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HEDGING AND MANAGING EXCHANGE RATE AND RELATED MACROECONOMIC EXPOSURE

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This is a preliminary paper. Comments are welcome.

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Abstract

Hedging transaction and translation exposures to exchange rate
changes may increase the economic exposure of the firm and reduce the
information value of firms' quarterly statements. In this paper hedging
macroeconomic exposures, of which exchange rate exposure is one type, is
discussed in terms of choice of macroeconomic variables for which
exposures could be measured, choice of strategy for managing exposures,
and choice of financial instruments for hedging different exposures.

I.   Introduction

The measurement and management of exchange rate exposure has
received widespread attention in the financial management literature.
The relative neglect of uncertainty about other macroeconomic variables
can perhaps be explained by the relatively recent breakdown of the fixed
exchange rate system under which exchange rate risk was clearly
associated with large discretionary adjustments of fixed rates. During
this period most central banks followed a policy of pegging the interest
rate. This policy continued even under the flexible exchange rate
system at least until the mid-1970s, when a few central banks started to
follow money supply rules and interest rate variability became more
prominent. Price level variability and uncertainty about the relative
price of major commodities, similarly, did not receive substantial
attention in most countries until after the first oil price shock and
the increase in inflation rates in the 1970s.

After more than a decade of more or less flexible exchange rates
the limitations of traditional partial approaches to exchange rate
management have become obvious. In particular, the interdependence
among exchange rates, inflation rates, interest rates, and even some
relative prices is recognized in economic theory. Accordingly, new
approaches to exposure management are called for.

There are still reasons to take seriously the traditional
approaches in spite of their deficiencies from an economic point of
view. It is possible that after a comprehensive evaluation of risk, a
traditional, partial and accounting based measure of exposure will be
found sufficient for a particular firm. However, such a decision should
be based on deliberate exclusion of certain factors from exposure

analysis based on knowledge about the relative importance of these factors. We provide a brief overview and critique of traditional approaches to measuring exchange rate exposure in Section II.

A measure of the firm's exposure to changes in exchange rates and other variables should be operational in the sense that it provides relevant guidelines for hedging and cover decisions, if so desired. Three problems arise in this connection. The first problem concerns the relevance of the exposure measure relative to the firm's objective. Second, the measure should be stable in the sense that a certain type of measure should be applicable in more than one period. The third problem is one of relating hedging instruments to exposure measures. In this paper we discuss these three aspects of management of exposure to policy and non-policy shocks in the macroeconomic environment.

We turn in Section IIIa to the hedging of exposure to macroeconomic risk, when this exposure is measured as sensitivity-coefficients in a regression of cash flows on macroeconomic price variables such as exchange rates, inflation rates and interest rates. In Oxelheim and Wihlborg (1986), we discussed how such regressions could alternatively be specified by using actual macroeconomic disturbances, such as money supply shocks, in order to obtain stability of coefficients.

In Section IIIb we discuss how to estimate the hedging contracts for exposure to changes in monetary policy, fiscal policy, and other macroeconomic disturbances. Section IV contains a brief discussion of the potential use of option contracts for hedging macroeconomic risk. Finally, in Section V we discuss how an operational exposure management strategy may be determined taking into consideration the objectives of the firm while making information requirements manageable.

II. Traditional Approaches to Measuring and Managing Exchange Rate

Exposure - A Review

Three common measures of exchange rate exposure are (a) transaction exposure, (b) translation exposure and (c) approximations of economic exposure. We describe briefly each of these measures and aspects of their management. Then in sub-section (d), relationships among the measures are discussed.

a. Transaction Exposure

This type of exposure refers to uncertainty about the domestic currency value of a specific future cash flow in a foreign currency. Transaction exposure, therefore, refers to uncertainty about cash profits due to unanticipated exchange rate fluctuations.

Most often the concept of transaction exposure is reserved for contractual flows in foreign currencies. This limitation is obviously not necessary, but taking non-contractual cash flows into account demands a substantially larger information base. A consequence of this limitation is that transaction exposure usually does not take exposure of a firm's commercial operations into account but emphasizes financial commitments in foreign currencies. Certain future commercial cash flows can naturally be contracted for in money terms in advance of delivery of goods, and it is possible that financial flows are not definitely contracted for in money terms at the time a loan is taken. Nevertheless, as a rough approximation, financial flows are contractual flows while most commercial flows are non-contractual. Often, an expected cash flow is initially a non-contractual expected sale or purchase, which at the date of delivery becomes a contractual financial flow in the form of accounts payable or receivable. A simple example of

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how transaction exposure is often measured is provided in Table 1. As is often the case, transaction exposure is here limited to contractual flows.

Net exposure before covering is estimated in the given currency denominations of contracts. Thereafter, the desired exposure must be decided on before offsetting covers can be undertaken by entering, for example, forward market contracts. In the case of transaction exposure for contractual flows nearly exact covers can be obtained by entering forward contracts, when the exact day on which each cash flow will occur is known. (There is always a credit risk associated with accounts receivable). If more extended definitions of transaction exposure are used, including non-contractual commercial flows, then exact covers cannot be obtained, but the cover decision must be based on expectations of cash flows.

b. Translation Exposure

Translation exposure is most often an accounting concept, though one could theoretically define a corresponding economic concept. Accounting translation exposure in a particular currency (often called simply accounting exposure), may be defined as the net balance sheet position in a foreign currency. Since translation gains are estimated over reporting periods, exposure is often measured as a period average. Furthermore, a firm's translation exposure in a particular currency refers usually to the consolidated balance sheet of a multinational corporation in quarterly or annual reports to stockholders.

In the short term, translation gains or losses on exposure have no cash flow effects; i.e., they are not realized over the reporting period. Cash flow gains or losses occur, however, if the firm is

TABLE 1

AN EXAMPLE OF TRADITIONAL TRANSACTION EXPOSURE

| | Quarter | | | |
	I	II	III	IV
Accounts receivable from exports	60	40	40	40
Accounts payable for imports	-30	-20	-20	-20
Foreign interest payments (net)	-5	-5	-5	-5
Amortization of the foreign debt (net)	-20	0	-20	0
Net exposure before covering	5	15	-5	15
Sales of foreign currency in forward markets	-5	-5	5	-5
Net exposure	FC 0	FC 10	FC 0	FC 10

liquidated, or they will occur in the future when assets and liabilities produce cash flows. Thus, _ideally_ translation exposure should capture the sensitivity of economic value to exchange rate changes in the form of either liquidation value or the present value of future cash flows.

It is not easy to evaluate the different methods of calculating translation exposure since many conflicting elements enter the analysis. As is argued in Oxelheim (1985), exposure cannot be determined satisfactorily by one method; a combination of methods is needed, or at least a method may have to be adapted to a particular country or industry. For many firms, net income and the change in owners' equity is quite sensitive to the choice of translation method. It is important to note, however, that there are no tax or cash flow effects of the choice of method.

c. Approximations of Economic Exposure

Ideally, translation exposure should be evaluated in terms of exchange rate effects on the present value of future cash flows. Lessard (1979), Wihlborg (1980), Oxelheim (1985), and Glick (1986) as well as major textbooks on international business management agree on this point but execute the concept in different ways. Many firms seem to have some concept of economic exposure in the form of an adjusted accounting translation method. For example, a firm may consider its inventory exposed, but not its plant and equipment. In this case it would measure economic exposure as under FASB 8 (the monetary/non-monetary or the temporal method) but its inventory in foreign subsidiaries is added to the FASB 8 exposure. This method of measuring exposure for a particular balance sheet position has the drawback that it implicitly implies that a certain exchange rate change has the same

effect on the values of all exposed assets and liabilities. Economic exposure, on the other hand, should ideally measure a value <u>sensitivity</u> to exchange rate changes.

There is a common pitfall in exposure analysis in equating the search for a translation rule (i.e., current, historical, or another rate) with the search for a method to evaluate exposure. The objective of a translation rate could be, for example, to obtain a measure of the value of foreign assets that is <u>comparable</u> in economic terms to the value of domestic assets. The dollar value so estimated may or may not be a good exposure measure and the value may not correctly reflect the economic value of foreign assets unless domestic assets also have been correctly evaluated in economic terms.

d. <u>The Purpose of Accounting Rules and the Relationship Among Exposure Measures</u>

In the above discussion of economic exposure we argued that translation exposure based on any of the existing accounting rules cannot capture economic exposure consistently. It may be unfair, however, to ask this of an accounting rule. Such a rule should be designed to inform stockholders and financial markets about the impact of exchange rate changes on the firm's value. However, economic value depends on expectations, which may differ among individuals. Thus, the purpose of a rule could simply be to provide the best possible information to market participants. Different individuals may then form their own judgments and expectations about the impact of exchange rate changes on a firm. We cannot go into all the facets of how to provide financial markets with information here, but the necessity that any rule be clearly understood and its objective clearly defined is obvious. For

example, the objective may be to capture changes in the value in the parent company's currency. Such value changes differ from _real_ value changes for shareholders, however, since inflation must be taken into account to determine real values, and the consumption bundle differs among shareholders, especially when they reside in different countries. A translation rule could never take all such real value changes into account, but if shareholders can interpret the data given in nominal terms, then individuals may determine exposure themselves.

Another possible objective of accounting rules may be to make changes in income and/or changes in owners' equity comparable among subsidiaries in different countries. In this case, translation rules should perhaps not capture economic value, since accounting principles used for each subsidiary in their respective currencies do not. Instead, translation rules should be made consistent with other accounting principles.

From an information signalling point of view the all current method may be superior to other methods since it is very simple and market participants can more easily infer from the income statement and the balance sheet in domestic currency what the firm's position is in foreign currencies.

Ultimately, the actual choice of translation rule may not be very important for market valuation when market participants learn to understand it and to extract information from it. Then market participants can reinterpret the accounting data themselves and form their own valuation. Empirical evidence is contradictory on this point, however. This view of the purpose of a translation rule as a rule for

providing information implies that there is no economic sense in hedging translation exposure.
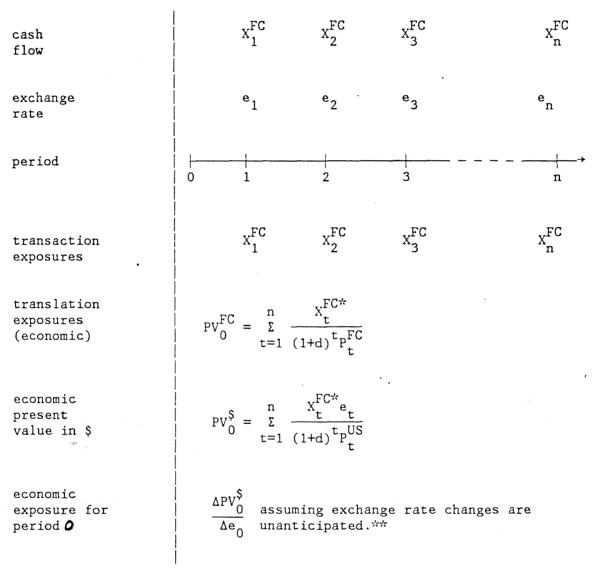
In addition to the relationship between accounting (translation) and economic value, it is important to understand the relationship between transaction exposure, on the one hand, and economic and translation exposures on the other. Are, for example, transaction and translation exposures complementary or substitutes? Can they be added together to obtain a measure of economic exposure?

To an important extent the answers to the above questions depend on whether translation exposure is viewed as a measure of the value of the expected foreign currency position. The economic value consists of the present value of a number of cash flows through time. Economic exposure is more properly a sensitivity measure for the economic value. In Table 2 we define transaction exposure in the conventional way as the cash flows in foreign currency in each period. The (economic) translation exposure here is the foreign currency present value of cash flows, while economic exposure is defined as the sensitivity of the dollar value of the firm to an exchange rate change during a period. Economic exposure defined this way can take into account that a near term change may or may not be expected to be permanent.

To an extent there is substitutability between transaction and translation exposure. The firm that locks in the dollar value of all future transactions $(X_1, \ldots, X_n)$ is obviously not economically exposed to exchange rate changes at all. Reducing translation exposure to zero for one period by locking in the dollar value in the period of the foreign currency value of the firm may overprotect against economic exposure. The reason is that exchange rate changes are sometimes

TABLE 2

DIFFERENT CONCEPTS OF EXCHANGE RATE EXPOSURE,
DISREGARDING INTERDEPENDENCE BETWEEN EXCHANGE RATES AND OTHER VARIABLES

cash flow	X_1^{FC}	X_2^{FC}	X_3^{FC}	X_n^{FC}
exchange rate	e_1	e_2	e_3	e_n

period

$$
\begin{array}{ccccc}
0 & 1 & 2 & 3 & n
\end{array}
$$

transaction exposures	X_1^{FC}	X_2^{FC}	X_3^{FC}	X_n^{FC}

translation exposures (economic)

$$PV_0^{FC} = \sum_{t=1}^{n} \frac{X_t^{FC*}}{(1+d)^t P_t^{FC}}$$

economic present value in \$

$$PV_0^{\$} = \sum_{t=1}^{n} \frac{X_t^{FC*} e_t}{(1+d)^t P_t^{US}}$$

economic exposure for period 0

$$\frac{\Delta PV_0^{\$}}{\Delta e_0}$$ assuming exchange rate changes are unanticipated.**

* X_t^{FC} may be a function of the exchange rate in period t.

** Δ = % rate of change. Economic exposure may also be defined by the sensitivity of cash flows to exchange rate changes.

Source: Oxelheim and Wihlborg, 1987

perceived to be temporary, in which case the present value in dollars of all future cash flows does not change in proportion to the exchange rate. However, if all exchange rate changes are expected to be permanent (which means that the direction of next change is random), then reducing translation exposure in Table 2 to zero is equivalent to reducing economic exposure to zero. In this case, economic exposure can be reduced to zero either by locking in the dollar value of all transactions $(X_1, \ldots, X_n)$ or by consecutively eliminating translation exposure one period at a time. On the other hand, if the expected exchange rate change for one future period is negatively correlated with the expected exchange rate change in the following period, then exchange rate changes are expected to be temporary, and eliminating translation exposure (PV_0^{FC}) would in fact cause economic exposure. Partial reduction of translation exposure would instead eliminate economic exposure and serve as a substitute for eliminating transaction exposure.

III. Hedging Macroeconomic Exposure

In order to recognize the interdependence among exchange rates, inflation rates, interest rates, and relative prices for the firm, exposure to each variable could be measured as sensitivity coefficients in a regression of cash flows or value on these variables. This approach is discussed in Oxelheim and Wihlborg (1986). It is an extension of the regression approach suggested by Adler and Dumas (1980), Hodder (1982), and Garner and Shapiro (1984) to a multiple regression analysis from which exposure coefficients are defined.

A weakness of the regression approach is that historical data must be used to derive exposure, which forms the basis for forward looking

decisions. Thus, it is important that regressions allow the estimation

of stable coefficients. It is suggested in Oxelheim and Wihlborg (1986)

that when there is variability in the relative frequency with which

monetary and fiscal policy shifts occur, exposure coefficients for

exchange rates and other price variables might be unstable, since

different shocks would have different effects on market-price variables.

In this case, cash flow exposure to actual macroeconomic disturbances

and policy shocks may be more stable. However, if there is substantial

variation in the behavioral rules followed by monetary and fiscal

authorities (policy regimes), then this latter regression approach might

lead to unstable coefficient-estimates. Thus, the behavior of policy

authorities is crucial for the choice between market price variables and

variables reflecting macroeconomic disturbances when measuring

macroeconomic exposures.

In Oxelheim and Wihlborg (1987), we present as an alternative to

the regression approach--a scenario-approach for estimating exposure

coefficients. The need for consistent historical data is reduced under

the latter approach. Instead, the exposure analyst must have a very

good grasp of macroeconomic modelling and the relationship between

economic disturbances and relative prices of importance for the firm.

Whether exposure coefficients are estimated by means of regression

or scenario analysis, and whether coefficients refer to market price

variables or macroeconomic and policy disturbances, the coefficients may

have to be used as a guide for hedging decisions, unless the firm is

risk-neutral. We turn now to the derivation of hedging contracts,

assuming exposure coefficients have been estimated for the relevant cash

flows. We may assume that the cash flows refer to relatively

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non-adjustable flows in terms of country of sales and currency of denomination, and they may include flows from sales as well as financial flows. In Subsection IIIa, we assume that exposure has been estimated for market price variables while in IIIb, we discuss hedging of exposure to actual macroeconomic disturbances.

IIIa. Hedging exposure to market price variables

In this section we illustrate how cash-flow or value exposures measured by regression equations can be hedged. We prefer the term "hedge" to "cover" since there need not be a one-to-one correspondence between the position in a currency and the offsetting contract.

The first issue is the form in which regression equations should be estimated. Assume that cash flow exposure measures are estimated in a regression in which all variables are expressed as rates of change. The firm has obtained the following result regressing the percentage rate of change of a firm's real cash flow on unanticipated changes in price levels abroad and at home, the exchange rate, domestic and foreign interest rates, and relative prices of special importance:

$$
\Delta \frac{X_t^\$}{P_t^{US}} = E_{t-1} \left[\Delta \frac{X_t^\$}{P_t^{US}}\right] - .3(\Delta P_t^{US} - E_{t-1}[\Delta P_t^{US}])
$$

$$
+ 0(\Delta P_T^F - E_{t-1}[\Delta P_t^F]) - .8(\Delta e_t - E_{t-1}[\Delta e_t])
$$

$$
- .015(\Delta i_t^{US} - E_{t-1}[\Delta i_t^{US}]) + 0(\Delta i_t^F - E_{t-1}[\Delta i_t^F])
$$

$$
+ .8(\Delta r_t - E_{t-1}[\Delta r_t]) + \varepsilon_t \tag{1}
$$

where:

$X_t^\$$ = total non-adjustable cash flow in dollars

P_t^{US} = price level in the US (share-holders' habitat)

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E_{t-1} = expectations operator in period t-1

P_t^F = foreign price level

e_t = exchange rate

i_t^{US} = interest rate in the U.S.

i_t^F = foreign interest rate

r_t = relative price(s) of relevance for firm's profitability

ε_t = error term

This equation shows the percentage change (Δ) in the U.S. purchasing power of cash flows for a one percent unanticipated change in each of the right-hand side variables holding other variables constant. Note that an individual's price index may differ from the index of the representative shareholder, in which case the individual's exposure may differ as well. With knowledge of such consumption differences, individuals may wish to take additional hedge contracts, which we do not discuss here. The first term on the right-hand side indicates the expected change in cash flows. The figure for this term must be obtained by forecasting. Next, we see that a one percent unanticipated change in the U.S. price level (inflation) leads to a .3 percent fall in real cash flows. Real cash flows are insensitive to changes in the foreign price level and the foreign interest rate, while a one percent unanticipated change in the exchange rate causes a .8 percent drop in real cash flows, holding other variables constant. Furthermore, a one percent unanticipated interest rate change (i.e., from 10 percent to 10.1 percent) causes a .015 percent fall in real cash flows. The relative price r measures the firm's output and/or input prices relative to a price index. A one percent increase in this ratio induces an increase of .8 percent in real cash flows.

To obtain the magnitude in dollar terms we need to know the level of expected cash flows. Assume this level is $60 million. Then we can calculate cash flow effects in dollars as in Table 3. Examples of changes that would cause effects of the described kind are given in the right hand column. As noted above, it is important to note that all exposure coefficients are partial, i.e., they refer to the sensitivity of real cash flows to changes in each variable, while other variables are held constant. For example, the exchange rate coefficient indicates the effect of a real exchange rate change at a constant price level and a constant interest rate. The relative price coefficient is the sensitivity of cash flows to purely commercial disturbances in the relative price. The firm can now decide whether it wishes to hedge all kinds of macroeconomic exposure or only, say, exchange rate exposure.

Let us assume that there is a forward market for foreign exchange (pounds in this case) and a futures market for T-bills. Thus, there are two types of hedging contracts but four types of exposure. It is, in this case, impossible to hedge completely unless two types of exposure can be hedged by internal means. For example, inflation exposure could be hedged by indexation of contracts. We assume in (i) that the firm chooses this route for inflation risk and decides not to hedge purely commercial risk. It remains then to hedge the real exchange rate risk and the real interest rate risk, i.e., is the risk of changes in exchange rates and interest rates at a constant inflation rate. Thereafter, in (ii), we assume instead that the firm chooses to hedge the real interest rate risk internally and the inflation risk through the T-bill futures markets, while remaining exposed to commercial risk.

IIIa. i. <u>Hedging real exchange risk and real interest rate risk</u>

We use the data in Table 3. In addition, we know that the forward rate (three months) is $1.5/£. We know that, if there is a one percent depreciation of the dollar from $1.5 to $1.515, then there is a real cash flow loss of $.48 million. Thus, in order to hedge, the firm should buy in the forward market the number of pounds such that if the future spot dollar rate depreciates by one percent more than expected, then there would be a cash gain on the forward contract equal to $.48 million. Set the contract size equal to C_F. Then,

$$480,000 = C_F (1.515 - 1.500) \qquad (2)$$

On the left-hand side is the desired gain on the forward contract in dollars from a one percent change in the exchange rate. On the right hand side is the contract size in pounds, C_F, times the gain per pound if the exchange rate changes one percent relative to the forward rate, i.e., if pounds are bought at $1.50, and then sold at $1.515. The contract size C_F is £32 million. Buying this amount of pounds for delivery in three months implies that, if there is a depreciation of the dollar equal to one percent, then the firm obtains a cash gain of .48 million, offsetting the cash flow loss of the same amount.

A similar operation can be performed in the futures market for T-bills. We know that a one percent change causes a real cash flow loss of $.009 million, or $9,000. Assume that the three-month T-bill rate is 8 percent, or 2 percent on a quarterly basis, today as well as in the futures market. Then, the spot and future price of a $1,000 three-month T-bill is $980.39 (1,000/1.020). <u>How many such T-bills for delivery in three months should be bought in order to gain $.009 million if the interest rate goes to 8.08?</u> Such an interest rate change would cause a

TABLE 3

CASH FLOW EFFECTS IN MILLION $ OF A ONE PERCENT
(UNANTICIPATED) CHANGE IN A MARKET PRICE VARIABLE,
HOLDING OTHER VARIABLES CONSTANT, ASSUMING EXPECTED
REAL CASH FLOWS ARE $60 MILLION

	Exposure Coefficient	Real Dollar effect (millions)	Example of a one percent change in price variable
Domestic price level	-.3	-.18	Consumer price index (CPI) goes from 100 to 101 (unanticipated) or a rise in inflation from 10% to 11%
Foreign price level	-.8	-.48	
Exchange rate	-.015	-.009	$/£ from $1.50 to $1.515.
Domestic interest rate	-.015	-.009	Interest rate from 10% to 10.1%
Foreign interest rate	0	0	
Relative price	.8	.48	output price index relative to CPI increases from 1 to 1.01.

fall in the three-month T-bill price to $980.20(1,000/1.0202). The number of contracts to obtain an offsetting gain for a one percent increase in the interest rate is C_T in:

$$9,000 = C_T(980.20 - 980.39)) \tag{3}$$

C_T is -47,368. In other words, 47,368 T-bills should be <u>sold</u> in the futures market. Then, if the interest rate goes up from 8 to 8.08 percent, the price on T-bills falls in three months. Accordingly, to fulfill the contract, the firm buys 47,368 T-bills in the future spot market and fulfills the contract to deliver, receiving a $.19 gain on each contract, or $9,000. This gain offsets the $9,000 loss in the firm's cash flow, due to the same interest rate change.

In this case, only the risks due to changes in the inflation rate and relative prices remain, but by indexing wage contracts, loan contracts, etc., inflation exposure can be avoided. Therefore, all macroeconomic exposures have been hedged and the firm can focus on dealing with uncertainty in its commercial operations, i.e., its exposure to changes in demand and cost conditions.

IIIa. ii. <u>Hedging real exchange risk and inflation risk</u>

In this subsection we assume that real interest rate risk is of no concern. The manager may consider the real interest rate stable. Instead, inflation is uncertain and fluctuations in the inflation rate may cause fluctuations in the nominal interest rate, as well as uncertainty about the profitability of the firm's commercial operations. Both effects are captured by the inflation sensitivity coefficient in equation (1). Thus, the firm wishes to hedge exposure to inflation risk as well as real exchange rate exposure. The latter exposure is hedged as in the previous example. Since real interest rate risk is

negligible, the T-bill futures market can be used to hedge inflation risk.

In this case the first task is to obtain a measure of the sensitivity of the T-bill interest rate to inflation, since T-bill futures are used to hedge inflation risk. Assume a regression for the T-bill interest rate on unanticipated inflation shows that:

$$i = 8 + .6(\Delta P_T^{US} - E_{t-1} [\Delta P_t^{US}]) \qquad (4)$$

where 10 is the anticipated T-bill rate and .6 is the change in the T-bill rate from a one percent change in the inflation rate. For example, a one percentage point increase in the inflation rate would lead to a change from 8 to 8.6 percentage points in the interest rate.

We know from Table 3 that a one percentage point unanticipated increase in the inflation rate causes a loss of $180,000. Thus, we ask how many T-bill futures should be bought in order to gain $180,000 when the inflation rate increases one percentage point? First, we observe that the increase in the inflation rate causes an increase in the interest rate from 8 to 8.6 percent. As a consequence, the three-month T-bill price falls from 980.39 to 978.95(=1,000/1.0215). Accordingly, to obtain an offsetting gain the number of T-bills to buy in the futures market, C_I, should be

$$180,000 = C_I(978.95 - 980.39) \qquad (5)$$

Thus $C_I = 125,000$. The firm sells T-bills in the futures market, and if the inflation rate goes up by one percentage point, the interest rate would go up by .6 percentage point, the spot price of T-bills would fall by $1.44 per contract, and the firm would make this gain on each T-bill it must deliver.

In the above examples, one macroeconomic risk--either inflation risk or real interest rate risk--had to remain unhedged or be hedged by internal means since there were only two hedging contracts for three types of macroeconomic risk (in addition to the commercial relative price risk).

IIIb. Hedging macroeconomic exposures: A general approach

We have mentioned that exposures can be measured by running the regression for cash flows or value on policy disturbances, and possibly other disturbances of a macroeconomic nature. Such a regression for cash flows can be formulated with all variables as percentage rates of change in the following way:

$$\Delta \frac{X_t^{\$}}{P_t^{US}} = E_{t-1} [\Delta \frac{X_t^{\$}}{P_t^{US}}] + a_1 (\Delta M_t^{US} - E_{t-1} [\Delta M_t^{US}]) \cdot$$

$$a_2 (\Delta M_t^{F} - E_{t-1} [\Delta M_t^{F}]) + a_3 (\Delta D_t^{US} - E_{t-1}[\Delta D_t^{US}])$$

$$+ a_4 (\Delta D_t^{F} - E_{t-1} [\Delta D_t^{F}]) + a_5 (\Delta r_t - E_{t-1}[\Delta r_t]) + \Pi_t \quad (6)$$

where:

M^{US}, M^{F} = The money supplies of the United States and foreign country(ies), respectively

D^{US}, D^{F} = The budget deficit of the United States and foreign country(ies), respectively

Π = error term

As noted in Oxelheim and Wihlborg (1986), it is most desirable to use this type of equation for exposure measurement when each policy authority follows a reasonably stable rule of behavior but the relative frequency of policies vary. It is, of course, possible to include non-policy disturbances as well in (6). From a hedging point of view, the firm is now faced with the problem that there are not hedging contracts

directly corresponding to money supply uncertainty and budget deficit uncertainty, respectively, in each country. This problem is easily solved, however, by running regressions for the variables that determine profits and losses on hedging contracts on the same macroeconomic disturbances that determine the firm's real cash flows in equation 6. Accordingly, in addition to running a regression determining the sensitivity of cash flows to disturbances, the firm runs the following regression for exchange rate changes:

$$\Delta e_t = E_{t-1}[\Delta e_t] + \alpha_1(\Delta M_t^{US} - E_{t-1}[\Delta M_t^{US}])$$

$$+ \alpha_2 (\Delta M_t^F - E_{t-1}[\Delta M_t^F]) + \alpha_3(\Delta D_t^{US} - E_{t-1}[\Delta D_t^{US}])$$

$$+ \alpha_4 (\Delta D_t^F - E_{t-1}[\Delta D_t^F]) + \alpha_5(\Delta r_t - E_{t-1}[\Delta r_t]) + \Pi_t \qquad (7)$$

where $E_{t-1}[\Delta e_t]$ is also the forward premium. This regression shows how the value of a forward contract in foreign currency depends on changes in the money supply, budget deficits, and relative prices. Similar regressions can be run for changes in the domestic interest rate (Δi^{US}) with coefficients β_1 through β_5 and changes in the foreign interest rate (Δi^F), with coefficients γ_1 through γ_5, which reveal gains or losses on future contracts in T-bills in U.S. dollars and foreign currency, respectively.

Assume now that there is considerable uncertainty about the U.S. money supply for a three-month period and the firm wishes to hedge against the real cash-flow effects of an unanticipated change in the money supply. From equation (6) it is known that a one percent unanticipated increase in the U.S. money supply causes a a_1 percent increase in real cash flows. Thus, in order to hedge, the firm should take contracts in the forward market and the T-bill futures markets such

that the total effect of a one percent increase in the money supply will be a loss of a_1 percent.

We can solve the hedging problem by considering the matrix in Table 4. Real cash flow effects are described in the first line, while the sensitivity of hedging contracts are described in the next three lines. In order to hedge against U.S. money supply uncertainty we take contracts C_F in forward markets, C_T in domestic T-bill futures, and C_{FT} in foreign T-bill futures such that:

$$-a_1 E_{t-1}[\frac{X_t^\$}{P_t^{US}}] = C_F \alpha_1 + C_T \beta_1 + C_{FT} \gamma_1 \qquad (8)$$

Since a_1 is the coefficient for the percent rate of change in cash flows, the left-hand side shows the level of the real dollar loss of a one percent increase in the U.S. money supply. The right-hand side shows the sum of the gains on hedging contracts of sizes C_F, C_T, and C_{FT}, respectively, of a one percent change in the U.S. money supply.

It can be seen that if the firm is interested in hedging only U.S. money supply risk, then there are many possible combinations of contracts that may constitute a hedge. In fact, only one type of contract is needed. On the other hand, if the firm wishes to hedge all four macroeconomic risks, then three types of hedging contracts are insufficient. The firm may then select one of the risks, say foreign budget deficit risk, as relatively unimportant, and focus on hedging the other three by solving for C_F, C_T and C_{FT} in a system of three equations consisting of equation (9) and the following two equations:

$$-a_2 E_{t-1}[\frac{X_t^\$}{P_t^{US}}] = C_F \alpha_2 + C_T \beta_2 + C_{FT} \gamma_2 \qquad (9)$$

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TABLE 4

SENSITIVITY COEFFICIENTS PERCENTAGE CHANGE

	$\Delta M_t^{US} - E_{t-1}[\Delta M_t^{US}]$	$\Delta M^F - E_{t-1}\Delta M_t^F$	$\Delta D^{US} - E_{t-1}[\Delta D_t^{US}]$	$\Delta D^F - E_{t-1}[\Delta D_t^F]$
$\Delta \dfrac{X_t^{\$}}{P_t^{US}}$ real cash flows	a_1	a_2	a_3	a_4
Δe_t forward contract	α_1	α_2	α_3	α_4
Δi^{US} domestic T-bills future	β_1	β_2	β_3	β_4
Δi^F foreign T-bills future	γ_1	γ_2	γ_3	γ_4

$$-a_3 \, E_{t-1}[\frac{X_t^{\$}}{P_t^{US}}] = C_F\alpha_3 + C_T\beta_3 + C_{FT}\gamma_3 \qquad (10)$$

In this case, the complete hedge can be obtained from a combination of contracts. The remaining variance of the firm's real cash flows would depend on the variances of foreign budget deficits, relative price changes due to factors other than policy disturbances and the pure unsystematic error term Π_t in equation (6).

IV. <u>Options and Hedging</u>

We have so far only analyzed the use of forward contracts and interest rate futures for hedging macroeconomic risk. It is obviously possible to extend the analysis to include stock market futures as well as different kinds of options. In this section we limit the discussion to foreign currency options.

The purpose of using options in a hedging strategy is clear if the firm wishes to buy an insurance against adverse movements in the exchange rate for a particular contract denominated in a specific currency. However, macroeconomic exposure, as defined here, refers either to the sensitivity of cash flows to exchange rate changes at constant price levels, interest rates, etc., or to the sensitivity to macroeconomic disturbances. In either case, there is not a one-to-one correspondence between the value of the option contract, which depends primarily on the nominal exchange rate and its variability, and real cash flows of the firm, which depend on real exchange rates, inflation rates, etc., or on macroeconomic disturbances. There is no option contract for which the value depends on the level of any of these variables. Nevertheless, option contracts may be part of the hedge portfolio of the firm since the value of a foreign currency option

contract would be correlated with one or more variables among the real exchange rate, the inflation rates, interest rates and monetary and fiscal disturbances.

In the options literature, the concept of delta, gamma, theta, and lambda are used to analyze how option values depend on underlying stochastic processes (see, for example, Grabbe, 1986). These concepts can be used to clarify the role of options for hedging of, for example, money supply risk or budget deficit risk. If it has been found that cash flows are best explained by macro-disturbances such as money supply shifts, then option values should also be described in terms of these variables for management purposes. Thus, option value formulas expressed in terms of the stochastic characteristics of a price variable like the exchange rate, would have to be reformulated in terms of the stochastic processes for underlying disturbances.

The option delta is defined as the derivative of the option value with respect to the price of the underlying asset, i.e., the exchange rate for a foreign currency option. Similarly, we would like to construct the deltas of a foreign currency option with respect to unanticipated changes in the money supply, the budget deficit, and other disturbances. Denote by δ_M, the derivative with respect to the money supply. In contrast to forward and futures contracts, the value of the option is expected to be non-linearly related to the underlying variables, i.e., the macroeconomic disturbances.

The gamma coefficients are the partial derivatives of the option deltas with respect to different macroeconomic disturbances in this context. For example, γ_M is the derivative of δ_M with respect to the money supply. Movements in this coefficient can be compared to

movements in the regression coefficients in the previous sections. Such movements would affect the optimal contract size, and depends on the level of the underlying variable, as well as on its volatility.

The theta of an option describes the value of an option as a function of time. The value of an option depends on time to maturity. If the firm is concerned about hedging the value of its cash flows, the value of an option would depend on the time at which cash flows are expected, and the time to maturity of the option.

The lambda finally describes how the value of an option depends on the volatility of underlying variables. Option values are highly sensitive to volatility and it is usually assumed that volatility is constant. Similarly in the regression analysis for cash flows and other variables in Section III, volatilities are assumed to be constant. However, the latter regression coefficients are less sensitive to volatility than option values.

Just like coefficients for cash flow (or value) sensitivity to macro-disturbances are derived in order to determine macroeconomic exposure, and the sensitivity of futures contract-values are derived in order to estimate the size of hedging contracts, the sensitivities of option values (δ) to these disturbances could be estimated for the purpose of hedging in options markets.

Since deltas are not linear with respect underlying disturbances, i.e., gammas are not zero, the optimal option contract for the purpose of hedging a cash flow would vary over time. Similarly, changes in the evaluation of volatility and the time to maturity would affect the magnitude of the option contract for hedging.

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V.   Strategies for Exposure Management

In the previous section we discussed hedging of all cash flows under the assumption that the firm has the objective of minimizing cash flow exposure. The firm's objective may be different, however. First, its aim may be to reduce the variance of its economic value rather than cash flows in which case minimizing cash flow variance every period may be sub-optimal. Second, its risk-aversion may be limited to some types of cash flows. For example, its major concern could be to reduce employment and sales-cash flow variability rather than total cash flow or value variability. Third, even if its objective is defined over total cash flows, its risk-attitude may be such that it is sub-optimal to minimize exposure to macroeconomic disturbances. As in Oxelheim and Wihlborg (1987), we can define the following types of strategies:

1.   aggressive strategy

2.   laissez faire strategy

3.   selective hedging strategy

4.   risk minimization strategy

The first strategy implies that the firm uses forecasts in order to always maximize cash flows or value. The second strategy implies that there is no hedging of exposures that arise as a result of normal operating decisions. Both these strategies presume little concern for risk and the second is usually based on the belief that markets are efficient. The third strategy presumes "risk-averse" behavior, i.e., the firm is willing to pay a cost for decreasing exposure. In this case, the firm must determine the opportunity costs of hedging, i.e., the expected costs of hedging-contracts as defined in Section III by evaluating the speculative profit-opportunities in markets for foreign

exchange and T-bills. The always cover strategy can be based on either "risk-paranoid" attitudes or on milder risk-aversion coupled with the belief in very strong market efficiency under which the forward rate is equal to the expected future spot rate and the expected rate of change of the exchange rate equals the interest rate differential (Fisher Open). Then some risk aversion would induce the firm to always cover. The selective covering strategy is the most difficult to implement, but it is the one that would be consistent with some risk-aversion and a belief that the firm's forecasters can "beat" the market.

Most practitioners would argue that they do not believe financial market efficiency to be as strong as Fisher Open (FO) implies. For example, risk premia may explain deviations from FO even in efficient markets. They would also argue that goods markets adjust sluggishly, and that they are risk-averse. As a result, they place themselves in the most demanding position in terms of information requirements for carrying out a selective covering strategy. Forecasts of relevant variables are required, as well as exposure coefficients for non-adjustable cash flows as well as for adjustable cash flows of different kinds. In addition, managers must determine their willingness to reduce the expected return for a reduction in exposure (see Oxelheim and Wihlborg, 1987, for a more elaborate discussion of information needs and strategies).

Assume that a firm's primary target variable is its economic value, and that it is risk-averse so that some stabilization of value is desirable. Furthermore, assume that it believes in some forecastability (i.e., non-FO), and more or less temporary deviations from the law of

one price (LOP) and purchasing power parity (PPP). Under these assumptions, the information requirements to determine production, sales, and financial positions such that a desirable trade-off between level and variance of value can be obtained, seem overwhelming. Before discussing how simplifying assumptions can be made in order to determine a feasible strategy, we describe in more detail how the desired information would be obtained based on the regression/exposure coefficient approach we have outlined.

First of all, it is necessary to decide on the percentage decrease in economic value (discounted cash flows) the firm is willing to sacrifice in order to decrease variance by a percentage point. Thereafter, market value and variance of market value must be determined for different combinations of sales in different countries and different financial positions. One of these combinations is then selected.

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 their exposure. The components can then be added and weighted with their respective exposure coefficients to obtain a total exposure measure on which the firm can base its decisions to cover, hedge or adjust its cash flows. Table 5 suggests a decomposition for a multinational firm with a number of products. 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.

TABLE 5

DECOMPOSITION OF CASH FLOWS

1. By subsidiary

2. By product group

3. Commercial and financial cash flows

4. Contractual and non-contractual cash flows

5. By adjustability in pricing

6. By adjustability in currency denomination

7. By adjustability in contract length

The adjustability of different flows depends on the nature and the time-horizon of the flows. Near term sales would normally be non-adjustable as would long-term debt amortization. Only short-term borrowing and lending and hedging flows would be adjustable within, say, a quarter. Over a longer time horizon price and invoice currency for sales can be adjusted. The longer the time horizon, the more adjustable are cash flows. The profitability of different production and sales plans can be evaluated from real exchange rate and price forecasts, while exchange rates and interest rates determine expected borrowing costs in different currencies.

A suitable point of reference for exposure analysis is to determine adjustable and non-adjustable sales, production, and financial positions that maximize economic value. Similarly, the exposure of these positions, i.e., the variance of the value, is determined from knowledge of the exposure coefficients for different cash flows.

Given this point of reference, adjustable sales, production, and short-term financial positions are varied, and value and variance are determined for different combinations. To the extent the optimal combination cannot be obtained by means of adjustable internal means, hedge contracts as in Section III may be used to obtain desired exposure.

Cash flows may be variable in many directions, and the number of possible combinations may become extremely large as the time horizon increases. For example, invoice currency, trade credit conditions, and other methods can be used to adjust the exposure of cash flows. The search for an optimal exposure position becomes tedious, time-consuming,

and costly, though computer programs similar to those used to determine optimal security portfolios could be used.

The information problem is further compounded by the potential unreliability of exposure-analysis based on historical data. By breaking down cash flows into components as suggested, internal judgmental information may be used to complement the analysis to determine exposure coefficients. Nevertheless, if simplifications of the strategy can be accomplished without substantial compromising of the firm's objective, it is obviously desirable.

We turn next to a discussion of simplifying assumptions which may help determine a feasible strategy. The costs and benefits of the following simplifying assumptions will be discussed. We assume in order that:

1.   Commercial cash flows are non-adjustable to exposures.

2.   LOP and PPP holds.

3.   FO holds.

4.   Risk-neutrality with respect to all or some cash flows.

5.   Use of accounting based measures of exposure.

6.   All changes are either permanent or temporary.

These assumptions are not mutually exclusive.

Va.   Treating commercial flows as non-adjustable to exposure

Firms make substantial investments in product categories and in their commitments to customers in different countries. Therefore, once these investments (sunk costs) have been made, it is often prohibitively costly to shift sales among both countries and product groups. The magnitude of sunk costs depends naturally on the product. In the extreme case there is a commitment to a sales-volume per country and

only extraordinary changes in the profitability picture are sufficient to motivate a shift in plans.

In firms with some adjustability, i.e., somewhat lower sunk costs, product and country sales plans may be adjusted only in response to expected real exchange rate changes and relative price changes above a certain magnitude depending on sunk costs. The sunk costs could be too large for it to be worthwhile to adjust sales plans to risk-considerations. Accordingly, exposure adjustment is left entirely to the financial side of the firm. The financial positions would then be determined with the total exposure in mind, but commercial exposure is treated as given by the financial managers.

The benefit and costs of this strategy with respect to commercial flows depends, as we noted, on the magnitude of sunk costs related to particular consumer groups, the time horizon over which investments are made, and on how rigid payment conditions are in terms of invoice currency and trade-credits.

It has been argued that payment conditions and invoice currency are of no importance to the firm (see, e.g., Rao and Magee, 1980), since in competitive markets prices would adjust to reflect risk-bearing by sellers and buyers. In that case, a reduction in exposure can be achieved only by selling at a lower price. It would then seem as if exposure management for commercial flows were irrelevant. However, there are many firms with very different exposure characteristics and risk-preferences in one market. If contract terms are standardized, it is highly unlikely that all firms can be compensated for risk-taking in prices in such a way that they are indifferent between actual contract terms and other sets of terms with lower exposure and lower price.

The costs to the risk-averse firm of viewing commercial cash flows as non-adjustable to exposure depends also on its risk-attitude, and on goods and financial market efficiency. Firms may be risk-averse primarily with respect to sales and output fluctuations, if it is costly to change the number of employees in production. For such a firm it is very costly to regard commercial flows as non-adjustable, since it is averse to the variance in these particular flows and the financial position is irrelevant.

For firms that are risk-averse with respect to all cash flows or value, the costs are most likely smaller. Their magnitude depends on how frequent, large, long-lasting, and unpredictable deviations from LOP and PPP, and relative price changes in goods markets are after macroeconomic disturbances, since these variables determine the extent of exposure.

The FO relationship is relevant for the "costs" of an exposure management strategy under which commercial flows are not adjusted for exposure, because when FO holds, the cheapest way to influence exposure is always through financial positions. The reason is that there is no market opportunity cost of changing the financial position among currencies. As we argue below, when FO holds, it is rational for the risk averse firm to minimize the variance of total cash flows solely by means of financial transactions, while maximizing commercial cash flows.

In general, the flows that can be adjusted to reduce exposure at the lowest opportunity cost should be adjusted first. Even when FO does not hold perfectly, it is not far-fetched to assume that the opportunity cost of adjusting financial flows is lower, in general, than the opportunity cost of adjusting commercial flows. The closer FO holds and

the larger the sunk costs in sales commitments, the more validity this viewpoint has.

Vb. Assuming LOP and PPP hold

The advantage of a belief in strong goods market arbitrage, so that LOP holds for all goods and PPP holds, is that exposure and profit opportunities for commercial non-contractual exposure do not arise. Therefore, it is costless to focus entirely on financial exposure. This view seems unrealistic, however, based on, for example, observation of the large and long-lasting real appreciation of the dollar in the early 1980s. It is worth noting that even if LOP holds for a particular firm's product, such as for oil and other raw materials, large price changes occur relative to other products when there are large deviations from average PPP. These relative price changes among products are as important for exposure and profit opportunities as relative price changes among countries, i.e., deviations from LOP. We conclude therefore that basing exposure management on the PPP assumption may be costly and expose the firm to considerable risk on commercial flows.

Vc. Assuming FO holds

We have already noticed that when FO holds, the value of commercial cash flows can be maximized and risk considerations need enter only financial decisions. This argument holds even if commercial flows in principle are adjustable. A second drastic simplification as a result of FO is that financial positions can be used to minimize exposure. The difficult evaluation of the trade off between risk and return is unnecessary. Thus, hedging for variance minimization as described in Section III can be pursued.

The benefits of assuming FO are substantial. How large are the costs? The answer to this question depends on the firm's potential profits on financial positions from attempts to forecast exchange rates and interest rates. These potential profits can be realized only if the firm can beat future and forward rates of foreign exchange and T-bills. Evidence is gathering that it is not impossible for individuals to realize such profits for some time but the costs in terms of time spent on forecasting may be substantial. The mixed empirical evidence and lack of agreement on the biasedness of the forward rate as a predictor of future spot rates is an indication that the opportunity cost of behaving as if FO holds may be small for most firms.

Vd. Risk-neutrality with respect to some or all cash flows

The great simplification that results from taking a risk-neutral attitude is that variance is of no concern and, therefore, commercial and/or financial positions are determined entirely from forecasts and based on cash flow or value maximization. The firm would choose an aggressive strategy unless PPP, LOP and FO are believed to hold.

As we have mentioned, the risk-attitude for financial flows may differ from the attitude for commercial flows, depending on the interests of different stakeholders. Under risk-neutrality with respect to shareholders, but risk-aversion with respect to employees, it becomes the firm's objective to maximize expected return on financial positions but to trade off expected cash flows versus variance for commercial flows. In this case it is obviously not possible to use financial positions to offset commercial exposure. This kind of exposure management strategy is entirely production and sales oriented and, given the limited adjustability of commercial cash flows once investments are

made, exposure consideration would enter primarily at the investment stage. Once investments are made, adjustment of sales and production to changes in the macroeconomic exposure are more costly, as we have noted.

Ve. Simplifications based on accounting data

This type of simplification is commonly used. As we noted in Section II, transaction and translation exposures are common measures based on which the firm hedges and covers. Transactions exposure may be seen as a near term cash-flow exposure measure, while translation exposure could be viewed as a measure of value exposure. We have already noted that these measures are designed specifically to measure exchange rate exposure without consideration of macroeconomic exposures in general. Transaction exposure is partial in an additional sense in that it focuses on financial flows, or possibly contractual flows in general.

Accounting based translation exposure measures are, as we noted, of little value in measuring economic value exposure to macroeconomic disturbances in general. Hedging translation exposure is, therefore, almost entirely a question of image.

Is it costly to hedge an irrelevant exposure? Since we expect that FO holds over time, the outright cost of hedging over time would be equal to transaction costs, which are relatively low. The cost would instead take the form of increasing confusion in the stock-market about the true exposure of the firm unless the firm announced exactly its hedging-transactions. In addition, by hedging an irrelevant exposure, the firm actually exposes itself in economic terms. Thus, if economic exposure is of concern as well, then such hedging could be costly.

For similar reasons the outright costs of managing transaction exposure would be limited to the costs of taking actual covers and employee time, which may be of considerable importance. Transaction exposure has some relevance, however, since it refers to part of the cash flows of the firm. Without knowledge of the exposure of other flows, i.e, non-contractual flows, covering transaction exposure may increase, as well as decrease, the near-term cash flow exposure, even to exchange rate changes. Thus, it seems essential to expand conventional transaction exposure measures to include a wider variety of flows and periods beyond the next few quarters.

Transaction exposure also neglects other exposures than exchange rate exposure. This drawback may or may not be serious in the short run, however, since the short-term variance of the real exchange rate tends to dominate exposure to the more stable price levels and interest rates. Interest rate variability has increased substantially, however, since many central banks have switched from interest rate targeting to money supply targeting.

One may interpret the strategy of a firm hedging total translation exposure and covering total transaction exposure as being based on:

1.   A risk-averse attitude.

2.   The use of accounting net worth as the target variable.

3.   A belief in FO as a reasonable approximation.

4.   A belief that PPP and LOP do not hold, since all assets are considered exposed under accounting rules.

5.   Independence between exchange rates and other price variables.

The firm covering all near-term transaction exposures consecutively would differ in its implicit assumptions, because: (1) its target variable is near term cash flows rather than value and (2) implicitly commercial cash flows are not considered exposed since they are not part of the exposure (i.e., LOP and PPP are implicitly assumed).

The firm choosing to selectively hedge or cover, is presumably also risk-averse but it does not believe in FO as a reasonable approximation. Its managers believe they can beat the market frequently or systematically. The burden of proof for this attitude should be laid rather heavily on the manager. Another problem faced with this strategy is that of determining a sensible and operational trade off rule between an acceptable increase in risk and an increased rate of return.

Vf. All changes will be either permanent or temporary

The information required to manage exposure for a firm with a reasonable discount rate is very large and includes cash flow exposure coefficients as well as the inter-temporal relationship among cash flows in different periods. Even if the firm wishes to minimize exposure, there is a need to understand how a change in the exchange rate, a price level, or an interest rate in the near future affects the likelihood of additional changes or reversals in the variables. Assume, for example, that cash flow exposure on a quarterly basis has been estimated, but the concern of the firm is value exposure or market value stabilization. In this case it is necessary to translate cash flow exposures into value exposures. If the real exchange rate is expected to remain at the current level or to return to it soon after unanticipated changes occur, then real exchange rate changes are expected to be temporary, and the cash flow exposure in real dollar terms to near term real exchange rate

changes is equal to the exposure of economic value to these changes. In other words, cash flow exposures for different time horizons are independent. Hedging of value can then be accomplished by hedging a series of cash flow exposures. The analysis of hedging in Section III is applicable again.

There exists weak and highly controversial empirical evidence that the real exchange rate follows a random walk (Roll, 1979; and Piggott and Sweeney, 1985). If this is correct, any unanticipated real exchange rate change would be considered permanent, that is, if the rate changes, then the best guess is that the rate will remain at the new level. In such a case, the exposure coefficients for the percentage change in cash flows can be applied on value exposure, since the percentage change in value of an unanticipated change must be equal to the percentage change in cash flows during the same period. The reason is that expected cash flows in all periods would be influenced to the same degree as cash flows in the period the real exchange rate change occurred. The measurement of value exposure is, therefore, relatively simple when changes in macroeconomic variables are expected to be either permanent or temporary.

The difficulty in obtaining an operational measure of value exposure increases when changes in variables are neither temporary nor permanent, and especially when changes vary in this respect over time. In the latter case, there is no fixed rule for translating between cash flow and value exposure. Even if a constant relationship exists, it would take time to obtain observations based on which a well-informed estimate of the degree of permanence can be formed.

VI. Summary

Traditional exchange rate exposure measures are either partial, accounting based, or both. Partiality implies that a measure refers to a limited share of cash flows and/or that it neglects exposures to variables related to the exchange rate in a general equilibrium system. Since changes in these related variables also cause exposure, management of exchange rate exposure and exposure to related macroeconomic variables should be coordinated.

We showed in Section III how the firm can hedge cash flow exposures based on coefficients from regression equations that isolate the influence of different macroeconomic variables or disturbances from each other and from pure business conditions for the firm.

We have not discussed in detail whether it is optimal to hedge fully, partially, or not at all. However, in Oxelheim and Wihlborg (1987), we analyze how firms may choose an exposure management strategy consistent with its objectives and its views of goods and financial market adjustment. In Section V of this paper, this analysis was used to demonstrate that relatively simple exposure management strategies can be derived, even when managers' views of objectives and market adjustment are such that optimal hedging policies require an overwhelming amount of information. For example, if it is relatively costly to adjust the country and product composition of sales, or if deviation from the Fisher Open condition in financial markets is small on the average, then exposure and hedging transactions can be centralized to the financial division of the firm. Furthermore, if deviations from Fisher Open are expected to be small, then financial positions and hedging contracts may have the objective of minimizing the

variance of total cash flows or value of the firm, while commercial flows are maximized.

Whether these simplifications are utilized or not, meaningful exposure management is impossible unless accounting based concepts for exposure are disregarded. Sensitivity coefficients for cash flows to changes in market price variables, such as exchange rates or to macroeconomic disturbances, may be the two most easily attainable exposure measures which can provide guidance for hedging decisions. Such coefficients for cash flows are useful for hedging exposure in terms of economic value as well, if the degree of permanence of macroeconomic disturbances can be assumed to be reasonably constant over time.

References

Adler, M. and B. Dumas, in B. Antl (Ed.), <u>Currency Risk and the Corporation</u>. London: Euromoney Publications (1980), pp. 145-158.

Garner, K. and A. Shapiro, A practical method of assessing foreign exchange risk, <u>Midland Corporate Finance Journal</u>, Fall (1984), 6-17.

Glick, R., Market neutrality conditions and valuation of a foreign affiliate, <u>Journal of Business Finance and Accounting</u>, 13, Summer (1986), 239-299.

Grabbe, J. O., "Foreign Currency Options: A Survey," in Khoury, S. J., and A. Ghosh (eds.), <u>Recent Developments in International Banking and Finance</u>, Vol. 1, Lexington Books, D.C. Heath and Company (1986).

Hodder, J. E., Exposure to exchange rate movements, <u>Journal of International Economics</u>, Nov. (1982), 375-386.

Lessard, D. R., Financial management of international operations, Introduction, in Lessard (ed.), <u>International Financial Management, Theory and Application</u>, Warren, Gorham and Lamont (1979), Boston.

McKinnon, R., <u>Money in International Exchange</u>, Oxford University Press, Oxford (1979).

Oxelheim, L., <u>International Financial Market Fluctuations</u>, Wiley, Chichester (1985).

Oxelheim, L., and C. Wihlborg, Measuring Exchange Rate and Related Macroeconomic Exposure, in Khoury, S. J., and A. Ghosh (eds.), <u>Recent Developments in International Banking and Finance</u>, Vol. I, Lexington Books, D.C. Heath and Company (1986).

Oxelheim, L., and C. Wihlborg, <u>Macroeconomic Uncertainty--International Risks and Opportunities for the Corporation</u>, John Wiley and Sons, Chichester (1987)

Rao, R. and S. Magee, The currency of denomination of international trade contacts, in R. M. Levich, and C. Wihlborg (eds.), <u>Exchange Risk and Exposure</u>, Lexington Books, D.C. Heath and Company (1980), Lexington, Massachusetts.

Wihlborg, C., Currency exposure--taxonomy and theory. In R. M. Levich and C. Wihlborg (Eds.), <u>Exchange Risk and Exposure</u>, Lexington Books, D.C. Heath and Company (1980), Lexington, Massachusetts.