trade than do small changes is not novel. Orcutt (1950) conjectures that large price changes have a quantum effect on import volume. Krugman (1986) conjectures that the strong dollar induced hysteresis in the US trade balance due to dynamic economies of scale.

A preliminary draft of this paper, Baldwin (1986), presents three versions of a model (the beachhead model) which display hysteresis in import quantities. The present paper extends the latter by allowing for an infinite horizon, a more general demand structure, and the presence of home firms. Moreover, it shows that hysteresis can occur in import prices, as well as quantities.

A number of papers have extended the original beachhead framework. Baldwin and Krugman (1986) allows for a stochastic exchange rate process, and more importantly shows that hysteresis in imports leads to hysteresis in the equilibrium exchange rate. Dixit (1987a, 1987b) uses a related setup to show that quantity hysteresis can occur when the exchange rate follows a continuous–time random walk. Foster and Baldwin (1986) examines a model of marketing capacity constraints in which hysteresis in quantities occurs. Bean (1987), using a modified beachhead model, finds evidence that the 1978–1981 sterling overvaluation had hysteretic effects on British exports.

The paper is organized in four sections. The first presents the model. The second studies the positive effects of exchange rate changes. The third presents some empirical evidence. The last section presents some conclusions.

I. The Beachhead Model

The basic economics of the model consists of two assertions: (i) real exchange rate shocks can alter a country's market structure, and (ii) market structure affects import prices and volumes. We use a modified Spence (1976) and Dixit and Stiglitz (1977) (S–D–S) framework to model the industry structure and imperfect competition in a partial equilibrium setting. Foreign and home firms engage in Cournot competition in the domestic market for a particular good with each firm selling a different S–D–S variety.

Home and foreign production costs (c measured in home currency and c^* measured in foreign currency) are linear homogeneous in output. Firms must also incur a fixed, sunk market–entry cost, F, which reflects the cost of the firm–specific and market–specific assets that are required to sell in the market. For example, F could represent the costs of setting up a distribution and service network, of establishing a brand name through advertising, or of bringing the foreign product into conformity with domestic health and safety regulations. The results would go through as long as at least part of F is sunk.

Each period the firm is active, the sunk investment requires maintenance represented by a fixed maintenance cost, G. For example if F represents the cost of a brand name introduction advertising blitz, G would represent the brand name maintenance advertising. F and G are incurred in the home country and so are independent of the exchange rate.[2] If G is not spent the sunk asset disappears, i.e., the firm exits.[3] We assume that $F > G$.

Since firms are making intertemporal decisions, the exact nature of firms' exchange rate expectations are crucial to the mechanics of the model. The most complete approach would be to specify a macro model (endogenizing the real exchange rate) with which firms would form their expectations. In many such macro models, persistent changes in domestic (or foreign) monetary and fiscal policies can result in perfectly anticipated real exchange rate shocks.[4] This paper omits the macro model, simply assuming that firms perfectly anticipate the exchange rate path. This assumption is not crucial to the hysteresis result.[5]

We limit our attention to shocks where the exchange rate equals e^o in period zero, jumps in period 1 to E, remains there for T–1 periods, and returns to e^o in period T for all future periods. We refer to this stylized shock as V(E,T). An overvaluation is denoted as V(A,T), and an undervaluation as V(D,T).

Chamberlain (1933) argues that an increase in the number of varieties in an industry shifts down and makes more elastic the demand curve for each variety. We therefore include the total number of S–D–S varieties sold by home and foreign firms in the domestic market, m_t, as an argument in the inverse demand functions. In the spirit of the S–D–S model, the inverse demand function for each firm is identical although each is for a different variety.

Formally a typical foreign firm chooses sales, y_t (all t), to maximize:

$\sum_{t=0}^{\infty} R^t(P[m_t,y_t]y_t - c_t^* e_t y_t - G) - F$, where $R=1/(1+r)$, r is a constant discount rate, and e_t is the exchange rate (domestic currency per foreign currency). Since e_t is deterministic, the issue of whether the foreigners maximize profits in home or foreign currency is moot. By S–D–S symmetry, y_t is identical for all foreign firms. Home firms chose sales x_t (all t) to maximize: $\sum_{t=0}^{\infty} R^t(P[m_t,x_t]x_t - c_t x_t - G) - F$. We assume the demand curve is such that marginal revenue is decreasing in sales so that the second order condition is met. Clearly the home operating profit function (the profit functions exclusive of F), $O\Pi$, has m_t as its argument. The foreign operating profit function, $O\Pi^*[e_t,m_t]$, has m_t and e_t as arguments. We assume $O\Pi$ and $O\Pi^*$ are smooth and decreasing in their respective arguments.

The period zero equilibrium is taken as given and plays the role of an initial condition. A prospective entrant calculates what its discounted profits would be if it entered (choosing sales optimally, based upon a period–by–period Cournot–Nash equilibrium) allowing of course for the possibility that it may exit in the future. If discounted profits are sufficient to cover F, the firm enters. Incumbant firms choose sales optimally, and if the anticipated revenues are enough to cover variable costs, they remain in the market. Since the period–by–period sequential entry equilibrium concept is Cournot–Nash, the multi–period equilibrium is sub–game perfect. Ignoring integer constraints, defining $S_\tau = \sum_{i=0}^{\infty} R^i(O\Pi_{\tau+i}[m_{\tau+i}])$, and $S_\tau^* = \sum_{i=0}^{\infty} R^i(O\Pi^*_{\tau+i}[e_{\tau+i}, m_{\tau+i}])$, the entry and exit conditions for home and foreign firms in period τ are, respectively:

(1) $$S_\tau > F, \quad S_\tau^* > F$$

(2) $$S_\tau < 0, \quad S_\tau^* < 0$$

Clearly there is a gap between the entry and exit conditions. The gap implies that there is not a unique number of firms in the period–by–period equilibria. This multiplicity of equilibria is the key to hysteresis. As we shall see below, a large enough V(E,T) will permanently change the market structure, resulting in permanent real effects.

II. The Equilibrium

Before studying the effects of exchange rate shocks, we calculate the equilibrium for a constant, or benchmark, exchange rate, e^o. For convenience, we assume that e^o is such that $c=e^o c^*$.[6] For this e^o, S_τ and S^*_τ equal S_b which is in turn a function only of a constant m, m_b (m is constant since e is). Figure 1 facilitates the determination of m_b. $S_b[m]$ is decreasing in m since OΠ and $O\Pi^*$ are. For $m < m_d$, (1) holds so firms would enter. For $m > m_u$, (2) holds so some firms would exit. Any m between m_u and m_d constitutes an equilibrium since neither (1) nor (2) is binding.

Foreign and home firms' sales, y_b and x_b respectively, are the solutions to the Euler equations:

$$0 = P[m_b,y_t] + y_t\partial P[m_b,y_t]/\partial y_t - c^*_t e_t,$$

(3)

$$0 = P[m_b,x_t] + x_t\partial P[m_b,x_t]/\partial x_t - c_t,$$

The benchmark prices, P^*_b and P_b are equal to $P[m_b,y_b]$ and $P[m_b,x_b]$, respectively.

A. Competitiveness Effects of Exchange Rate Shocks

Next we study the link between exchange rate fluctuations and m. As we shall show, V(E,T) fall into two types: V(E,T) which cause no entry or exit (we define these as small exchange rate changes), and those which do (we call these large exchange rate changes). Large V(E,T) themselves fall into two categories: those where m^o changes in period 1 and stays permanently at the new level, and those where m^o jumps up in period 1 and then falls back to m_u.

To facilitate the characterization of the exchange shock–market structure link, we define S^*_τ during an undervaluation and overvaluation as $S^*_\tau(D,T)$ and $S^*_\tau(A,T)$ respectively. Several properties of $S^*_\tau(A,T)$ and $S^*_\tau(D,T)$ are of interest: (i) they are monotonically decreasing in A and D respectively (for all $\tau<T$), (ii) $S^*_\tau(A,T)$ is increasing in T, and $S^*_\tau(D,T)$ is decreasing in T, and (iii) $S^*_\tau(A,T)$ is non–increasing, and $S^*_\tau(D,T)$ is non–decreasing through time (for all $\tau>1$). Properties (i) and (ii) follow directly from the definition of V(E,T) and the properties of

$O\Pi^*(e_t,m_t)$. To demonstate (iii), suppose on the contrary, $S^*_{T-i-1}(A,T) < S^*_{T-i}(A,T)$. Since $e_{T-i-1} \leq e_{T-i}$, the supposition can hold only if $m_{T-i} < m_{T-i-1}$. This in turn implies exit occurs in period T–i, so $S^*_{T-i}(A,T)=0$, or $S_{T-i}=0$. But then the supposition (or $m_{T-i} < m_{T-i-1}$) implies that $S^*_{T-i-1}(A,T)$ (or S_{T-i-1}) is negative. This is a contradiction, since exit insures that they remain non–negative. A symmetric argument shows that $S^*_\tau(D,T)$ is non–decreasing with time.

We consider first the set of small V(E,T). We can ignore S_τ, since V(E,T) affects it only through changes in the m_t's. The set's end points, A' and D', are given by $S^*_1(A',T)=F$, and $S^*_1(D',T)=0$ for $m_1=m^o$. A' and D' depend on m^o as well as on T. Specifically by (i) and (ii), the longer the overvaluation is, the closer are A' and D' to e^o, and the closer m^o is to m_u (m_d), the closer is A' (D') to e^o.

Property (i) implies that for all V(E,T), where A'<E<D', neither the entry nor exit condition are binding in period 1. For any small $A<e^o$, $S^*_\tau(A,T)$ falls over time up to τ=T where $S^*_T(A,T)=S_b(m^o)$. For small $D>e^o$, $S^*_\tau(D,T)$ rises over time to $S_b(m^o)$. Clearly then neither (1) nor (2) ever binds, so m will not change. This finishes our characterization of small exchange rate shocks.

Next we characterize the first type of large V(A,T). Figure 1 shows an example. S_1 depends only on m's so $S_1=S_b$. The V(A,T) shifts S^*_o up to S^*_1, thus driving m^o to m_1. By (iii), S^*_τ shifts back to S_b, yet m remains at m_1 since neither (1) nor (2) holds after τ=1. We shall show that any V(E,T) which causes m^o to jump to an m_1 within the m_d–m_u range is a member of this first type. If m is to jump to m_1 and stay there, then (1) and (2) must not bind after τ=1. By definition of a large V(A,T), $S^*_1(A,T)=F$. By (iii), $S^*_\tau(A,T)<F$ after τ=1, so (1) does not hold regardless of the size of m_1. By definition of V(A,T), $S^*_T(A,T)=S_b$. Thus if $m_1<m_u$, $S^*_\tau(A,T)>0$ for all τ, so (2) never binds. When $m_1=m_u$, then $S^*_T(A,T)=0$ with $m=m_1$. Similar reasoning indicates that for all V(D,T) where $m_1 \geq m_d$, m jumps down to m_1 and remains there. In both cases, home firms never enter or exit since m stays in the m_d–m_u range.

We shall show that the second category of large shocks involves V(A,T) which cause m_1 to be greater than m_u. If $m_1>m_u$, then m must fall to m_u by period T. Otherwise $S^*_T(A,T)$ would be negative. Property (iii) implies that m falls from m_1 to m_u, and then remains there. For such V(A,T) all home firms exit, since with $m_1 > m_u$ $S_T < 0$. Note that no V(D,T) can drive m_1 below m_d because of home firm entry.

B. Price Effects of Small and Large Exchange Rate Changes

To summarize, small V(E,T) cause no change in market structure, while large V(E,T) do. An exchange rate shock can be "large" when it is very big (E is very different from e^o) or very long (T is large). Large shocks can change the size and home/foreign composition of m. We turn next to the effects of exchange rate movements on the price of imports.

Rearranging (3) implies import prices are related to e by:

$$P_t = \frac{1}{1 - 1/\epsilon[m_t, y_t]} c_t^* e_t. \tag{4}$$

The perceived elasticity, ϵ, is a function of m (due to the Chamberlain assumption) and y (to allow for the non–constantancy of the demand elasticity).

The time paths of P, e and m are depicted in figure 2a for a small exchange rate shock. At time zero all firms realize that e will follow the path shown. In response they lower import prices. Since the shock is small (i.e., $A' < E < e^o$) there is no change in m so that when the exchange rate returns to e^o, P returns to its original value. Figure 2b shows the time paths for a large shock. Upon announcement of the overvaluation, m jumps up. The price falls due to the marginal cost reduction (lower e reduces foreign costs measured in home currency), and to the market structure change (more competition forces down profits margins). After the overvaluation passes, the marginal costs return to their original level. However m is still higher so the post–shock price is permanently lower than the pre–shock price. This is hysteresis.

III. Empirical Evidence

The beachhead model argues that a large enough appreciation can induce entry and that the presence of additional entrants can affect pricing behavior. In a standard time series regression of the relationship between the exchange rate and import prices this event would appear as a structural break. The unprecedented magnitude and duration of the 1980s real dollar shock provides one opportunity to test the predictions of the model.

Clearly, earlier real exchange rate shocks could conceivably have induced hysteresis. However the 1980s shock dwarfs previous swings; lending support to the notion that it is the first large (as defined above) shock since the breakdown of Bretton Woods. Figure 3 shows that between 1971 and 1980 the real dollar depreciated relatively steadily, apart from a number of swings which are small compared to the 1980s swing. Krugman and Baldwin (1987) argue that the 1970s dollar decline does not reflect a shift in competitiveness (which would be required to induce hysteresis) but rather a bias in foreign productivity growth. Regardless of the cause, Mann (1986) finds that the US pass–through relationship has been quite stable prior to the 1980s. For these reasons, we test only for hysteresis during the 1980s.

The evidence in this section does not directly test the model. It is simply intended to establish 1) that the historical relationship between the exchange rate and US aggregate, non–oil import prices has shifted in the 1980s, and 2) that the nature of the shift is not inconsistent with the predictions of the model. Mann (1986), (1987a), (1987b), Foster (1986), and Feinberg (1987) find strong evidence of parameter shifts in import price pass–through equations at both the aggregate and industry level. These studies are ad hoc in that they contain no formal explanation for the cause, timing or exact nature of the parameter shifts. Related literature supports the beachhead model by showing that market structure affects foreign firms' pricing behavior (Dornbusch 1987, Feinberg 1986 and Mann 1987a).

A. Three Testable Implications

Before turning to the data, we discuss three testable implications of the model. Section 2 shows that m, and therefore ϵ, should jump up upon "announcement" of the overvaluation. The structural break should therefore occur upon announcement. Operationally, we assume that firms realized sometime in the early 1980s that persistent changes in the international mix of fiscal and monetary policies would lead to a prolonged dollar overvaluation. Thus:

Implication 1: A structural break in the pass–through equation should have occurred sometime in the early 1980s.

This implication is robust to the exact details of the imperfect competition model chosen. As long as there is a multiplicity of equilibria and real exchange rate shocks can shift the economy between these equilibria, then implication 1 would hold in the broad class of models where pricing is affected by market structure.

To formulate more specific implications about the structural break, we extend the section two model to account for lagged exchange rate effects and aggregation. All section 2 assumptions are maintained. Additionally we assume foreign firms face delivery lags and stochastic demand curves. Foreign firm j's problem is to:

$$\max_{\{y_t^j\}} E\{\sum_{t=0}^{\infty} R^t\Big[R^{n_j}P[m_{t+n_j}, y_t^j, v_{t+n_j}^j]y_t^j - c_t^{*j}e_t y_t^j - G^j\Big]\} - F^j, \tag{5}$$

where n_j is its delivery lag and $v_{t+n_j}^j$ is the variety–specific random demand shock. Note that P_{t+n_j} is a function of v and m from $t+n_j$, and y from period t. Adopting the notation that $x_{t|t-1}$ is the expectation of x_t formed at time t–1, the typical Euler equation for y_t^j is:

$$P_{t+n_j|t}^j = R^{-n_j}\Big[\frac{c_t^{*j}e_t}{1 - (1/\epsilon^j[m_{t+n_j}^h])}\Big], \tag{6}$$

Here we have assumed a constant elasticity demand curve, where the ϵ^j is a non–stochastic function of industry h's m. Assuming firms face a variety of delivery lags ranging from 0 to N periods, the log of the aggregate import price index, $P_t = \prod_{j=1}^{\ell} [P_{t|t-n_j}^j]^{\theta^j}$ (ℓ is the number of firms, θ^j is firm j's weight in the index) will be related to current and lagged values of an index of firms' marginal costs, $C_{t-i}^* = \prod_{j\in\Psi_i} [c_{t-i}^{*j}e_{t-i}]^{\theta^j}$, where Ψ_i is the set of firms with a delivery lag of i periods.

Assuming rational expectations, and using standard macroeconometric arguments, it is easy to derive the time series properties of the expectational error (u_t) when observed P's are substituted for their expectations. Namely u_t follows a moving average (MA) process of order N–1. Since u is not orthogonal to the regressands, we must instrument. Rationality also implies that any variable lagged N periods or more is a potential instrument.

Empirically we use an import price index, P_t', and a marginal cost proxy, $C_t^{*\prime}$, which we assume are related to P and C^* by: $P_t=\nu P_t'$ and $C_t=\delta C_t^{*\prime\rho}$. Defining $\lambda=(\delta/\nu)$, $\Omega^h=\sum_{j\in\Gamma_h} R^{-n_j}$ (Γ_h is the set of firms in industry h), H as the number of industries, and $\varphi_i=(\rho+\sum_{j\in\Psi_i}(\theta^j))$, the pass–through equation is:

$$\text{(7)} \qquad \log(P_t') = \log(\lambda \prod_{h=1}^{H}\left[\frac{\Omega^h}{1-(1/\epsilon^h[m_t^h])}\right]^{\theta^h}) + \sum_{i=0}^{N}\varphi_i \log(C_{t-i}^{*\prime}) + u_t.$$

The constant term is the parameter we are most interested in. (7) shows the constant term is inversely related to the ϵ^h's which are directly related to the m_t^h's. According to the beachhead model, the m_t^h's should jump up (for industries with low enough F's), forcing the ϵ^h's up, and the constant term down. Thus:

<u>Implication 2</u>: The structural break should take the form of a reduction in the constant term of equation (7) beginning sometime in the early 1980s.

In the Chamberlainian framework, additional entry increases the aggregate import price elasticity (which is simply the weighted sum of the variety–specific elasticities). Also each firm has a lower constant term but there are more firms, so the aggregate constant (which is the sum of firms' constants) may increase or decrease. Lastly, the income elasticity shift is ambiguous. This gives us:

<u>Implication 3</u>: The price elasticity in the aggregate import demand equation should rise (in absolute value) synchronous with the structural break in the pass–through equation. The constant term and income elasticity may rise, fall or remain unchanged.

B. Evaluating the Implications

To test implications 1 and 2, we estimate (7) allowing for a once–off shift in the constant term via the inclusion of an intercept dummy (see appendix for data details).[7] Table 1 presents the two stage least squares (2SLS) estimates of (7) using a WPI–based costs proxy and allowing for a maximum delivery lag of 5 quarters (N=5 was chosen a priori as a reasonable upper bound).[8] Since the exact timing of the break is not known, the equation is estimated for a variety of break points. The results provide strong support for implications 1 and 2. For each break point, the shift in the intercept term is significant and of the expected sign.

The table 1 results have several problems. First, as is usually the case with pass-through equations, the point estimates of the lagged effects are often negative or insignificant — due most likely to multicollinarity. However, for none of the negative coefficients can we reject the hypothesis that the true parameter is actually positive; nor can we accept the hypothesis that their sum is zero. Next, the Durbin–Watson statistics are low despite the fourth–order MA correction. However for all but the 1982:1 breakpoint, the values lie within the upper and lower bounds of the 5 percent points. We therefore cannot accept or reject the positive first–order autocorrelation hypothesis.

Although the WPI–based measure is probably a good proxy for marginal costs, it includes only industrialized countries — leaving open the possibility that the shift stems from the exclusion of the newly industrializing countries (NICs). Also, between 10 and 20 percent of US non–oil imports are commodities so the index can be expected to perform poorly during periods of large commodity price swings. Additionally WPIs inevitably contain the price of foreign final goods which do not affect production costs. To partially redress these problems, and to check that our results are robust to the specific cost proxy, we test implications 1 and 2 on two additional cost proxies: one based on normalized unit labor costs (NULC), and one based on consumer price indices (CPI).

NULC provides a direct measure of a significant component of firms' marginal costs. It avoids the problem of including imported final goods prices, but fails to reflect the cost of imported intermediate goods and commodities (especially fuels). Also it includes only industrialized countries. The third proxy consists of the Federal Reserve Board's foreign costs proxy, which is based on CPIs from the G–10 countries and 8 major NICs. CPIs are a poor proxy for marginal costs (inter alia, they include non–traded and imported final goods prices); however, they are available for a wider range of countries and for longer periods than are more direct measures. Details are in the appendix.

Table 2 summarizes the results for various break points and N's (multicollinearity hinders precise identification of the lag length). The CPI results, like the WPI results, strongly support implications 1 and 2. The dummies are negative and significant in all cases. The NULC data provide only weak support for the two implications. In only 2 of the 16 cases are the dummies significant at the 90 percent level. However in both cases they are negative. In all but 4 of the other cases, the dummies are negative but insignificant. The insignificance of the NULC estimates may be due in part to the shorter sample period, but also to the nature of the NULC. Since most fuels are priced in dollars, the NULC excludes a cost component which is not directly affected by the exchange rate. Clearly then the NULC underestimates foreign costs during the strong dollar period (1980–1987). This argues that the dummies may be insignificant because the coefficients overestimate the true dummy parameters.

The beachhead model predicts that the parameter shift should have occurred sometime during the rising dollar. Mann (1986) and Foster and Baldwin (1986) suggest the shift occurred at the turning point of the dollar cycle. It is not possible to formally identify the break point from the data; however, it is possible to test these two well–specified hypotheses against each other.[9] To this end we estimate equation (7), with 2SLS, including an intercept dummy for the period from the break point to the peak of the dollar and a second for the post–peak period. If the beachhead model is correct, both dummies should be negative and significant; if the alternative is correct, only the second dummy should be significant. Table 3 presents the results.

For the WPI data (which is arguably the best proxy) the alternative is clearly rejected. For all the various break points both dummies are negative, and in all but 1 case they are significant. The NULC data tend to reject both hypotheses. In all cases the dummies are insignificant. In 3 cases both dummies are negative while in one case the first is positive and the second is negative. Again the low degrees of freedom and biases may account for these results.

The CPI data are ambiguous. In one case both dummies are negative and significant. In the other cases the first dummy is insignificant and in one case it is actually positive. The divergence of the CPI and WPI results may be due to the composition of the CPIs. If foreign currency production costs are constant, a rising dollar increases the competitiveness and therefore the sales of foreign firms. However the increased sales tend to put upward pressure on the foreign production costs (e.g., wages). Since CPIs place substantial weight on non–traded goods (housing and services) which are not directly subject to the upward pressure, the CPI underestimates foreign production costs during rising dollar periods. Consequently, the point estimates on the first dummy may be insignificant since they underestimate the true parameter.

Next we turn to implication 3 by testing an aggregate import demand equation for parameter shifts.[10] Specifically, working with first differences, we regress the log of non–oil import volume on the log of real US GNP and the log of current and 6 lags (quarterly data) of relative import prices.[11] The lag coefficients are constrained to follow a third order polynomial (data details are in the appendix).

Table 4 presents two types of evidence. The first line shows the point estimates and t–ratios for the import demand equation estimated on the entire sample period 1967:1 to 1987:2. The next 8 lines show how they change when the same equation is estimated on pre– and post–break data. For all four break points, the post–break demand is more elastic, providing some support for implication 3. However only in case 5 are the parameter shifts statistically significant. The second type of evidence is the results for import demand equations which include dummies for the constant and price elasticity terms. Slope dummies are allowed for the current and lagged price terms. Only the sum of the lags and dummies are reported.[12] The intercept and slope dummies are insignificant in all four cases and are evenly split between positive and negative point estimates.

Table 4 provides little support for implication 3. This does not necessarily cast doubt on the basic hysteresis hypothesis because implication 3 is not robust to small changes in the market structure assumptions. As is well–known, in a symmetric Cournot equilibrium with homogeneous products, each firm faces the total demand elasticity multiplied by the number of firms. Additional entry makes each firm face a more elastic demand curve but does not shift the aggregate curve. To make our basic theoretical point most clearly, we utilized the familiar Chamberlainian setup. If, as in Baldwin (1986), we had worked with homogeneous products, no volume equation shifts would be expected.

Tables 1 and 2 indicate that the elasticities perceived by individual firms increased; but table 4 indicates that the aggregate elasticity did not. One interpretation of these results is that most of the new entrants entered markets marked by homogeneous goods.

IV. Conclusions

This paper shows that in a simple industrial organization model, large exchange rate shocks can have persistent real effects, while small shocks cannot. In particular it shows that large exchange rate movements should be correlated with parameter shifts in standard, estimated trade equations. Moreover we conjecture that the possibility of hysteresis has theoretical implications for several fundamental issues in international economics. Further theoretical research is required to explore this conjecture.

Empirical tests find evidence for the predicted structural breaks in the US pass–through equation in the 1980s, although not for the import volume equation. In particular, we find evidence that the structural break in the pass–through equation occurred in the rising dollar phase rather than in 1985 as is commonly asserted. Nevertheless, the tests have little power against alternative hypotheses so the breaks may be due to causes totally unrelated to the beachhead model. Further empirical work is needed to directly evaluate the model. Direct tests require time series data on the number of varieties of imported goods and their close substitutes on an industry–level. Unfortunately, such data (or good proxies) appear to exist only for a few industries (e.g., automobiles). A direct test of the model on macro data therefore appears to be impossible.

Finally, the beachhead model focuses on supply–side factors, yet empirically demand–side factors may be even more important. In the familiar experience–goods framework, it seems likely that real exchange rate shocks could cause persistent changes in consumers' information sets, and thereby have hysteretic effects. Additional research is needed to explore this conjecture.

FOOTNOTES

1. Hysteresis is the "failure of a property changed by an external agent to return to its original value when the cause of the change is removed".

2. If F and G involved foreign currency costs, appreciations would lower entry costs as well as marginal costs, making entry more likely.

3. Allowing for the possibility that not all of the sunk asset disappears when the firm exits, would imply that the re–entry costs are below entry costs. This consideration would complicate the analysis without providing any compensating insight.

4. For example, Dornbusch (1976).

5. Baldwin and Krugman (1986), and Dixit (1987a) make alternative assumptions.

6. This assumption reduces the number of cases which must be addressed in determining the impact of V(E,T) on m, but it does not alter the main results.

7. We assume that the 1980s shock was a large V(A,T) of the first type since not all competing US firms exited.

8. For instruments, we use lagged values of the nominal exchange rate, the nominal foreign cost proxy and nominal domestic costs.

9. If a test statistic is to have a well–defined distribution under both the null and alternative hypotheses, the model must be correct under both. That is, the hypotheses must be nested. Searching for break points violates this condition. Nevertheless, it may be of interest that for the WPI data the 1982:3 breakpoint had the highest R–squared.

10. A standard assumption used to identify the import demand equation is to assume that supply is infinitely elastic.

11. Imports and GNP are trended, so the asymototic distribution of the estimator is not well–defined. First differencing removes the time series' explosive component.

12. As usual the point estimates on lagged price effects are often negative or insignificant due most likely to multicollinearity.

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APPENDIX

Figure 3 is based the Federal Reserve Board's foreign cost proxy converted to dollars and divided by the US GNP deflator. The Board's proxy is a trade–weighted index of CPIs from the G–10 and Mexico, Brazil, Taiwan, Singapore, Hong Kong, South Korea, Philippines and Malaysia. Table 1 uses the NIA non–oil import price and a dollar–denominated, import–weighted marginal costs proxy made from IMF data on manufactured goods WPIs from Canada, Japan, Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland and UK. Both measures are deflated by the US manufactured goods WPI. For lack of a better measure, we use the NIA deflator (which is a variable weight index based on unit value indices). Shifts in import commodity composition may contribute to the parameter shifts. This cannot be the whole explanation since many studies show that even industry level pass–through equations (where fixed weight indices are used) have shifted.

Table 2 NULC data is a dollar–denominated, import–weighted index of the IMF NULC data from the above mentioned 15 countries and the NIA deflator, both divided by the US NULC.

Table 4 data is the NIA non–oil import value converted to volume by the corresponding deflator; and the relative price term is the the NIA deflator divided by the US GNP deflator. These data choices are standard (Helkie and Hooper 1986) but subject to well known measurement error biases. However there is no reason to suspect that the biases have changed, so the structural break tests are still valid.

Table 1: Estimate Results for Pass-Through Equation on WPI data, N=5

Break Point	C	DUMMY	LMC	LMC_{-1}	LMC_{-2}	LMC_{-3}	LMC_{-4}	LMC_{-5}	SE	DW	R^2
1980:3	3.3	-.08	.23	-.38	.14	.11	-.06	.25	.03	1.2	.90
	(10.5)	(-3.3)	(1.1)	(-1.3)	(.8)	(.4)	(-.2)	(1.6)			
1982:1	5.1	-.18	-.20	.04	.22	.01	-.12	-.07	.04	0.9	.80
	(3.8)	(-2.1)	(-.6)	(.2)	(.9)	(.0)	(-.3)	(-.2)			
1982.3	3.9	-.11	-.07	.11	.19	.11	-.13	-.07	.02	1.7	.96
	(10.4)	(-4.2)	(-.4)	(.6)	(2.2)	(.7)	(-.8)	(-.5)			
1983:1	3.3	-.07	-.00	.08	.31	-.11	.04	-.03	.02	1.3	.95
	(13.4)	(-4.0)	(-.0)	(.3)	(3.0)	(-.5)	(.2)	(-.2)			

t-statistics in parentheses.
LMC indicates log of marginal cost proxy.
DUMMY indicates intercept dummy.
C indicates constant term.
SE indicates standard error of regression.
DW indicates Durbin-Watson statistic.
R^2 indicates R-squared statistic.
Sample period 1975:1-1987:1, quarterly data.

TABLE 2 - Intercept Dummies: Various Data Sets and Break Points

	Sample period:	Manuf. WPI (1975:1-'87:1)	Unit Labor Cost (1975:1-'86:3)	CPI (1967:1-'87:2)
Max. Lag	Break Point			
(N=7)	1980:3	na	-	- **
	1982.1	na	-	- **
	1982.3	- **	+	- **
	1983.1	- **	+	- **
(N=5)	1980:3	- **	na	- **
	1982.1	- **	+	- **
	1982.3	- **	+	- **
	1983.1	- **	na	- **
(N=4)	1980:3	- **	-	- **
	1982.1	- **	-	- **
	1982.3	- **	- *	- **
	1983.1	- **	-	- **
(N=3)	1980:3	- **	-	- **
	1982.1	- **	-	- **
	1982.3	- **	- **	- **
	1983.1	- **	na	- **

- indicates that intercept dummy is negative, implying that perceived demand elasticity increases in magnitude after break point.
+ indicates that intercept dummy is positive, implying that perceived demand elasticity decreases in magnitude after break point.
na indicates the test could not be performed due to non-convergence.
** indicates no change in constant term hypothesis rejected at 95% level.
* indicates no change in constant term hypothesis rejected at 90% level.

Table 3: Tests for Timing of Structural Break in Pass-Through Equation, N=5

	WPI		NULC		CPI	
	Rising $ Dummy	Falling $ Dummy	Rising $ Dummy	Falling $ Dummy	Rising $ Dummy	Falling $ Dummy
Break Point						
1980:3	- *	- **	+	-	+	- **
1982:1	-	- *	-	-	- *	- **
1982:3	- *	- **	-	-	-	- **
1983:1	- **	- **	-	-	-	- **

- indicates intercept dummy is negative.
+ indicates intercept dummy is positve.
* indicates dummy is significant at 90 percent level.
** indicates dummy is significant at 99 percent level.

Table 4 : Structural Break Tests on Import Volume Equation, 1st differences

ESTIMATION ON SUB-SAMPLES

Case	Sample Period	C	(t-stat)	GNP	(t-stat)	Sum of Terms	Price (t-stat)	SE	DW	R^2
1	67:1-87:2	.004	(0.7)	2.07	(4.2)	-0.80	(-2.1)	.04	2.6	.34
2	67:1-80:3	.003	(0.3)	1.91	(2.7)	-0.69	(-1.1)	.05	2.6	.32
	80:4-87:2	.000	(0.0)	2.40	(3.1)	-1.08	(-1.1)	.03	2.7	.35
3	67:1-82:1	.003	(0.3)	1.92	(3.3)	-0.63	(-1.2)	.05	2.6	.32
	82:2-87:2	-.026	(-1.3)	2.93	(2.8)	-2.10	(-1.8)	.03	3.1	.46
4	67:1-82:3	.003	(0.5)	1.89	(3.4)	-0.70	(-1.4)	.05	2.6	.32
	82:4-87:2	-.029	(-1.4)	3.58	(2.8)	-1.63	(-1.3)	.03	2.4	.50
5	67:1-83:1	.003	(0.3)	1.94	(3.4)	-0.67	(-1.4)	.05	2.6	.3
	83:2-87:2	-.021	(-1.7)	2.51	(3.1)	-2.26	(-2.4)	.02	1.6	.73

ESTIMATION WITH DUMMIES

Break Point	Intercept Dummy	Sum of Price Dummies
1980:3	-	-
1982:1	-	-
1982:3	+	+
1983:1	+	+

Price term is sum of coefficients on current and 6 lagged terms.
C indicates constant term.
None of the dummies are significant at the 90 percent level.

Figure 1: Equilibrium range of firms

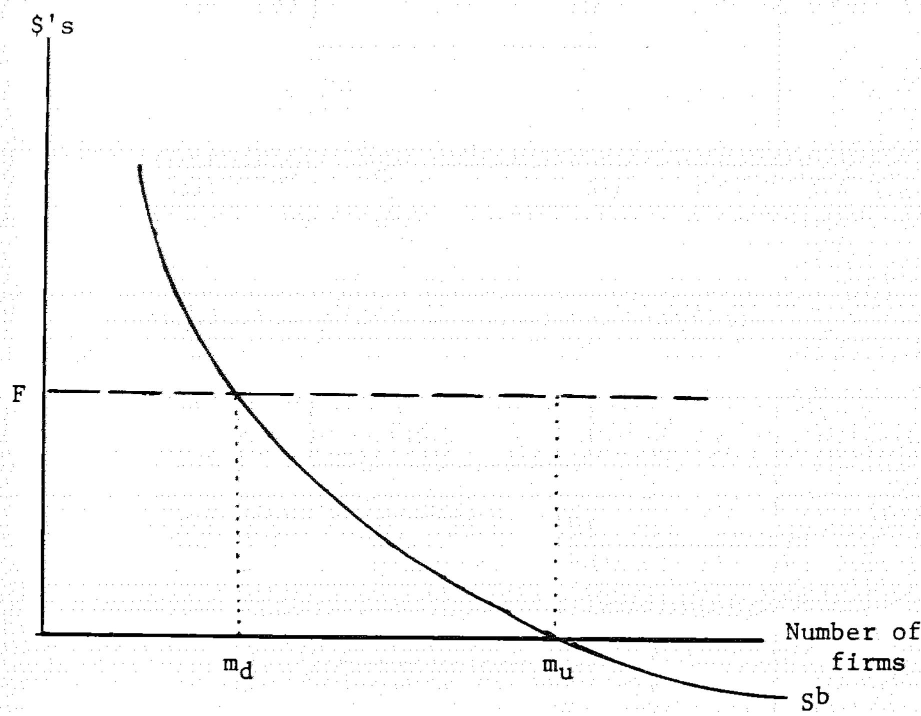

Figure 2a: Time Paths of e, m, P for Small Overvaluation

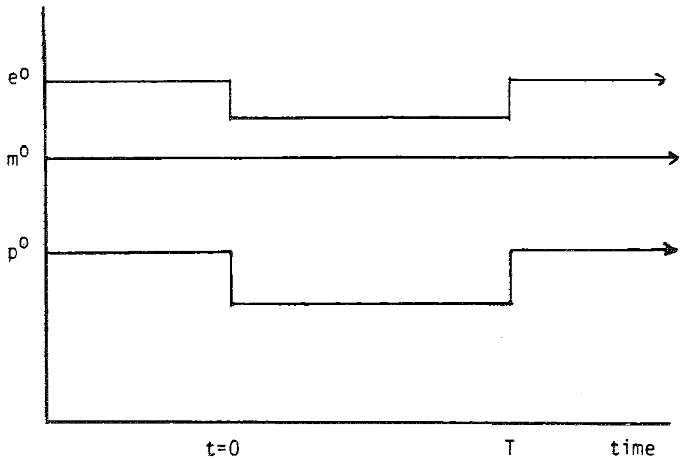

Figure 2b: Time Paths of e, m, P for Large Overvaluation

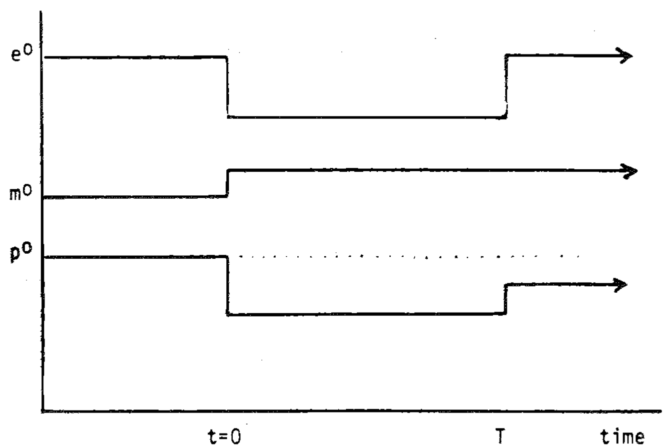

Figure 3: The US Dollar Real Exchange Rate