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EXCHANGE RATE AND RELATED ECONOMIC EXPOSURES - A THEORY FOR MANAGEMENT STRATEGY AND INFORMATION NEEDS

by

Lars Oxelheim and Clas Wihlborg

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by

Lars Oxelheim
The Industrial Institute for Economic
and Social Research (IUI),
Stockholm

and

Clas Wihlborg
University of Southern California
and The Claremont Center for
Economic Policy Studies
Claremont, CA

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I. Introduction

The firm is exposed to several kinds of risks related to uncertainty about the domestic and foreign macroeconomic environment. In the literature it is possible to distinguish between exchange rate risk, inflation risk, interest rate risk, commercial risk of relative price changes, and country risk related to changes in the rules under which firms and individuals participate in markets. Generally these risks are viewed as distinct and separable.

Out point of departure, in this paper, is that a certain disturbance at a macroeconomic level might express itself in one or more of the following variables: the exchange rate, interest rates, relative prices and/or exchange, and credit controls. In each case there is an impact on firms in international and domestic markets. Thus, we can find that a threatening devaluation may be converted into a financial risk by the central bank defending its currency with an increase in interest rates. For this reason, uncertainty about exchange rate changes may not be independent of uncertainty about interest rates. Similarly, arguments can be made that exposures to inflation and relative price changes are not independent of exchange rate uncertainty.

Other recent papers have emphasized the need to consider the exchange rate's correlation with other variables when defining exchange rate risk. Adler and Dumas (1983), Cornell (1980), Shapiro (1984), Oxelheim (1984), Wihlborg (1980a), and Hekman (1985) have discussed, in different ways, the theoretical and practical drawbacks surrounding a partial foreign exchange risk analysis.

In Oxelheim and Wihlborg (1986a and b) it is argued that in the absence of agreement on a suitable macroeconomic model, cash flow and/or present value exposure of a firm could be measured by identifying coefficients in an equation for cash flows (or present value) as a function of either market price variables (e.g., price levels, real exchange rates) or macroeconomic disturbances (e.g., fiscal and monetary policy variables). In this paper we choose to define exposure in terms of market price variables, though a large part of the analysis applies as well to the case when exposure is defined in terms of underlying macroeconomic disturbances. Oxelheim and Wihlborg (1986b) also contains a scenario analysis of exposure to macroeconomic risk. Such an analysis requires detailed knowledge of macroeconomic structure, however.

Given the definition of the firm's cash flow exposure, our purpose is to analyze how an exposure management strategy can be chosen and to determine the information need associated with each strategy. We consider, in particular, how the objective of the firm (including its planning horizon and risk attitude), its view of goods and financial market adjustment, and the nature of the firm's cash flows influence strategy choice and information requirements.

Conventional exchange rate management strategies are determined by ad hoc exposure measures which may be chosen on the grounds of accounting conventions and the availability of accounting information. The use of such measures may lead to unknown consequences for the total economic exposure of the firm and may be inconsistent with the firm's objective. (see e.g. Lessard and Lightstone, 1986) Our approach should allow the firm to evaluate conventional exposure measures and strategies

in the light of managers' views of international goods and financial markets, and the firm's overall objective.

A desired strategy's information requirement must also be evaluated. Alternatively, given available information, it should be possible to evaluate the extent to which the firm must compromise in exposure management relative to its objective and its view of international markets. An additional advantage of our approach is that even if exposure management is handled within several functions of the firm, a sub-target for each function can be chosen with the consequences for the whole firm in mind.

Section II begins by expressing a firm's cash flow and its value as functions of various market price variables. We, thereafter, differentiate among cash flows of different kinds in order to describe exposure in more detail in Section III. In this section we discuss how exposure depends on market efficiency and adjustment speed in financial and goods markets. The importance of the firm's time perspective for exposure analysis is discussed in Section IV, while in Section V we turn to the firm's risk attitude. Thereafter, we have the basis for choosing strategy and identifying associated information needs in Section VI. In Section VII we discuss briefly how exposure management can be simplified and information needs reduced.

II. The Focus in Exposure Management--Present Value and Cash Flows

Adler and Dumas (1980), Hodder (1982), and Garner and Shapiro (1984) have suggested that exchange rate exposure may be identified by the regression coefficient $\text{Cov}(X_t,e_t)/\text{Var}(X_t)$ where X_t is the firm's cash flow in period t and e_t is the exchange rate. Although this measure of exposure is superior to traditional transaction and

translation exposures, since it is more comprehensive in the sense that it considers all exchange rate effects on the firm, it is still too partial in one important way. The reason is that it may be partially overlapping with analogous measures of relative price exposure, price level exposure, interest rate exposure, etc. Such overlaps occur to different degrees depending on the covariance between the exchange rate and other variables. Therefore, the above measure could be highly unstable. As an alternative, Oxelheim and Wihlborg (1986 a and b) suggested that cash flow exposure be defined based on the coefficients in the following type of regression equation for the firm's local currency (LC), real cash flow in period t:

$$\frac{X_t^{LC}}{P_o^{LC}} = E_{t-1}\left[\frac{X_t^{LC}}{P_t^{LC}}\right] + a_1(r_t - E_{t-1}[r_t]) +$$

$$a_2(P_t^{LC} - E_{t-1}[P_t^{LC}]) + a_3(P_t^F - E_{t-1}[P_t^F]) +$$

$$a_4(e_t - E_{t-1}[e_t]) + a_5(i_t^{LC} - E_{t-1}[i_t^{LC}] +$$

$$a_6(i_t^F - E_{t-1}[i_t^F]) + \varepsilon_t \qquad (1)$$

where X_t^{LC} = local currency cash flows

r_t = relative price(s) of firms output (inputs)

P^{LC} = local currency price level

P^F = foreign price level(s)

e_t = exchange rate(s)

i^{LC} = domestic interest rate

i^F = foreign interest rate(s)

E = denotes expectations

ε_t = error term

In (1) we have limited ourselves to one foreign country, but the analysis could easily be extended to include several countries. In general, variables (countries) may be added until the error term obtains desired properties.

Coefficients a_1 through a_6 describe the relative covariance between real cash flows and unanticipated changes in each variable holding other variables constant. For example, coefficient a_3 for the nominal exchange rate refers to unanticipated <u>real</u> exchange rate changes, since it is defined at constant price levels. Coefficient a_1 describes a pure commercial exposure while exposure to relative price changes associated with inflation, exchange rate changes and other macroeconomic disturbances are captured by the other coefficients.

Oxelheim and Wihlborg (1986a and b) suggested, as an alternative, that the equation above should contain exogenous macroeconomic disturbances rather than market price variables. However, it was argued that if there is instability in policy-authorities' behavior, the above equation is preferable. Furthermore, if historical regression analysis is not feasible, estimates of coefficients a_1 through a_6 must be obtained with current data available internally. In this case it may be easier for the firm to form a judgment on the exposure to price variables rather than to exogenous disturbances.

We have distinguished between anticipated and unanticipated changes in price variables in eq. (1) and define exposure as cash flow sensitivity to unanticipated changes. Hekman (1985), on the other hand, discusses exposure to anticipated exchange rate changes. The cash flow effects of anticipated changes are contained in the first term on the right hand side and they may be contained in the firm's budget. The

cash flow sensitivity to anticipated and unanticipated price changes, respectively, may or may not be different. In the remainder of the paper we do not carefully distinguish between the two but assume that the sensitivities are the same.

Eq. (1) is written in local currency and may be thought of as cash flows of a local subsidiary of a US multinational. The value of this subsidiary to the shareholders in the USA depends on the discounted value of local currency cash flows in the following way <u>if</u> all (net) cash flows are remitted immediately to the parent:

$$\frac{NPV_o^{US}}{P_o^{US}} = E_o \left[\sum_{t=o}^{\infty} \frac{X_t^{LC} \cdot e_t}{(1+d)^t (P_t^{US}/P_o^{US})} \right] \tag{2}$$

$$= E_o \left[\sum_{t=o}^{\infty} \frac{X_t^{LC}(u_t/u_o)}{(1+d)^t (P_t^{LC}/P_o^{LC})} \right] \tag{3}$$

where we utilize that $(e_t/e_o) \equiv [(P_t^{US}/P_o^{US})/(P_t^{LC}/P_o^{LC})](u_t/u_o)$, $u_t \gtrless 1$ is a deviation from PPP (purchasing power parity), and d is the real discount rate of the firm.

Dividend adjustability would reduce the shareholders' exposure, since in (3) the value depends on anticipated real exchange rate changes at the time of remittance. In reality, firms may be able to avoid remitting at unfavorable real exchange rates. This discussion illustrates the importance of <u>adjustability</u> in time and currency denomination of cash flows. Cash flows may be divided into <u>adjustable</u> and <u>non-adjustable</u> flows, respectively. It could be argued that equation (1) should be estimated separately for non-adjustable flows and adjustable flows, respectively. We return to this issue below.

In order to demonstrate how different flows are exposed and what determines coefficients in (1), we construct a simple example in the form of a cash flow table for a local subsidiary. Table 1 shows the subsidiary's cash flows in period 0. In the current period 0 all cash flows may be contracted in magnitude and currency-denomination. Assume, as in Table 1, that sales revenues will be received in the form of FC20, USD30, and LC50. Payments for inputs are USD40 while wages amount to LC30. Interest costs are 10 percent of an LC debt equal to LC100. For simplicity we set the exchange rates at time 0 equal to one, so that all figures are dollar equivalents.

For any future period t most expected cash flows are not contracted for in every respect. Sales may respond to different factors, while currency denomination may or may not be adjustable. We describe in Table 2 after tax cash flows from sales in each currency (country) in period t as the cash flows in period 0 adjusted for changes in price levels (P_t/P_o), and adjusted for relative price changes on output (OP_t/P_t), inputs (IP_t/P_t) and wages (W_t/P_t), respectively. Relative price changes may be associated with sales volume effects as well. In Table 2, γ_1 refers to quantity adjustments as a result of intracountry relative price changes for output. γ_2 refers to quantity adjustment as a result of deviations from the "Law of One Price" (LOP).[1] The footnotes in Table 2 show that volume effects depend on the size of the relative price change and sales elasticities.

We turn now to financial cash flows which may be contracted to a smaller or larger extent.[2] Coefficients of exposure for financial flows--particularly to interest rates and price levels--would depend on

the degree to which financial flows are contracted over shorter or longer periods.

Table 2 shows how financial flows may be expressed for period t in local currency, when all loans are denominated in this currency. These flows may vary over time depending on the variability of the interest rate and the covariance between the current interest rate and current inflation and exchange rate changes. In some cases, loans may be indexed to a price level. If not, inflation causes real gains or losses.

In Table 2, D_o^{LC} represents the original net-financial liability position. We assume that the firm holds a fixed share (D/V) of its total liabilities in the form of financial liabilities. Thereby we may treat the capital structure and the discount rate as a constant. Then if there is inflation and the firm's asset value increases proportionately, its borrowing capacity (D_t) at a fixed discount rate increases proportionately. We assume that such inflation gains are available for distribution to shareholders. These (untaxed) gains appear on the left-hand side in Table 2 and are equal to the inflation rate in period t times the debt position.

On the right-hand side we have the tax-deductible pure interest costs on the firm's financial position ($D_o \cdot P_t^{LC}$). These costs consist of three components--the beginning of period t real interest rate ($E_t[i_t^{RLC}]$), the expected inflation rate ($E_t[P_t^{LC}]$), and the adjustment due to partial or complete indexation. When $\beta = 1$, indexation is complete, while if $\beta = 0$, there is no indexation for the period. In the latter case, nominal interest costs correspond to the nominal

interest rate which can be contracted for at varying intervals. This nominal interest cost for the non-indexed loan is defined as:

$$i_t^{LC} \equiv E_t\,[i_t^{RLC}] + E_t[\hat{P}_t^{LC}] \quad . \tag{4}$$

To obtain total LC financial cash flows we deduct from the tax-deductible interest costs on the right-hand side in Table 2 the non-taxable gain--the increase in debt-capacity--on the left-hand side. Thus, in the absence of indexation:

LC-financial flows ($\beta = 0$) =

$$-D_o^{LC} P_t^{LC}[(1 - T)(E_t[i_t^{RLC}] + E_t\hat{P}_t^{LC}) - \hat{P}_t^{LC})] \tag{5}$$

while with complete indexation:

LC-financial flows ($\beta = 1$) =

$$-D_o^{LC} P_t^{LC}[(1 - T)(i_t^{RLC} + \hat{P}_t^{LC}) - \hat{P}_t^{LC}] \tag{6}$$

The degree of indexation depends on the length of period t, and the frequency with which interest rates on loans are renegotiated. The more flexible the interest rates, the closer $E_t(\hat{P}_t)$ in (5) is to $\hat{P}_t$ and the closer $E_t[i_t^{RLC}]$ is to i_t^{RLC}. In (6) we can also note that even in the case of perfect indexation inflation is not neutral, since taxes in most countries apply to nominal interest payments. Before discussing exposure in greater detail we must discuss important relationships among prices, exchange rates, and interest rates.

III. Market Price Relationships and Exposure

It is well known that the degree of efficiency of international financial markets and adjustment speed in international goods markets are important for the exposure of firms.[3] We will, nevertheless, summarize important relationships and apply them within the above cash flow framework.

Exchange rates and inflation are irrelevant for a firm's commercial operations if the law of one price (LOP) holds for all goods and if relative prices among goods are independent of exchange rate changes and inflation. In the remainder, we mean by PPP that LOP holds for all goods. One may, nevertheless, observe deviations from PPP as a result of relative price changes when consumption bundles differ among nations. However, from a firm's perspective, it is often the deviations from PPP in terms of a particular bundle of goods that matters. For such a bundle, PPP must hold if LOP holds for all commodities and services. Exchange rate changes may, nevertheless, be correlated with relative price changes with the implication that coefficient a_4 in (1) for the exchange rate can be non-zero even when LOP holds for all goods.

We define the relationship between the exchange rate and inflation rates in a foreign country (FC) and the host country of a firm (LC) as in Section II and define the real exchange rate (u_t) in the following way:

$$u_t/u_o = (e_t/e_o)/[(P^{LC}_t/P^{LC}_o)/(P^{FC}_t/P^{FC}_o)] \quad . \tag{7}$$

u_t is the average deviation from LOP, i.e., deviations from PPP. The magnitude and duration of real exchange rate changes are important for the exposure of cash flows in Table 2, since it influences the competitiveness of firms located in different countries. Thus, the path of u_t is an important component of coefficient a_4.

The price level P in any country consists of, say, two goods y and z in the following way:

$$P_t = \alpha P_{y,t} + (1 - \alpha)P_{z,t} \tag{8}$$

Deviations from LOP for, for example, good y is denoted by u_y in the following expression between local and foreign currencies,

$$e_t/e_o \equiv [(P^{LC}_{y,t}/P^{LC}_{y,o})/(P^{FC}_{y,t}/P^{FC}_{y,o})(u_{y,t}/u_{y,o})] \qquad (9)$$

where LOP holds in a relative sense, if $(u_{y,t}/u_{y,o}) = 1$.

If there are deviations from LOP to varying degrees among sectors in the adjustment process to macroeconomic disturbances, then relative prices among sectors as well as among countries change during both an inflation and an exchange rate adjustment process. The effects of such relative price changes on cash flows appear particularly in coefficients a_2, a_3 and a_4 in equation (1), and their magnitudes depend on the nature of the macro-economic adjustment process as well as on γ_1 and γ_2 in Table 2, i.e., the volume sensitivities to relative price changes.

To illustrate how market relationships affect cash flows, we may take the cash flow FC20 in Table 1, for period 0. In period t the LC-value of this cash flow is expressed in Table 2 as $20 \cdot P^{FC}_t \cdot (OP^{FC}_t / P^{FC}_t) \cdot (LC/FC)_t[1 + \gamma^{FC}_1 + \gamma^{FC}_2]$. The exchange rate LC/FC can be denoted by e. Then, using (9) for the output commodity (OP), the local LC value in period t for the subsidiary's exports to the foreign country may be expressed as:

$$20 \cdot P^{FC}_t (OP^{FC}_t/P^{FC}_t)(OP^{LC}_t/OP^{FC}_t) \cdot u_{OP,t} \cdot [1 + \gamma^{FC}_1 + \gamma^{FC}_2]$$

assuming all prices are one in period zero. In <u>real</u> (time 0) local currency terms the expression before brackets reduces to $20 \cdot (OP^{LC}_t/P^{LC}_t) \cdot u^{FC}_{OP,t}$. Thus, the sensitivity of nonfinancial cash flows to changes in macroeconomic price variables in equation (1) depends on the relationship between each right hand side variable and

domestic relative prices, deviations from LOP, and volume effects in the adjustment. Any one firm may have to be concerned with a number of relative prices for outputs, inputs, and wages. From an information gathering point of view, therefore, it is advantageous if a regression equation like (1) can be estimated.

We turn now to financial markets and financial cash flows. The degree to which the Fisher Open (FO) relationship holds is particularly important for the choice of currency denomination of the firm's debt. FO is often referred to as the highest level of international financial market efficiency. It holds if information and transaction costs are negligible, and there are risk-neutral speculators in the market who consider assets denominated in different currencies perfect substitutes. In its approximate form, FO at the beginning of period t can be written as:

$$i_t^{LC} = i_t^{FC} + E_t[\hat{e}_t] \qquad (10)$$

When this relationship holds, a firm's expected borrowing costs are independent of the currency denomination of debt, provided exchange gains and losses are treated like interest costs for tax purposes.[4]

In order to evaluate the exposure of financial cash flows in different currency denominations, we compare these cash flows of the subsidiary when it borrows in local currency and in foreign currency, respectively. The first case has already been discussed in Section II where we saw how the real value of financial cash flows depend on the expected real interest rate, the expected inflation rate in local currency, and the degree of indexation. The case of borrowing in foreign currency is described in Table 3. On the right-hand side we have the LC-value in period t of interest costs in foreign currency.

On the left-hand side we have the gain or loss in debt capacity as a result of changes in asset values with LC inflation. As before, the firm borrowed the equivalent of LC100 in period o and initial prices and exchange rates are one.

Our treatment of exchange gains and losses on the right-hand side in Table 3 implies that we consider such gains (or losses) taxable (or tax-deductible). To form an expression for total financial cash flows with and without indexation, we utilize an approximate relationship between exchange rate changes and inflation rates-- $\hat{e} \equiv \hat{P}^{LC} - \hat{P}^{FC} + \hat{u}$. The exposure of financial flows related to FC-loans is best understood by inserting this exchange rate expression in Table 3 and adding the two sides. In the absence of indexation we obtain that:

LC-financial flows (FC loan, $\beta = 0$)

$$= - D_o P_t^{LC}\{(1 - T)(E_t[i_t^{RFC}] + (1 - T)(E_t[\hat{P}_t^{FC}] - \hat{P}_t^{FC} + \hat{u}) - T\hat{P}^{LC}\} \quad (11)$$

In the case of indexation we obtain:

LC-financial flows (FC loan, $\beta = 1$)

$$= - D_o P_t^{LC}\{(1 - T)\, i_t^{RFC} + (1 - T)\hat{u} - T\hat{P}^{LC}\} \quad (12)$$

Comparing (11) and (12) we note again that as the time-period over which interest rates are fixed shortens, expression (11) for non-indexation approaches expression (12) for indexation, since the difference between $E[\hat{P}_t^{FC}]$ and $\hat{P}_t^{FC}$ approaches zero.

Comparing the indexed FC loans in (12) to the indexed LC loan in (6) we observe that they differ in exposure to real exchange rate changes, $\hat{u}$, but are identical in their inflation exposure to

LC-inflation. This exposure is due to the non-taxation of the increase in debt capacity.

Comparing the non-indexed FC-loan in (11) to the non-indexed LC loan in (5), there is a difference in their inflation exposures over the contract period. The FC loan is exposed to foreign as well as local inflation over the period while the LC loan is exposed only to local inflation.

The above expressions illustrate how coefficients in a regression equation like (1) for the real value of financial cash flows will depend on the currency denomination of loans and on the degree of indexation. Note that there is exposure to local inflation in all cases. However, only the non-indexed FC loan is exposed to foreign inflation captured by coefficient a_3 in (1). Interest rate exposure, i.e., the coefficients for interest rates in (1), depends obviously on the effect of real interest rates on cash flows. Furthermore, interest rate coefficients depend on the relationship between inflation expectations, actual inflation at the time contracts are entered, and the real interest rate. Assume, for example, that inflation expectations co-vary perfectly with current inflation, and that real interest rates are constant. Then, coefficients a_5 and a_6 for interest rate exposures are zero, while coefficients a_2 and a_3 for inflation capture the total financial exposure in each currency denomination.

Note finally that risk related to contractual cash flows may depend on the consumption bundle of investors and borrowers. Specifically, when the real exchange rate is correlated with relative prices among commodities as described above, the purchasing power of an investment (a loan) in a particular currency varies with the exchange rate even when

LOP holds for all goods and services.[5] An example may illustrate this case. Assume that an American investor plans to purchase a Jaguar in the USA in three months and is facing the question of whether to hold dollars or pounds for three months. The payment is going to be made in dollars to the US dealer. The Jaguar price in the US follows LOP so that the US price is the constant list price in pounds times the dollar/pound exchange rate. In this case, the investor would avoid risk by holding pounds since, if the pound appreciates, both the dollar value of the investment and the dollar price of the Jaguar will increase.

IV. The Role of the Firm's Time Perspective

The above analysis of cash flows and market relationships reveal the nature of information need assuming cash flow exposure is a serious concern for the firm and it wishes to decrease this exposure. However, it is not obvious that such an exposure management strategy is consistent with the firms' objective. We turn now to two aspects of a firm's objective--time perspective in this section and risk-attitude in Section V--which contribute to the choice of strategy.

The time perspective of the firm reveals itself in eq. (2) for the value in the real discount rate, d, by which expected cash flows are discounted. The firm using a high discount rate puts a relatively large weight on cash flows in the near future.[6]

The firm with a longer time perspective (a low d) needs to consider the extent to which individual period cash flows may be negatively or positively correlated. If there is negative serial correlations, cash flow exposure for any period t need not translate into a value exposure at time o. Real exchange rate changes tend to be

negatively serially correlated or not correlated at all (see, e.g., Roll, 1979; and Pigott and Sweeney, 1985). On the other hand, inflation rates are strongly positively correlated. These considerations would determine how simple cash flow exposure coefficients translate into value exposure coefficients.

The importance of having an exposure management strategy which is consistent with the firm's time perspective can be illustrated by considering the effect on the variance of the present on the value of a certain foreign currency cash flow for a firm that covers these flows in different ways. Compare first a strategy of never covering and one of covering consecutively the expected flow for the next quarter. Oxelheim and Wihlborg (1986a) show that the variance of following the latter strategy relative to the former is $1/(1+d/4)^2$, if changes in three months forward rates are equal to changes in spot rates. For example, if the real discount rate is 10%, the reduction in the present value variance of always covering is only about 5%.

Levich (1979), Oxelheim (1980) Mussa, (1982), and Shapiro (1983) have demonstrated that as an empirical regularity, changes in forward rates are closely related to changes in spot rates. In Table 4 we exemplify this regularity with data from the Swedish spot and forward exchange markets. The table indicates that the variances of the forward rates are nearly identical to the variances in the spot rates. We conclude, therefore, that a firm concerned with present value variance has little to gain from traditional transaction exposure-covering of near term cash flows, unless its discount rate is very high.

V. Risk Attitude

We distinguish between two risk attitudes: risk aversion and risk neutrality. The risk-neutral company is only concerned with the expected cash flows or their present value. To the risk neutral company the variance of cash flows or value is of no interest. Companies with more or less risk aversion, on the other hand, are interested in the trade-off between the expected value and its variance. In other words, they are willing to incur a cost for decreasing variance. It has been argued that risk aversion is not an appropriate attitude in efficient markets, but costs of default may be a sufficient reason for a firm to consider the variance of its value as well as the expected value (see also Adler and Dumas, 1983). In addition, if there are fixed costs associated with employment contracts, then changes in output are costly. The firm may be induced to avoid markets with uncertain prices and demand, and/or take steps to reduce the impact of price and exchange rate changes on its output (see Shapiro and Titman, 1984, and Oxelheimr and Wihlborg, 1986b).

VI. Exposure Strategies and Information Need

In this section we combine the above elements to describe how a desired exposure management strategy and information needs can be determined by risk-attitude, time perspective, choice of target variable, market relationships, and the nature of cash flows.

First, management strategies and the nature of operational decisions will be determined by risk-attitude and goods and financial market relationships. Then, information needs will be determined for each strategy by considering how a particular target variable is exposed to different risks. We limit the discussion here by using total real

cash flows as the target variables. In principle, the analysis applies when economic value of commercial cash flows is the target variable. Actual hedging and cover policies will differ, however, depending on the target available as mentioned in Section IV.

In Table 5.a, we list the risk-attitude of the firm in column (1) and financial market adjustment in terms of belief or non-belief in FO in column (2). Then, a strategy can be chosen for financial cash flows in isolation in column (3), though we see later that it is usually not optimal to manage financial exposure independently of commercial exposure to macroeconomic variables.

The firm's view of goods market adjustment over the relevant time horizon is listed in column (4). It may believe in PPP, that there are real exchange rate changes between countries, or that exchange rate changes are correlated with both real exchange rate changes and relative price changes of relevance to the firm. Columns (5), (6) and (7) list the strategies for the operational decisions that would follow from the combination in previous columns for nominally contracted cash flows (primarily financial and depreciation) (5), non-contractual commercial flows from sales and purchases (6), and non-contractual financial (flexible interest) cash flows (7). Thereafter, in Table 5.b, we list in columns (8), (9), and (10) the information needs associated with the different strategies in order to implement operational decisions.

Certain interesting aspects of the table can be discussed without going into great detail. First, macroeconomic disturbances are completely irrelevant only in row 1. There are no financial profit opportunities, no commercial profit opportunities as a result of macro-disturbances, and the firm is not concerned with variances of cash

flows. From this simple case the degree of complexity of the management task increases with the complexity of market adjustment and the degree of risk-aversion. Financial and commercial decisions are separable in lines (1-6) characterized by risk-neutrality.

The risk-neutral firm's exposure management strategy is always to maximize expected cash flows or economic value. However, with FO and PPP the "laissez faire" strategy applies since there are no profit-opportunities in the macroeconomic adjustment process. All prices are equalized quickly among countries and the firm can focus its energies entirely on economic developments in its markets without concern for the macroeconomic environment.

Without FO, there are potential profit-opportunities in selecting the currency with the highest expected rate of return, and without PPP there are profit opportunities in shifting sales from one country to another, or in adjusting production and sales as a result of relative price changes among sectors. These profit opportunities may arise as a result of macroeconomic disturbances such as monetary policy shifts. The information need in Table 5.d with risk-neutrality is limited to forecasts of real exchange rates, interest rates, and relative prices. Sensitivity coefficients to unanticipated changes in variables are not necessary since these potential changes are not considered when decisions are made. Sensitivity coefficients to anticipated changes in prices are, of course, valuable in order to forecast sales at expected prices. This kind of information is always needed to forecast cash flows and not particularly limited to exposure management decisions. Forecasting is nevertheless an extremely important and difficult task and it is an important decision to determine what kinds of forecasting

deserve the firm's resources. For example, if managers believe that FO holds well, then publicly available interest rates and forward rates tend to be the best available forecast of exchange rates (see, e.g., Levich, 1980).

With risk-averse attitudes the firm's information needs for exposure management increase, and exposure management becomes more complex. On lines (7) through (10) in Table 5.a, commercial decisions are still separable from financial decisions, however. On lines (7) and (10) for PPP, the reason for this separability is that the firm does not expect any price differentials among countries for its product. Thus, exposure management can be limited to financial cash flows while exposure of commercial cash flows need not be considered unless they are contracted at fixed prices. On line (7) with FO the exposure management strategy becomes variance minimizing, i.e., hedge as much as possible since there are no profit opportunities in international goods and financial markets. On line (10) a trade-off decision must be made between acceptable financial exposure and the cost of decreasing this exposure.

Lines (8) and (9) are particularly interesting. FO is assumed to hold while both commercial and financial flow exposure exist. Even here financial and commercial exposure decisions can be separated, though the financial decision should be based on knowledge about commercial exposure. Specifically, commercial decisions can be made without considering risk. Commercial cash flows can simply be maximized. Then financial decisions could be used to minimize the variance of all cash flows. The reason why financial positions may be adjusted in this way to whatever exposure arises on the commercial side, is that with FO

expected returns and borrowing costs are equalized across currencies. Therefore, the only cost of a financial hedging operations is the transaction cost.

The truly complex management strategy and information requirements arise with risk-aversion when real exchange rates and/or relative prices are sensitive to macro disturbances and when FO does not hold on rows 11 and 12. All exposure coefficients could then differ from zero for financial as well as commercial cash flows. The strategy becomes one of trading off risk and return over commercial as well as financial cash flows. The exposure of all cash flows should be estimated, and commercial as well as financial decisions should be evaluated in terms of both return and risk. If regression equations can be obtained for different kinds of flows using historical data, then the exposure coefficients for different kinds of cash flows could be estimated easily. However, if historical data is unreliable, exposure coefficients would have to be obtained from internal information.

The analysis in Sections II and III demonstrated how different kinds of cash flows may depend on the different market price variables. The expressions presented there for cash flows in terms of price levels, real and nominal exchange rates, and real and nominal interest rates, can be used as a basis for judgment concerning the exposure of different cash flows. Thereafter, in order to evaluate the firm's total exposure to each price variable, it is necessary to evaluate the overlap among different kinds of exposure, i.e., to form estimates of the covariances among price levels, exchange rates, and interest rates. Without taking this interdependence among variables into account, partial hedging of

exchange rate exposure may increase another exposure, such as inflation exposure.

The proper definitions of exposure coefficients are listed in Table 5.c. For example, coefficient a_1 for relative price exposure depends on the covariance between cash flows and relative prices after deducting the impact on cash flows of exchange rate effects on relative prices. Most econometric textbooks contain formulas for the exact relationship among exposure coefficients such as a_1 - a_6 and measures of the simple covariance between cash flows and individual variables.

Obviously, it takes detailed knowledge of both the determinants of the firm's cash flows and the relationships among market price variables to evaluate exposure without regression analysis. The information may also be widely dispersed since, for example, the nature of the relationship between exchange rates and interest rates and the behavior of policy authorities differ across countries.

In principle, the above analysis is independent of the firm's time perspective. However, the longer the perspective, the more important it is to take into account the relationship between near-term adjustment of exchange rates and other price variables, and more distant changes in the same variables. Formally, the information requirements increase with the time horizon. On the other hand, many underlying price variables may, over time, follow a random or a mean-reverting process as mentioned in Section IV. Then, based on such qualitative judgments, it may be determined that the firm need not be concerned with one or more kind of exposure. It can then behave in a risk-neutral fashion with respect to these variables.

VII. Towards an Operational Exposure Management Strategy

Most practitioners would argue that they do not believe in financial market efficiency as strongly as FO, that goods markets adjust sluggishly and that they are risk-averse. As a result, they place themselves in a difficult part of our Tables 5.a and b. Since most firms work primarily with short-term transactions and translation exposure, it would seem that their exposure management strategies, from an economic viewpoint, are highly inconsistent with their stated view of the world. We may then ask if, given firms' objectives it would be best to give up exposure management completely, or whether relatively simple and consistent operational strategies can be designed. We have already pointed to the longer planning horizon as one potential simplification on the grounds that many important variables tend to be independent of macro-disturbances in the longer run.

It is also noteworthy that the FO assumption simplifies the exposure management task drastically, even when the firm is risk-averse and it is concerned with exposure of commercial as well as financial cash flows. The reason is that under FO, commercial cash flows can be maximized while financial positions are adjusted to minimize the variance of total cash flows as demonstrated in the previous section. Financial positions cannot be taken independently of commercial exposure, however, but the finance function must obtain information about the commercial exposure.

The applicability of historical data analysis to current exposure simplifies the evaluation of exposure by means of regression analysis. To implement such an analysis, the total cash flows must be decomposed into components that are stable in terms of exposure. The components

can then be added and weighted with their respective exposure coefficients to obtain a total exposure measure based on which the firm can cover, hedge, or adjust its cash flows.

In Section II we decomposed cash flows for a subsidiary or a firm in a particular country. Table 6 suggests a decomposition for a multi-national firm with a number of products. In addition to the decomposition in Section III, we break down cash flows by subsidiary and product. Furthermore, for management purposes, all flows are divided into non-adjustable and adjustable flows in terms of financial or commercial exposure.

The decomposition in Table 6 may be necessary before regression analysis for the identification of coefficients in eq. (1) is performed. It may also be helpful for a more judgmental approach to exposure analysis, since the further we break down the cash flows, the more likely it is that there are individuals within an organization with relevant information and judgment on determinants of coefficients as defined above. This judgmental approach and the regression analysis of exposure may, at times, be complementary. The reason is that exposure coefficients may be unstable over time as a result of shifts on the macroeconomic environment and the behavior of policy authorities. Current knowledge of policy behavior and macroeconomic structure help the firm adjust exposure coefficients in response to such shifts.

Another type of simplification and decentralization may be obtained for the risk-averse firm as well, if the firm's remittance policy is flexible. Then, an individual subsidiary's exposures is relatively independent (see Section II), and a subsidiary can be given exposure

management objectives while the parent focuses on the timing of the dividend remittance policy.

A common simplification is that exposure of nominally contracted near-term cash flows is managed separately as transaction exposure without taking into account the longer term and the non-contractual side of the firm. Such a strategy does not seem to make much sense in our framework, since the effective separation of financial flow-exposure presumes that PPP holds, if the firm is risk-averse. However, if PPP holds, there is inflation risk to consider. This risk is often the largest one for relatively long-term nominal commitments. Short-term transactions exposure, on the other hand, is relevant when the real exchange rate is uncertain and the firm's time horizon is short. But, in this case, the short-term exposure of commercial cash flows is, for most firms, substantial as well and cannot be considered independently as with traditional measures of transaction exposutre.

VIII. Conclusions

We have developed a framework for choosing an exposure management strategy from information about the firm's time-perspective, its risk-attitude, its view of the adjustment process in financial and goods markets, and the nature of its cash flows. It can be used to develop a strategy or to check what implicit assumptions underlie a firm's current strategy. These implicit assumptions can then be compared for consistency with management's objectives and world view.

Most firms' objectives and view of adjustment in international markets is such that highly complex strategies would follow, and associated information requirements would be large. Our framework can then be used to identify suitable simplifications and compromises

relative to objectives or views of market adjustment. Space limitations prevented us from going into greater detail on how to choose and develop an operational and feasible strategy with a limited amount of available information. Oxelheim and Wihlborg (1986b) develop such an analysis further.

An extended view of macroeconomic exposure beyond exchange rate exposure for financial assets raises important issues for the organization of exposure management, i.e., the level at which operational decisions are made. In general, the choices of strategy and organization should be simultaneous, but a firm's current organization may constrain these choices. Our framework can, in this situation, help identify which exposure objectives are feasible and which must be sacrificed. Many times, it is better policy to refrain from managing a particular kind of exposure rather than manage one just because the firm's current organization, information structure, and accounting system are suitable for managing it.

SYMBOLS

PPP	=	Purchasing Power Parity
NPV	=	Net present value
X	=	Net cash flow
e	=	Nominal exchange rate
u	=	Real exchange rate (deviation from PPP)
i	=	Nominal rate of interest
i^R	=	Real reate of interest
d	=	Discount rate
P	=	Price level index
$\hat{P}$	=	Inflation rate
OP	=	Output price index
IP	=	Input price index
WP	=	Wage index
γ	=	Price elasticity
α	=	Share of a commodity in a price index
T	=	Tax rate
V	=	Variance
Cov	=	Covariance
E	=	Mathematical expectation

Footnotes

[1]With few exceptions such as Wihlborg (1980), Hodder (1982), Adler and Dumas (1983), and Garner Shapiro (1984), volume effects are usually ignored in the exposure literature. There is literature, however, on the effects of trade and production on exchange rate changes, which we neglect here. It is useful for deriving conditions for increasing or decreasing volumes and production in response to relative price changes. Lessard and Lightstone (1986) is an example of the more recent concern with exchange rate effects on sales volume.

[2]We ignore cash flows due to depreciation tax shields though they can easily be added. Such flows are similar to financial flows that are contracted in nominal terms for long periods.

[3]See, for example, Wihlborg (1978), Lessard (1979), Cornell (1980), Shapiro (1984), and Glick (1986).

[4]Oxelheim (1985) shows how the timing of the realization of gains and losses due to exchange rate changes as compared to the timing of interest payments may influence the expected borrowing costs.

[5]See, e.g., Wihlborg (1978), and Grauer, Litzenberger and Stehl (1976).

[6]Adler and Dumas (1980) proposed that treasurers be concerned with the mean and variance of the consolidated net worth or consolidated cash

balances in the company's functional currency, measured at some cut-off date.

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TABLE 1

CASH FLOWS IN PERIOD 0

IN_o	X_o^{LC} (in US dollar equivalents[1]) OUT_o
(1-T)FC 20 • $(LC/FC)_o$ (sales)	(1-T)USD 40 • $(LC/USD)_o$ (inputs)
(1-T USD 30 • $(LC/USD)_o$ (sales)	(1-T) LC 30 • (wages)
(1-T)LC 50 (sales)	(1-T) LC 10 (interest costs = $D_o^{LC} \cdot i_o^{LC}$)
	X_o^{LC} = (1-T) [LC10 - USD 10 • $(LC/USD)_o$ + FC 20 $(LC/FC)_o$] = to cash or shareholders in LC

[1]Translation rate = 1.

T = tax rate

D_0^{LC} (debt) = LC 100

i_0^{LC} = 10%

TABLE 2

AFTER TAX CASH FLOWS IN PERIOD t

IN_t	X_t^{LC}	OUT_t
$(1-T)FC\ 20 \cdot P_t^{FC}(OP^{FC}/P^{FC})_t \cdot (LC/FC)_t[1 + \gamma_1^{FC} + \gamma_2^{FC}]$ [a/]		$(1-T)USD\ 40 \cdot P_t^{USA}(IP^{USA}/P^{USA})_t \cdot (LC/USD)_t\ [1 + \gamma_1^{A} + \gamma_2^{A}]$ [b/]
$(1-T)USD\ 30 \cdot P_t^{US}(OP^{US}/P^{US})_t \cdot (LC/USD)_t[1 + \gamma_1^{US} + \gamma_2^{US}]$		$(1-T)LC\ 30 \cdot P_t^{LC}(WP^{LC}/P^{LC})_t \cdot [1 + \gamma_1^{A} + \gamma_2^{A}]$
$(1-T)\ LC\ 50 \cdot P_t^{LC}(OP^{LC}/P^{LC})_t \cdot [1 + \gamma_1^{LC}]$		$(1-T)LC\ D_0 \cdot P_t^{LC} \cdot i_t^{LC} = LC(1-T)D_o P_t^{LC}\{E_t[i_t^{RLC}] + E_t[P_t^{LC}] + \beta(\hat{P}_t^{LC} - E_t[\hat{P}_t^{LC}])\}$
$LC\ D_o^{LC} \cdot P_t^{LC} \cdot P_t^{LC}$		
		Residual to cash to share-holders in LC

a/ γ_1^{FC} refers to increase in sales due to a relative price change and equals

$\left(\frac{OP_t^{FC}}{P_t^{FC}} = 1\right) \cdot \varepsilon_1^{FC}$, where ε_1^{FC} is the elasticity of sales with respect to the relative price.

γ_2^{FC} refers to the increase in export sales due to a deviation from LOP and equals

$\left(\frac{OP_t^{FC} \cdot (LC/FC)_t}{OP_t^{LC}} - 1\right) \varepsilon_2^{FC}$, where ε_2^{FC} is the elasticity of sales in the FC country with respect to a deviation from LOP.

b) γ_1^{A} and γ_2^{A} are averages of volume effects.

TABLE 3

FINANCIAL CASH FLOWS. FC-loan

IN in LC	OUT in LC
$LC\ D_o P_t^{LC} \bullet \hat{P}_t^{LC}$	$LC(1-T)D_o P_t^{LC}\{E_t[i_t^{RFC}] + E_t[\hat{P}_t^{FC}]$ $+ \beta(\hat{P}_t^{FC} - E_t[\hat{P}_t^{FC}]) + \hat{e}_t\}$

TABLE 4

VARIANCES IN THREE MONTHS RELATIVE CHANGES IN SPOT RATES (EX POST) AND IN FORWARD RATES (EX ANTE), SEK/FOREIGN CURRENCY

Per cent per quarter, Tuesday closing market rates

Foreign currency		GBP	USD	DEM	FRF	BEC	CHF	NLG	NOK	DKK	ITL	ATS	JPY	FIM*
1974–														
1984	σ_e	5.31	5.54	4.74	5.02	4.81	6.52	4.81	4.50	3.20	5.26	4.68	6.84	2.64
n=123	σ_f	5.45	5.26	4.77	4.78	4.94	6.35	4.76	4.30	3.03	5.62	4.53	6.71	2.31
1974–														
1976	σ_e	4.87	5.34	1.51	3.66	1.06	3.43	1.23	1.39	0.96	5.48	1.16	4.92	2.04
n=36	σ_f	5.24	4.82	2.03	3.47	1.22	3.46	1.57	1.42	0.79	6.56	1.52	4.59	2.04
1978–														
1984	σ_e	4.57	5.41	5.46	5.42	5.56	7.11	5.66	5.43	3.74	4.77	5.49	7.30	2.41
n=75	σ_f	4.79	5.31	5.42	5.15	5.78	6.93	5.63	5.25	3.58	4.84	5.26	7.31	2.18

* The number of observations for FIM is 106 (1975-1984) and 19 (1975-1976).

TABLE 5.a

STRATEGIES FOR EXPOSURE MANAGEMENT

	(1) Risk-Attitude	(2) Financial Mkt. Adj.	(3) Financial Cash Flow Strat.	Strategies for Operational Decisions: (4) Goods Mkt. Adj.	(5) Nominally Contracted Flows	Non-Contractual: (6) Commercial	Non-Contractual: (7) Financial
1				PPP		Laissez faire	
2		FO	Laissez faire	Real exch. rate changes	Laissez faire	Int'l trade opportunities	Laissez faire
3	Risk -			Rel. price + real exch. rate changes		Int'l and intersectoral opportunities	
4	neutral		Expected value maximi-zation	PPP	Select highest expected value currency	Laissez faire	Select highest expected value currency
5		Non-FO		Real exch. rate changes		Int'l trade opportunities	
6				Rel. price + real exch. rate changes		Int'l. and intersectoral opportunities	
7				PPP	Minimize infl. risk	Laissez faire	Minimize infl. & int. rate risk
8		FO	Variance minimi-zation	Real exch. rate changes	Minimize total cash flow variance	Int'l trade opportunities	As column 5
9	Risk-			Rel. price + real exch. rate changes	Minimize total cash flow variance	Int'l and intersectoral trade opp.	As column 5
10	averse		Expected value/ variance trade off	PPP	Trade off expected value/infl. risk	Laissez faire	Trade off expected value/ infl. and int. rate risk
11		Non-FO		Real exch. rate changes	Trade off int'l trade and financial opportunities/variance of total cash flows		
12				Rel. price + real exch. rate changes	Trade off int'l, intersectoral and financial opportunities/variance of total cash flows		

TABLE 5.b

INFORMATION NEEDS RELATED TO MACRO-DISTURBANCES

	Nominally contracted flows (8)	Non-Contractual: Commercial (9)	Non-Contractual: Financial (10)
1		None	
2	None	E [real exch. rates] volume adjustment (γ_2)	None
3		E [real exch. rate] E [relative prices] volume adj. (γ_1, γ_2)	
4		None	E [interest rates] and
5	E [exchange rate]	E [real exch. rates] volume adj. (γ_2)	E [exchange rates]
6		E [real exch. rates] E [relative prices] volume adj. (γ_1, γ_2)	
7	a_2, a_3 for contractual flows	None	a_2, a_3, a_4, a_5, a_6 for financial flows
8	a_2, a_3, a_4, a_5, a_6, for contractual flows	a_2, a_3, a_4, a_5, a_6 for com. flows	as column 5
9	a_2, a_3, a_4 a_5, a_6 for contractual flows	E [real exch. rate], E [real. pr.] a_2, a_3, a_4, a_5, a_6, for com. flows	as column 5

TABLE 5.b (continued)

INFORMATION NEEDS RELATED TO MACRO-DISTURBANCES

	Nominally contracted flows (8)	Non-Contractual	
		Commercial (9)	Financial (10)
10	a_2, a_3 for contractual flows	None	a_2, a_3, a_4, a_5, a_6, for financial flows
11	E [exch. rate], E [real exch. rate], E [int. rates]/a_2, a_3, a_4, a_5, a_6, for total cash flows		
12	E [exch. rate], E [real exch. rate], E [relative prices], E [int. rates], a_2, a_3, a_4, a_5, a_6, for total cash flows		

TABLE 5.c

NOTATIONS AND DEFINITIONS IN TABLE

$E[\ ]$	=	expected value	
a_2	=	$\frac{\text{cov}[P_t^{LC}, (X_t^{LC}/P_t^{LC})]}{\text{Var}[X_t^{LC}/P_t^{LC}]}$	other variables constant
a_3	=	$\frac{\text{cov}[P_t^{FC}, (X_t^{LC}/P_t^{LC})]}{\text{Var}[X_t^{LC}/P_t^{LC}]}$	other variables constant
a_4	=	$\frac{\text{cov}[e_t, (X_t^{LC}/P_t^{LC})]}{\text{Var}[X_t^{LC}/P_t^{LC}]}$	other variables constant
a_5	=	$\frac{\text{cov}[i_t^{LC}, (X_t^{LC}/P_t^{LC})]}{\text{Var}[X_t^{LC}/P_t^{LC}]}$	other variables constant
a_6	=	$\frac{\text{cov}[i_t^{FC}, (X_t^{LC}/P_t^{LC})]}{\text{Var}[X_t^{LC}/P_t^{LC}]}$	other variables constant

TABLE 6

DECOMPOSITION OF CASH FLOWS

			subsid. 1	subsid. 2	total
non-contractual commercial	product group 1	adjustable[a]	c		
		non-adjustable			
	product group 2	adjustable[a]			
		non-adjustable			
non-contractual financial (flexible interest rate)	currency-denomination 1	adjustable[b]			
		non-adjustable			
	currency denomination 2	adjustable[b]			
		non-adjustable			
nominally contracted (financial and depreciation tax shield)	currency denomination 1	adjustable[b]			
		non-adjustable			
	currency denomination 2	adjustable[b]			
		non-adjustable			

[a]Adjustable commercial flows may be subdivided further into terms of sale and invoice currency.

[b]Financial flows could be subdivided further into maturities if these are adjustable.

[c]Empty spaces contain magnitudes and exposure coefficients as in eq. (1).