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Exchange Rate Economic Exposure when Market Share Matters and Hedging Using Currency Options[1]

Abstract

- The paper develops a model of exchange rate economic exposure faced by an exporting firm which participates in a competitive globalised export market. This firm is assumed to have a market share expansion objective and publish a dual-currency price list.
- The issue of hedging is also discussed on the basis of currency derivative instruments.

Key Results

It is shown that the risk profile of economic exposure is asymmetric depending whether the domestic currency depreciates or appreciates. Exporting firms which have a market share expansion objective and publish dual-currency price lists should hedge their economic exposure using currency options only.

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Introduction

This paper investigates the implications of exposure to movements in real (inflation-adjusted) exchange rates on the profit margins and/or market shares of firms whose activities cross national boundaries. Such firms include multinationals, as well as any firm which either imports inputs or exports some or all of its outputs. Exposure to movements in real exchange rates, from now on referred to as economic exposure [2, 3], arises in competitive (but not monopolistic) markets, in which competitors incur significant production costs, denominated in currencies which differ between firms, usually because the firms' production units are located in different countries. When firms which participate in the same market incur costs denominated in different currencies, the market concerned is said to be globalised.[4] In summary, economic exposure arises if three conditions are met: markets are competitive, markets are globalised and real exchange rates change.

A number of cases of economic exposure can be cited, which highlight the practical aspects of the problem. For example, Caterpillar, the U.S.A. heavy machinery manufacturer, faces economic exposure to movements in the Yen/$ exchange rate, since the costs of its main competitor (Komatsu) are denominated in Yen. After the real appreciation of the $ against the Yen in 1985, Caterpillar suffered a reduction in both market share and profit margin, because Komatsu was able to cut its prices and penetrate new markets. At the same time, Kodak, the U.S. photographic materials manufacturer, experienced a similar squeeze in profitability because its main competitor is Fuji, with costs also denominated in Yen. (Corporate Finance 1988).

The practical relevance of economic exposure provides the motivation for attempting to model methods of hedging against this problem.

The objective of this paper is to develop a model of economic exposure, under a new set of assumptions concerning the nature of globalised markets and the objectives of firms competing therein. Specifically, it is assumed that in globalised markets in which the level of competition is increasing over time, exporting firms pursue a market share expansion objective. To meet this objective, exporting firms publish a 'dual-currency' price list. The availability of the option for customers to make payment in either currency has implications for the profile of economic exposure, which is asymmetric depending whether the domestic currency depreciates or appreciates. Additionally, several industry-specific parameters (including relative productive efficiency and the level of competition) may affect the degree of this asymmetry.

Finally, the paper argues that an asymmetric economic exposure should be hedged using currency options only. Several currency option strategies can be designed, to hedge specific exposures whose degree of asymmetry depends upon industry-specific parameters.

Exchange Rate Economic Exposure and Hedging: Previous Work

Previous research on economic exposure can be classified into two broad categories.

The first comprises papers (Mann 1986, Lessard and Lightstone 1986, Flood and Lessard 1986, Dornbusch 1987, Fisher 1989) which seek to model the underlying factors which determine economic exposure. The nature of the firm's demand function (reflecting market structure, the level of competition and the degree of product differentiation) and the shape of its marginal cost curve are prime determinants of the extent of economic exposure. These papers do not allow for the effect on economic exposure of strategic decisions which may be taken by oligopolistic firms.

In contrast, papers in the second category (Flood 1985, Ware and Winter 1988, Luehrman 1990) model economic exposure under various assumptions regarding the strategic behaviour of firms in imperfectly competitive markets.

Luehrman (1990) allows for strategic responses to exchange rate shocks by participants in an imperfectly competitive global market. These responses are reflected in the ex-post adjustment of the optimal level of output after the realisation of the exchange rate. The economic exposure of an oligopolistic firm is found to be affected by its competitors' responses, although the effect is independent of the direction of the exchange rate movement, and is thus symmetric.

Ware and Winter (1988) focus on firms with strategic options (and therefore flexibility) and their export or import and production decisions, suggesting that their model is relevant for multinationals. They derive an asymmetric, convex risk profile of economic exposure, the nature of which depends upon whether the currency appreciates or depreciates.

Flood (1985) examines the effects on economic exposure of increasing competitive pressures in global markets. Exposure is shown to increase as competition increases, and firms are assumed to respond by adopting strategies such as seeking reductions in marginal costs and product differentiation. Such strategies are shown to be effective in reducing the magnitude of economic exposure although, in common with Luehrman (1990), the profile of exposure is symmetric between appreciation or depreciation of the exchange rate.

In this paper, economic exposure is modelled under a new assumption concerning the way in which firms respond to increased global competition. It is assumed that exporting firms pursue a market share expansion (or protection) objective, when faced with exchange rate shocks. Some empirical evidence in support of this hypothesis is produced. It is shown that firms can best pursue this objective by publishing prices which are denominated in both the domestic and foreign currencies; i.e. a dual-currency price list. The main theoretical contribution

of the paper is the conclusion that firms which operate in this way will face a concave, and thus, asymmetric, profile of economic exposure.

The model developed in this paper belongs in the second category of research on economic exposure, but also differs from previous work in this category. It differs from Flood (1985) in respect of the policies assumed to be adopted by firms to cope with increased competition, and in respect of the shape of the exposure profile which is derived. By focusing primarily on exporting firms, it differs from Ware and Winter (1988), whose main concern is the multinational firm; this distinction also has implications for the shape and the symmetry of the exposure profile. Finally, the present model differs from that of Luehrman (1990) in respect of the assumptions made about responses of competitors; here, the main distinction is between Luehrman's assumption of ex-post adjustment of output and our assumption of ex-ante publication of a dual-currency price list. Again, the different assumptions lead to different conclusions concerning the symmetry or asymmetry of the exposure profile.

Hedging strategies for managing economic exposure have also been investigated extensively in the previous finance literature. Srinivasulu (1981), Aggarwal and Soenen (1989) and Lessard and Lightstone (1986) argue that economic exposure should be managed strategically, by developing production plants and/or sourcing in countries whose currencies are undervalued. This approach emphasizes the role of real options[5, 6] for management of exposure in the long-term.

In contrast, Adler and Dumas (1984) emphasise the point that exposure also has short-term, dynamic aspects, which can not be dealt with by means of real options involving long-term strategic commitments. Evidently, time lags in 'placing' real option hedges may entail hedging inefficiency.[7] Such difficulties are more readily resolved by financial (rather than strategic) hedging. Ware and Winter (1988) focus on financial hedging and show that the convex exposure faced by multinational companies can be hedged using short currency options.

In the present paper, financial (rather than strategic) hedging is considered. The novel hedging hypothesis which is proposed is that the concave profile of economic exposure faced by exporters who publish a dual-currency price list, should be hedged by a long call on the currency in which the exporter's costs are denominated.

A Model of Economic Exposure in Competitive Globalised Markets where Market Share Matters

Assumptions

A number of standard assumptions which have been employed in previous investigations of economic exposure are adopted here. A two period (T_0 and T_1) export pricing model with two market participants is assumed. For simplicity, a U.S.-U.K. framework is adopted. A U.K. firm whose production costs and borrowings are denominated in £s exports to the U.S. market and competes against a U.S. firm whose costs and borrowings are denominated in $s.[8] Therefore, the U.S. market is a 'globalised' competitive market. Inflation rates are zero and there are no changes in income. Based on a partial equilibrium approach[9], nominal (and thus, real) exchange rate determination and the formulation of expectations are trivial under these conditions. Finally, the exchange rate is assumed to be stochastic.

Both firms are assumed to produce a homogeneous product under the same production function. Therefore, when the real exchange rate is at its equilibrium level, the ratio of relative costs (expressed in a common currency) is 1.

The export pricing decision is assumed to be based only on the conditions in the export (U.S.) market, so the Law of One Price does not hold.

The U.K. firm is assumed to have a market share expansion objective. It prefers protecting its market share when the £ appreciates and expanding its share when the £ depreciates to increase its profit margin.

The latter assumption is a key one, and merits further elaboration and justification. One rationale is provided by the empirical evidence produced by Cavusgil (1988) and Mann (1986). Cavusgil (1988), after interviewing business executives about their export pricing behaviour, concludes that as competition grows, firms tend to shift from profit maximising towards managerial objectives, placing greater emphasis on market share than on profit margin. Mann (1986) reaches a similar conclusion in respect of the objectives of foreign firms exporting to the U.S., which were facing increased competition in the U.S. market from new producers at the time of the study. Overall, this evidence supports our assumption that in competitive globalised markets, exporting firms pursue objectives related to market share rather than profit margin.

The next assumption is that if an exporting firm has a market share expansion objective, it will respond to a devaluation of the domestic currency by passing this devaluation on to the foreign market as a price discount, rather than by increasing its profit margin. This assumption is justified theoretically by Froot and Klemperer (1989), and empirically by Marston (1990) and Moreno (1991).

Froot and Klemperer (1989) conclude that if market share matters, a domestic currency depreciation will make the exporting firm impose a 'low' foreign currency export price, and thus hold the domestic currency price relatively fixed. The

higher the preference for market share over profit margin, the lower will be the increase in the domestic currency price.

This theoretical result is compatible with the empirical evidence of Marston (1990) who finds that for some commodities exported from Japan to the U.S. during the 1980's, the Yen-export price was constant when the Yen was depreciating (and thus, the $-import price was decreasing proportionately with the Yen depreciation). Such pricing behaviour suggests that Japanese firms were attempting to expand their U.S. market share while the Yen was depreciating.

Similar empirical evidence is provided by Moreno (1991), who attempts to explain the extraordinary performance of U.S. export sales during the second half of the 1980's , when the $ was depreciating. Ruling out explanations based solely on world market conditions, he argues that the observed phenomenon was primarily due to increased competitiveness resulting from modest pricing behaviour on the part of U.S. firms. Such behaviour '... would be consistent with growing competitive pressures caused by the entry of producers from Japan, and later the newly industrialising Asian economies in world markets previously dominated by U.S. producers'.[10]

A corollary of these assumptions, as far as the model is concerned, is that the U.K. firm seeks to undercut its competitors (and gain market share) when the £ depreciates, and to avoid being undercut (and losing market share) when the £ appreciates. This can be achieved by fixing the price in both £- and $-terms, i.e. publishing a 'dual-currency'[11,12] price list.

If the £ actually depreciates, U.S. customers will choose the £-denominated price since this price, when expressed in $s, will incorporate the discount effects of the depreciation. If the facility to pay in £s were not available, the firm would not undercut its U.S. competitor, since the price in $s would be unaffected, and the depreciation of the £ would entail a higher profit margin, and not a price reduction. Thus, under the facility to pay the price in £s, the effective $-price reflects the extent of the depreciation of the £.

On the other hand, if the £ actually appreciates, U.S. customers will choose to pay the $-denominated price, since the £-denominated price expressed in $s will have risen. If the facility to pay the $-denominated price were not available, the firm would be undercut by its U.S. competitor and would lose market share.

Consequently, regardless of which currency actually depreciates, the firm's effective $-bid export price (under either currency) always reflects the discount effects of the depreciation. In other words, a dual-currency price gives U.S. customers flexibility to buy the good in the currency which actually depreciates, to the benefit of the firm's market share expansion objective.

In summary, the statement that the U.K. firm will publish a dual-currency price list is a corollary of the assumptions that the firm has a market share expansion objective (as a result of its participation in competitive globalised markets) and wishes to price competitively in pursuit of this goal. Table 1 provides a summary of the key assumptions.

Table 1. Summary of the Key Assumptions

Assumption	Evidence
1. In Globalised competitive markets (where economic exposure arises), firms tend to adopt a market share expansion objective	Cavusgil (1988) Mann (1986)
2. When firms have a market share expansion objective, they tend to pass actual depreciations of the domestic currency on to export markets as price discounts	Froot and Klemperer (1988) Marston (1990) Moreno (1991)
3. In globalised competitive markets where firms have a market share expansion objective, they will publish dual-currency price lists	Corollary based on assumptions 1 and 2

Notation

p_e: the export price quoted by the U.K. firm, in £s.
e: the expected value at T_0 of the exchange rate at T_1; units of $s per £1.
p_e^* $(= e \times p_e)$: the price quoted by the U.S. firm, in $s.
s: the realised exchange rate at T_1.
P (P*): the effective bid price in £s ($s) of the U.K. (U.S.) firm, after the realisation of s.

Model Description

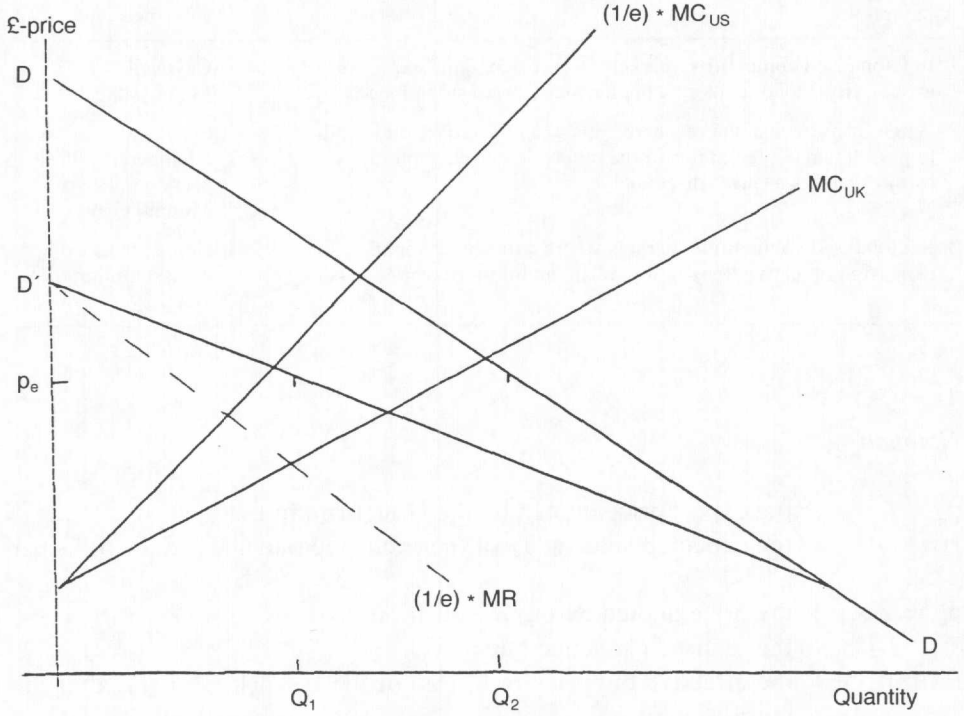
At time T_0, both firms face the problem of setting their selling price for time T_1, on the basis of the same expected exchange rate e. For expositional purposes, we assume that e is lower than the Purchasing-Power-Parity (PPP) rate, at which the marginal costs of the two firms coincide.

This means that the marginal cost curve of the U.K. firm is below the expected marginal cost curve of the U.S. firm, when the latter is expressed in £-terms using e. Thus, the U.K. firm is expected to be the low-cost price leader. The determination of the optimal export price in £s under the price-leadership model [13] is depicted in Figure 1. The optimal expected price is p_e.

At T_0, the U.K. firm publishes its dual currency price as $[p_e, p_e^*]$.

The U.S. firm faces exactly the same pricing problem, since it has the same production function, adopts the same expected exchange rate e, and thus faces an expected marginal cost curve as indicated in Figure 1. As a result of the homogeneous product assumption, the U.S. firm follows the price of the U.K. firm, so its price is p_e^*.

Figure 1. The Price Optimisation Problem of the U.K. firm, under the Price Leadership Model



$(½) \times MC_{US}$:	Expected marginal cost curve of the U.S. firm, in £-terms
MC_{UK}:	Marginal cost curve of the U.K. firm
DD:	Market demand in the U.S.
D′D:	Expected residual demand faced by the U.K firm (= DD − $(½) \times MC_{US}$)
$(½) \times MR$:	Expected marginal revenue curve
OQ_1:	Expected market share of the U.K. firm
Q_1Q_2:	Expected market share of the U.S. firm

At T_1, when s is realised, the effective bid price submitted by the U.K. firm in \$s is as follows:

$$(1) \qquad P^* = \begin{cases} p_e \times s, & \text{if } s < e \quad \text{(depreciation of £)} \\ p_e^*, & \text{if } s > e \quad \text{(appreciation of £)} \end{cases}$$

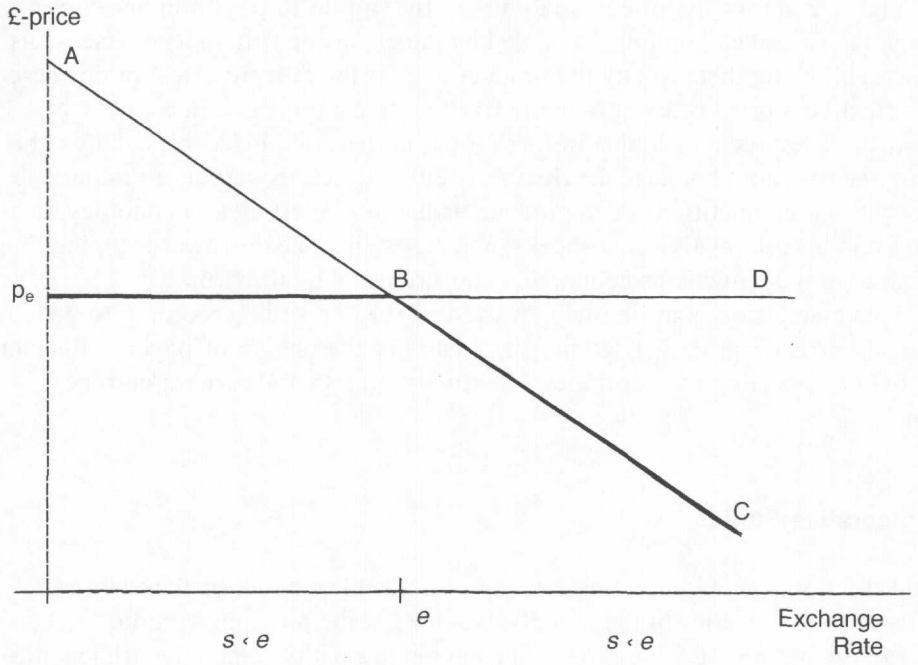
The bid price submitted by the U.S. firm is p_e^*, which is unaffected by s.

The market equilibrium price, determined by the lower \$-bid price of the two firms at any level of s, is as follows:

$$(2) \qquad P^* = \text{MIN}\,[p_e \times e,\ p_e \times s].$$

This is the exchange rate pass through relationship.

Figure 2. The Risk Profile of Economic Exposure of the U.K. Firm which Publishes a Dual-Currency Price



p_eD: The bid price of the U.K. firm
AC: The bid price of the U.S. firm, in £-terms
p_eBC: The locus of market equilibrium prices at any level of actual exchange rate. This is the locus of the lowest of the two bid prices, at any level of exchange rate
e: Exercise price of the granted business option

By dividing both sides of (2) by *s*, we can convert the $-bid price (P*) into its £-equivalent (P) as follows:

$$(3) \qquad P = \text{MIN}\left[p_e \times \frac{e}{s}, p_e\right].$$

Equation (3) expresses the economic exposure faced by the U.K. firm. Figure 2 provides a pictorial representation of (3).

The exposure profile p_eBC in Figure 2 is asymmetric. Any depreciation of the £ leaves the £-price unaffected at p_e, with the full benefit of the depreciation passed on to U.S. customers, whose effective $-price is reduced as a result of making payment in £s. On the other hand, if the £ appreciates, then U.S. customers pay the price denominated in $s, p_e^*, and the £-price received by the U.K. firm is less than p_e. The greater the appreciation of the £, the lower is the price received by

the U.K. firm. The decrease in P is proportional to the appreciation of the £, so section BC of the exposure profile in Figure 2 has a slope of –1.

Figure 2 shows that the availability of the option to pay in either currency amounts to a real call option [14] awarded by the exporting firm to its overseas customers, allowing them to buy the product in £s if the £ depreciates. In this case, the effective $ price is lower than the fixed price denominated in $s, p_e^*.

If the £ appreciates, the firm faces a cut in the price it receives. This is because the firm does not have the flexibility either to sell its output to another market (with no competition) or to produce using a more efficient technology, enabling it to absorb relative cost shocks, and realise p_e. The downward sloping line BC in Figure 2 depicts the economic exposure faced by the firm.

This conclusion is in line with Warren's (1987) results, according to which, 'a dual currency price list, giving the customer the choice of paying either in his own or his supplier's currency effectively offers a customer a currency option'.

Comparative Statics

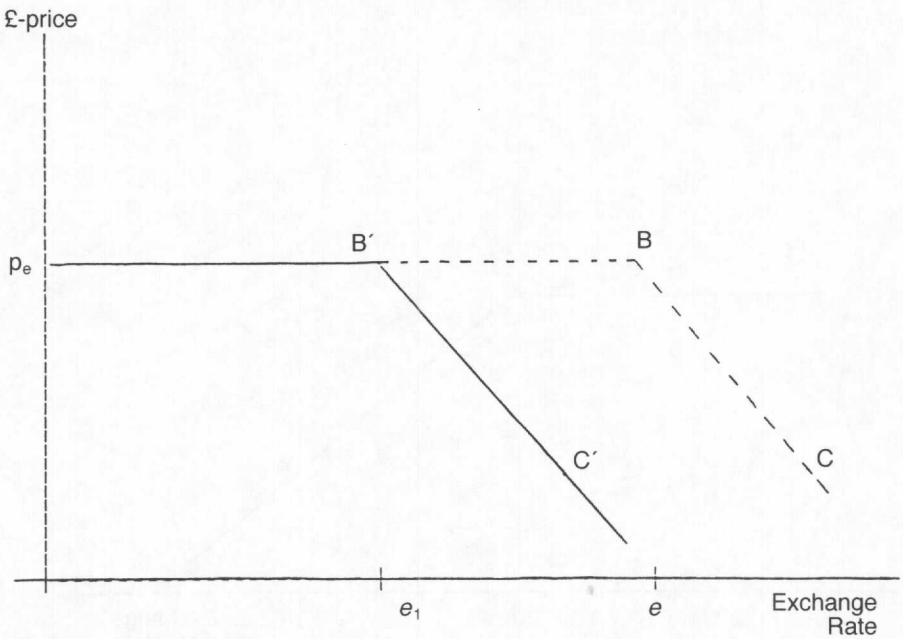
In this section, two of our earlier assumptions are relaxed in turn, in order to study the comparative statics of the model developed in the previous section.

Firstly, suppose that the U.S. producer operates with a relatively efficient production technology. This means that when the real exchange rate is at its equilibrium level (PPP holds), the marginal cost curve of the U.S. firm, expressed in £s, lies below that of the U.K. firm, and not above as in Figure 1. It follows that the more efficient the U.S. firm, the greater is the expected depreciation of the £ required to push the expected marginal cost curve of the U.S. firm above that of the U.K. firm. In other words, the more efficient the U.S. firm, the lower is the range of expected exchange rates at which the U.K. firm will be the price leader, and thus impose its price p_e, and the higher is the range of exchange rates at which the U.K. firm will act as a price taker and thus face economic exposure.

In terms of the earlier diagrammatic framework in Figure 3, the profile of economic exposure is horizontal up to some exchange rate $e_1 < e$. Beyond e_1, the profile becomes downward sloping. Therefore, the U.K. firm now faces economic exposure over a wider range of exchange rates than before. The locus $p_eB'C'$ reflects the consequences of competing against a more efficient producer, and portrays a case of more severe exposure than that portrayed by p_eBC, when the firms operate with equivalent production efficiency. The above results are compatible with those of Lessard and Lightstone (1986).

The second comparative statics analysis examines the effects of different attitudes concerning the trade-off between market share and profit margin when the £ depreciates. Such attitudes may reflect differences in the utility function of the

Figure 3. Economic Exposure of the U.K. Firm, if its Competitor is More Efficient



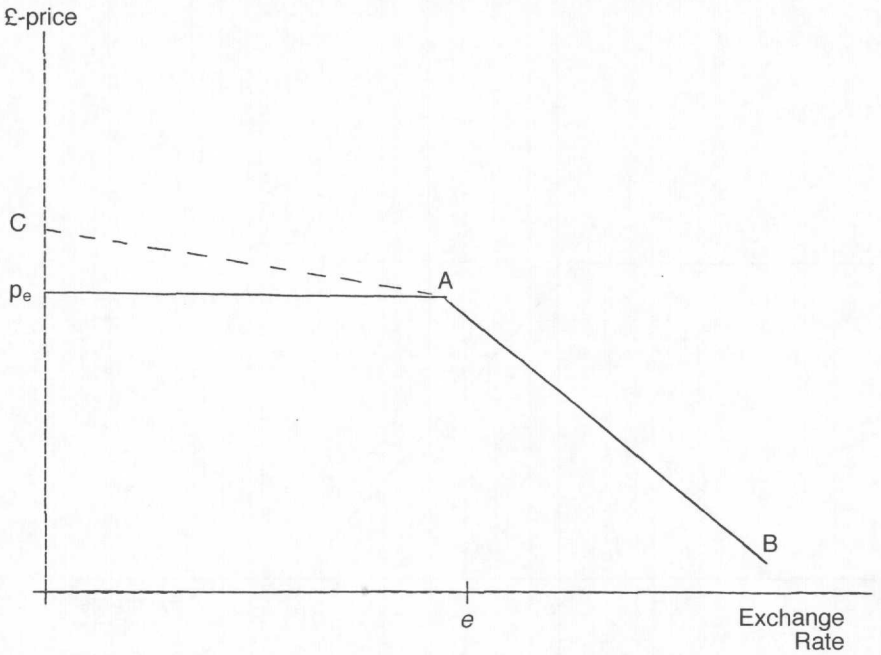
$p_eB'C'$: Exposure when the U.S. firm is more efficient
p_eBC: Exposure when both competitors are at the same level of efficiency

exporting firm, or different levels of competition or product homogeneity in the market.

For practical purposes, if the firm's objective function is such that the firm would choose some combination of a higher profit margin and an increased market share when the exchange rate falls, this suggests that the export price should be expressed partially in £s and partially in $s. This implies the price list can be written as $[a \times p_e + (1-a) \times p_e^*, p_e^*]$, where a and $(1-a)$ are weights, and $0 =< a <= 1$. These weights effectively depend upon the level of competition in the market and the firm's preferences regarding the trade-off between market share and profit margin. If the firm wants to increase its profit margin when the currency depreciates, it should set $a = 0$, which implies that it does not offer the customer the option to pay in £s. If the firm wants to exploit a currency depreciation to increase its market share by effectively cutting its price, it should set $a = 1$, as in the earlier analysis.

Clearly, different weights entail different exposure profiles. If $0 < a < 1$, a specific version of asymmetric economic exposure is obtained, which may be termed weakly asymmetric economic exposure (as distinct from the strongly asymmetric exposure depicted in Figure 2). Weakly asymmetric exposure is depicted in Figure 4.

Figure 4. Economic Exposure when the Firm has a More Balanced Attitude over Profit Margins



p_eAB: Economic exposure, if price is $[p_e, p_e^*]$ $(a=1)$
CAB: Economic exposure, if price is $[a \times p_e + (1-a) \times p_e^*, p_e^*]$, $(a < 1)$.

From the above, it could be argued that the U.K. firm will evaluate the competitive pressures in the market, and on the basis of its objectives concerning market share and profit margin, and its relative efficiency in production, will set a price list (p_e, p_e^* and a) which results in a specific type of economic exposure. Different levels of relative efficiency in production and different objectives regarding market share or profit margin lead to different exposure profiles.

Financial hedging against this exposure should involve an instrument which is flexible enough to exactly match various exposure profiles. The next section takes up the question of selecting an appropriate financial hedging strategy.

Financial Hedging Against Economic Exposure When Market Share Matters: Long Calls on Domestic Currency

The design of a hedging policy against economic exposure should be based on the profile of that exposure. In fact, efficient hedging (i.e. hedging which renders the

price independent of the actual exchange rate) requires that the profile of the hedging instrument should be the mirror image of that of the exposure. This means that a forward or futures contract cannot efficiently hedge the asymmetric exposure profile shown in Figure 2, since the profile of such contracts is symmetric (Ware and Winter 1988).

Concave economic exposure can be hedged by a call option on the £. The call should be placed at T_0, have an exercise rate equal to the expected exchange rate e (on which the optimal price is based), and expire at T_1.

If $s > e$ at T_1, then the call is in the money and its value is:

(4a) $c^* = s - e$ in \$ terms or

(4b) $c = \frac{s-e}{s}$ in £ terms

If the realised exchange rate at T_1 is s, then the loss to the firm in terms of the \$-price, dP*, is given by the first derivative of (2):

(5 a) $\frac{dP^*}{ds} = p_e$ or $dP^* = p_e \times ds$ or $dP^* = p_e \times (s-e)$

By dividing both sides of (5 a) by s, we convert the \$-price loss into its equivalent £-price loss, dP,:

(5 b) $\frac{dP^*}{s} = p_e \times \frac{s-e}{s}$ or $dP = p_e \times \frac{s-e}{s}$

By combining (4 b) with (5 b), it can be seen that this call option will perfectly hedge economic exposure if the hedge ratio (number of calls per unit of output exported), h, is:

(6) $h = p_e$.

If $s > e$, and C denotes the premium of the call when the hedge is placed at T_0, the net price after hedging, p_h, is as follows:

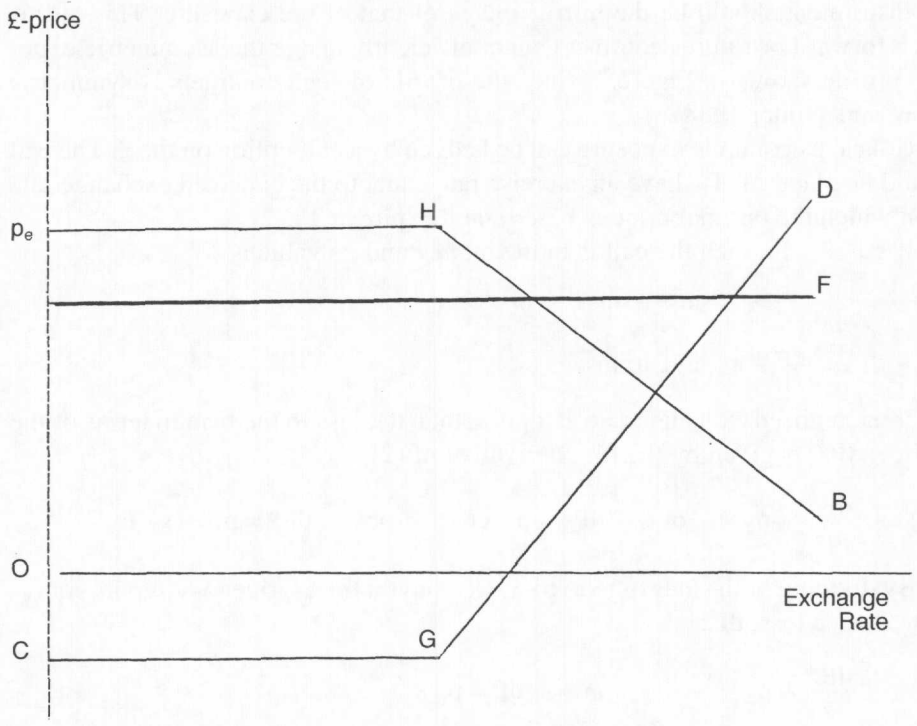
(7) $$p_h = (p_e - dP) + h \times c - C$$
$$= p_e \times \left(1 - \frac{s-e}{s}\right) + p_e \times \frac{s-e}{s} - C \quad \text{or}$$
$$p_h = p_e - C.$$

Since p_h is unaffected by s, efficient hedging has been achieved.

When the £ depreciates ($s < e$), then the call is out of the money. No opportunity or other cost is incurred by the firm, as would have been the case if a forward or a futures contract had been used. The price received by the firm, p_e, is not affected by the hedge, so (7) holds again.

Figure 5 provides a pictorial representation of the hedge. EF is horizontal for $s > e$. The upward sloping line representing the call payoff has a slope of +1, and

Figure 5. Hedging Economic Exposure Using a Call on the £



p_eHB: The risk profile of economic exposure
CGD: The risk profile of a long call on the £
EF: The risk profile of economic exposure after hedging

thus forms a 45-degree angle with the downward sloping economic exposure profile. The cost of the call is depicted by the distance OC = Ep_e.

The intuition behind this hedging hypothesis is that since asymmetric exposure is the effect of the U.K. firm's writing a real call option to its U.S. customers, complete elimination of such exposure requires that the U.K. firm buys back this call option. This can only be effected by going long on a currency call on the £ to offset the firm's short position on the real call.

Ware and Winter (1988) argue that convex economic exposure faced by firms with flexibility in their production decision should be hedged by going short on currency options. Here, it is argued that concave exposure faced by exporters who publish a dual-currency price list should be hedged by long currency options. The difference in these conclusions is due to the underlying assumptions and the resulting type of exposure. Both papers, however, emphasize the importance of currency options in hedging economic exposure and rule out the use of forward contracts.

Given that the U.K. firm should hedge using a currency option, and if we assume that period-average (as opposed to daily) exchange rates determine export prices (in order to avoid noise produced by daily rate changes), the type of option should be an average rate (Asian) option.[15] Such options are available in the Over-The-Counter (OTC) currency options market. The value of an Asian option is a function of the period-average rate and not of the end-of-period rate. Furthermore, the premium of an Asian call is lower (sometimes by as much as 40%) than the premium of an otherwise identical ordinary call.[16] The latter implies that an Asian call may be both a cheap and efficient way of hedging economic exposure.

Finally, we consider hedging weakly asymmetric economic exposure as illustrated in Figure 4. This exposure can be hedged by a portfolio of currency options, consisting of a long call and a short proportional coverage (hybrid) put.[17] The long call will match the downward part of the exposure profile, whereas the short hybrid put will match the upward part (to the left of e). In this case, if $s < e$ and the £-price partially increases, the firm (being the writer of the hybrid put) will incur a loss on its short put position. Depending upon the hedge ratio of the put, this loss will eliminate the partial increase in the £-price, so the net price after hedging, p_h, is as follows:

$$(8) \qquad p_h = p_e - L$$

where L is the net cost of effecting a long call and a short hybrid put. Note that $L < C$, since the firm receives a premium when it sells a hybrid put, so p_h in (8) is higher than p_h in (7).

However, the lower hedging cost and higher net £-price after hedging, under weakly asymmetric exposure, are offset by the smaller increase in market share in the overseas market which is implied by (8).

Therefore, different versions of economic exposure can be matched by different currency option strategies. The less competitive the market, the more probable that economic exposure will be weakly asymmetric, so the more inclined the

Table 2. Synopsis of Theoretical Findings

Profile of Economic Exposure	Hedging Strategy
Under a market share expansion objective and the publication of a 'dual-currency' price list, economic exposure is asymmetric and equivalent to the profile of a written call option.	Long positions on a call option on the domestic currency.
An objective function which favours a combination of higher profit margin and increased market share results in weakly asymmetric economic exposure.	Portfolio of a long call on the domestic currency and a short proportional coverage put on the domestic currency.

firm will be to use a portfolio consisting of long calls and short hybrid puts, and thus the lower will be the hedging cost. The same is true if the firm's objective function attaches more importance to profit margin than to market share. Finally, the less efficient the U.K. firm, the more severe is the exposure faced by the firm, and the higher is the cost of hedging. This is because the call must have a relatively low exercise rate, which will reflect the rate at which the cost disadvantage faced by the U.K. firm is overcome.

Conclusions

This paper undertakes a financial engineering exercise related to economic exposure. It asks the question: how does economic exposure respond to exchange rate changes when an exporter responds to increased global competition by publishing a dual-currency price list? The answer is that the profile of exposure is equivalent to the profile of a written call option.

The hedging implication is that only a long call will eliminate any reductions in the exporter's profit margin if the domestic currency appreciates; and will not reduce the exporter's profit margin if the currency depreciates (in contrast to the effect of purchasing a forward contract).

The practical message of this paper to treasurers and currency options traders is that if an exporting firm publishes a dual-currency price list, the resulting economic exposure should be hedged using currency options only.

Shortcomings of the model may be found in the assumption of homogeneity of the traded product. Furthermore, the model requires that the firms' adjustments of output in response to changes in demand are costless. Both of these assumptions may be restrictive.

An obvious possibility for further research would be an empirical investigation of whether, in globalised markets, export prices behave asymmetrically between periods of currency appreciation and depreciation. Data at a disaggregated, industry level would be required for this task. For those commodities whose prices appear to behave asymmetrically, a statistical investigation of the hedging effectiveness of OTC currency options would also be of considerable interest.

Notes

1 Financial support from the State Scholarships Foundation of Greece (I.K.Y.) is acknowledged. Thanks are due to John Goddard. Any errors are my own.

2 There are several types of exchange rate exposure. See Shapiro (1989).

3 Economic exposure is also known as exchange rate pass through (Flood and Lessard 1986) and Operating Exposure (Lessard and Lightstone 1986, Flood and Lessard 1986).
4 By globalised markets, we mean markets in which non-local producers have a market presence. This concept of globalisation is the same as in Flood (1985) and Lessard and Lightstone (1986). Luehrman (1990) adopts a different concept of globalisation implying a multimarket oligopoly.
5 Any project or business which embodies alternative operational routes of action which can be utilised when the firm desires, can be seen as a real option. See Kulatilaka and Marcus (1988) for a definition of real options. Here, real options in production (sourcing) give the firm flexibility to 'load' the factory which can produce most cheaply, given the exchange rates.
6 Caterpillar expanded its sourcing to Brazil, Mexico and South Korea to eliminate the effects of an increasing $ over the first half of the 1980's (Corporate Finance April 1988).
7 The depreciation of the $ in the second half of the 1980's rendered Caterpillar's sourcing transfer redundant (Corporate Finance April 1988).
8 Another equivalent assumption is that either firm has costs in a third currency and hedges using forward contracts.
9 For a general equilibrium model, see Murphy (1989).
10 Furthermore, the British companies ICI and Rover have both used the recent depreciation of the £ to price competitively in export markets and expand their market shares rather than to increase their profit margins (Financial Times 25 May 1993).
11 Giovannini (1988) has also dealt with the issue of the choice of currency of invoicing in a profit maximisation approach. Here, the 'managerial' aspects of this issue are considered.
12 The practical relevance of a dual-currency price list is highlighted in Warren (1987).
13 We assume that the strategic variable is the price. In industries where prices are fixed, and thus unaffected by actual exchange rates, the price-leadership model is irrelevant in modelling economic exposure. Mann (1986) adopts the same model in analysing pass through. A Cournot approach would be more appropriate, assuming that quantity is now the strategic variable.
14 See Note 4 for a definition of real options. Here, the real option refers to U.S. customers who are given the choice of buying the good at a 'low' price, at any exchange rate.
15 The risk profile of an Asian call (put) is exactly the same as that of an identical ordinary call (put). See Turnbull and Wakeman (1991).
16 See Turnbull and Wakeman (1991).
17 A proportional coverage option carries a lower premium than an ordinary option, and entails a proportional payoff if in-the-money. See Briys and Crouhy (1988).

References

Aggarwal , R./Soenen, L., Managing Persistent Real Changes in Currency Values: The Role of Multinational Operating Strategies, *Columbia Journal of World Business,* Fall 1989, pp. 60–67.
Adler, M./Dumas, B., Exposure to Currency Risk: Definition and Measurement, *Financial Management,* Summer 1984, pp. 41–50.
Briys, S./Crouhy, Michel, Creating and Pricing Hybrid Foreign Currency Options, *Financial Management,* Winter 1988, pp. 59–65.
Cavusgil, T., Unravelling the Mystique of Export Pricing, *Business Horizons,* May–June 1988, pp. 54–63.
Corporate Finance, Economic Risk: An Eye to the Competition, April 1988, pp. 15–17, (Name of author unavailable).
Corporate Finance, Daring to Hedge the Unhedgeable, August 1988, pp. 11–13, (Name of author unavailable).
Dohner, R., Export Pricing, Flexible Exchange Rates and Divergence in The Prices of Traded Goods, *Journal of International Economics,* 4, 1984, pp. 79–101.
Dornbusch, R., Exchange Rates and Prices, *American Economic Review,* 77, 1987, pp. 93–106.

Financial Times, Devaluation of Sterling Gives Share Boost to U.K. Exporters, 25 May 1993, p. 1.
Fisher, E., A Model of Exchange Rate Pass Through, *Journal of International Economics,* 26, 1989, pp. 119–137.
Flood, E., Jr., Global Competition and Exchange Rate Exposure, *Research Paper 837,* Stanford University Graduate School of Business, September 1985.
Flood, E., Jr./Lessard, D., On the Measurement of Economic Exposure to Exchange Rates: A Conceptual Approach, *Financial Management,* Spring 1986, pp. 25–36.
Froot, K./Klemperer, P., Exchange Rate Pass Through When Market Share Matters, *American Economic Review,* September 1989, pp. 637–654.
Garman, M./Kohlhagen, S., Foreign Currency Option Values, *Journal of International Money and Finance,* 2, 1989, pp. 231–237.
Giovannini, A., Exchange Rates and Traded Goods Prices, *Journal of International Economics,* 24, 1988, pp. 45–68.
Krugman, P., Pricing to Market When Exchange Rates Change', *Working Paper # 1926 M.I.T.,* May 1986.
Kulatilaka, N./Marcus, A., A General Formulation of Corporate Renal Options, *Research in Finance,* 7, 1988, pp. 183–199.
Lessard, D./Lightstone, J., Volatile Exchange Rates Can Put Operations at Risk, *Harvard Business Review,* July–August 1986, pp. 107–114.
Luehrman, T., The Exchange Rate Exposure of a Global Competitor, *Journal of International Business Studies,* Second Quarter 1990, pp. 225–242.
Mann, C., Prices, Profit Margins and Exchange Rates, *Federal Reserve Bulletin,* 27, 1986, pp. 366–379.
Marston, R., Pricing to Market in Japanese Manufacutring, *Journal of International Economics,* 29, 1990, pp. 217–236.
Mason, S./Merton, R., The Role of Contingent Claims Analysis in Corporate Finance, in: Altman, E./Subrahmanyan, M. (editors), *Recent Advances in Corporate Finance,* Homewood, IL: Richard Irwin 1988.
Moreno, R., Explaining the U.S. Export Boom, *Economic Review,* Federal Bank of San Fransisco, Winter, 1991, pp. 39–52.
Murphy, R., Import Pricing and Trade Balance in a Popular Model of Exchange Rate Determination, *Journal of International Money and Finance,* 8, 1989, pp. 345–357.
Shapiro, A., *Multinational Financial Management,* 3rd edition, Allyn and Bacon 1989.
Srinivasulu, S. L., Strategic Response to Foreign Exchange Risks, *Columbia Journal of World Business,* Spring 1981, pp. 13–23.
Turnbull, S./Wakeman, L., A Quick Algorithm for Pricing European Average Options, *Journal of Financial and Quantitative Analysis,* September 1991, pp. 377–381.
Ware, R./Winter, R., Forward Contracts, Currency Options and Hedging of Foreign Exchange Rate Risk, *Journal of International Economics,* 25, 1988, pp. 291–302.
Warren, G., Exposure Management Instruments: Future Developments, *The Treasurer,* February 1987.