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Note On Operating Exposure To Exchange-Rate Changes

This note examines operating exposure: the effect of a change in exchange rates on the expected value of a firm's future operating cash flows. It is useful to begin with a comparison of this phenomenon to another, similar one. Consider the oil shocks of the 1970s. When oil prices changed abruptly, the price of oil relative to other goods rose sharply. Many firms' expected future cash flows changed dramatically as a result, because manufacturing costs changed, consumption patterns changed, some technologies changed, etc. This change in the relative price of oil represented a real macroeconomic shock and most firms were exposed to it, some positively and others negatively, and each to a greater or lesser degree depending on many firm-specific factors. Similarly, large unexpected changes in exchange rates may represent real macroeconomic shocks and can result in changes in the value of firms' expected future operating cash flows. Operating exposure, sometimes referred to as "economic exposure," should be thought of as the response of operating cash flows to a real exchange-rate shock.

This definition of operating exposure immediately distinguishes it from two other types of foreign exchange exposures: contractual exposure (often referred to as "transaction exposure") and translation exposure. The former denotes the exposure of contracts *denominated* in a foreign currency; for example, firms may have cash deposits or debt obligations that carry a specified foreign currency denomination. With a few exceptions, it is easy to calculate the effect on these instruments of a change in the exchange rate. It is also easy to hedge this type of contractual exposure. Translation exposure, in contrast, denotes the change in a firm's reported results and financial condition brought about by changing exchange rates. For accounting purposes, it is necessary to express the firm's financial statements in a common currency, regardless of economic reality. Obviously, the particular rules adopted for effecting this translation will play an important part in determining translation exposure. Thus, contractual and translation exposures differ from operating exposure, first because they do not pertain to expected future operating cash flows and second, because the contemplated change in the exchange rate may or may not constitute a real shock.[1]

[1]For more on these other types of exposures, see "Note on Transition and Translation Exposure."

Professor Timothy A. Luehrman prepared this note as the basis for class discussion.

Purchasing Power Parity and Real Exchange Rates

The oil shock mentioned above was a real shock because oil prices rose *relative* to the prices of other goods. In the same way, a *real* change in exchange rates is one that changes the relative prices of the goods and services consumed and produced by firms. To see the importance of this distinction, suppose instead that oil prices rose no more or less than the prices of all goods and services. In such a case the general price level rises ("inflates"), but relative prices remain the same and firms and consumers have no reason to change their decisions about production and consumption. Similarly, if a change in a given exchange rate only reflects the difference in inflation rates associated with two currencies, then relative prices do not change and the shift in the exchange rate is said to be nominal rather than real.

To the extent that changes in exchange rates reflect only the differences in inflation rates among currencies, they are consistent with Purchasing Power Parity (PPP). PPP implies that the rate of change of an exchange rate should be equal to the difference between inflation rates for the two currencies. If PPP always held, changes in exchange rates would be nominal rather than real and would not give rise to operating exposure. However, empirical evidence indicates that PPP is not a good explanation of exchange rate movements, except in the very long run, and it has done especially poorly during the 1980s. Some of this evidence, for the specific case of the yen/dollar exchange rate, is presented in **Exhibit 1** and described in the Appendix to this Note.[2]

When PPP fails to hold, for whatever reason, changes in exchange rates may be associated with changes in relative prices. For example, the relative prices of manufacturing inputs, such as labor in the U.S. vs. labor in Japan, may change in response to a real change in the yen/dollar exchange rate. When this happens, cost structures change and firms may change their pricing and output decisions; as a result, expected future cash flows change.

Two final points should be noted. First, it is possible to have a real exchange-rate shock even if observed nominal exchange rates are constant. If two countries have different inflation rates, PPP says that the *nominal* exchange rate between their currencies should change. If it does not, then the *real* exchange rate does change; i.e. relative prices change and this will affect firms' cash flows (note this implies that firms have operating exposures even under fixed exchange-rate regimes). Second, it should be obvious that relative prices can change for reasons other than shifts in exchange rates (e.g., technological or demographic changes) and firms' operating cash flows are also exposed to these types of real phenomena.

The Responses of Operating Cash Flows

Estimating a firm's operating exposure requires an assessment of the responsiveness of operating cash flows to a given real change in exchange rates. The major categories of inflows and outflows are revenues and costs, respectively, and these are addressed first.

Consider a U.S. firm whose primary activity is manufacturing a product in the U.S. for sale in the U.S. and Germany. It imports none of its inputs, a large fraction of which is labor, and it exports roughly half of its output. Suppose now that the dollar unexpectedly appreciates against the mark and that this change is real; i.e., it represents a deviation from PPP. What happens to the cash flows of the U.S. firm?

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[2]For more on PPP and why it breaks down, see "Note on Fundamental Parity Conditions," Harvard Business School note 288-016; or M. Levi, *International Finance*, 2nd ed., McGraw-Hill, New York, 1990.

First, a currency must be chosen to measure cash flows. Since the firm is from the U.S., the dollar is the likely candidate, though this is not required. Next, consider the effect on the dollar costs of the U.S. firm. Since inputs are all sourced in the U.S. their prices, measured in dollars, may be unaffected by the exchange-rate change. Assume for the moment that this is the case and that the firm need worry only about revenues. In particular, let dollar prices and unit volume remain the same in the U.S. and focus instead on revenues from the German market.

When the firm exports to Germany, it must set a price in DM for its products because the German consumers have DM cash to spend (even if the firm quoted prices in US$, consumers would have to sell their DM and buy US$ at the prevailing exchange rate, so the firm would still be exposed to the DM/US$ rate). When the dollar appreciates, the firm must decide what to do with the DM price it has quoted. To pick two extremes, it can either leave the DM price constant or it can raise the DM price to offset fully the DM depreciation.

In the first case, with DM prices constant, German consumers may continue to purchase the product as if nothing had happened: unit volume remains constant, as does DM revenue. But the firm's shareholders measure their returns in US$; because the DM has depreciated (the US$ has appreciated), the same DM revenue represents a lower US$ revenue and, because US$ costs are unchanged, lower US$ cash flow. In the second case, the firm raises DM prices in order to keep US$-equivalent prices the same as before the exchange-rate shock. German consumers are bound to notice the DM price rise and can be expected to either lower their consumption of the product or purchase it from other (presumably German) producers. Either way, the consequence is a drop in unit volume for the U.S. firm and hence, again, a drop in US$ cash flow.

In the simple example just described the US$ cash flow of the firm is *negatively exposed* to the real DM/US$ exchange rate. When the real DM/US$ rate goes up, corresponding to a US$ appreciation, the US$ cash flows of the firm decline, regardless of how the firm adjusts its DM prices. This illustrates the traditional view of operating exposure, namely that a real home currency appreciation reduces the cash flow of home country firms engaged in exporting or competing at home with imports. This is because a home currency appreciation makes exports from the home country relatively more expensive for consumers abroad while making imports into the home country relatively cheaper. While it is important to understand this fundamental concept, it is also important to realize that it is quite simplistic and therefore may be very misleading.

Important Extensions

To consider the factors that complicate the traditional view of operating exposure, it is helpful to return to the example of the oil shock. When the relative price of oil rose dramatically in the 1970s (and when it subsequently fell) many economic actors changed their behavior. Energy users changed their consumption habits, primarily by conserving. Consumers changed their buying habits, for example, by buying smaller cars instead of bigger ones. Firms designed new products, modified manufacturing processes, and developed new technologies. Governments introduced new taxes and new tax incentives. The business cycle changed; some economies expanded and others fell into recession, with important implications for inflation and interest rates.

While the oil shocks may seem an overly dramatic example of changes in economic behavior, they illustrate the important point that people respond, sometimes very quickly and dramatically, to real macroeconomic shocks. Further, the recent changes in exchange rates have also been very dramatic; since 1980 the ¥/US$ rate has been both over ¥270/US$ and under ¥140/US$. Changes of this magnitude can be expected to have great impact on the world economy, principally because consumers, managers, and government officials all react to them.

Consumer reactions One aspect of the problem frequently overlooked is the direct effect of a real exchange-rate shock on consumers. Returning to the example above of a real appreciation of the US$ against the DM, note that because the change is real, the DM loses purchasing power relative to the US$. Consumers in both countries are affected directly by the change, regardless of what any particular firm decides to do. German consumers may cut back their purchases of many goods, including those of the U.S. exporter, even if the U.S. firm decides to keep DM prices constant. At the same time, U.S. consumers are better off because the relative purchasing power of the US$ has risen; they may demand more of many goods. So the firm may experience *both* an increase in U.S. demand and a decrease in German demand. How these effects net out depends on the behavior of German and U.S. consumers and on the relative importance to the firm of the two markets. If the U.S. market contributes significantly more to the firm's cash flow, the dollar appreciation may help the firm more than hurt it.

An example of this phenomenon is the rise of the US$ in the early 1980s. The traditional view is that such a rise is bad for U.S. producers who have to compete with imports. However, by 1984 the real increase in the dollar's value had put such purchasing power in the hands of the huge pool of U.S. consumers that the general economic expansion in the U.S. may have helped many firms more than imports hurt them. While the rise of the dollar should not be viewed as the sole cause of the expansion, such currency movements can clearly be good for consumers and at least some firms will benefit from this direct effect on their customers.

Competitor reactions Another important determinant of operating exposure is the nature of a firm's competition. Just as consumers respond to exchange-rate changes, so do competitors. A U.S. firm's exposure to the depreciation of the DM described above may be very different if its competitors in Germany are other U.S. exporters as opposed to German firms. If they are German, the competition may find themselves with a new cost advantage (e.g., German labor may have become relatively cheaper than U.S. labor). If competition is price-based, they may exploit this cost advantage to increase market share; alternatively, they may choose to keep DM prices and margins up, thereby increasing DM profits. On the other hand, if the competition comes from other U.S.-based exporters, it may be that none of them will obtain a relative cost advantage from the DM/US$ shift.

Note that even the U.S. business of a U.S. firm is exposed if it faces competition from non-U.S. producers. In the present example, the U.S. firm may find US$ prices changing in the U.S. market as (foreign) competitors react to the new level of the DM/US$ exchange rate. Other good examples of this sort of competitive exposure are the steel, textile, and machine tool industries in the U.S. Producers in these industries have found themselves significantly exposed to real exchange rates even though they may have no foreign operations themselves, because they compete with firms producing abroad.

Supplier reactions A third complication is the behavior of a firm's suppliers in the face of an exchange-rate shock. In general, they also are exposed to changes in relative prices and their reactions to an exchange-rate shock will be felt by firms using their products as inputs. An obvious example is imported inputs. If two U.S. firms are competing with each other and one imports more raw materials than the other, then a shift in the real value of the US$ may give one or the other a relative cost advantage, even if neither of them exports and neither faces product market competition from imports. How large an advantage is realized by which firm depends on how the firms' suppliers react to the exchange-rate change.

The nature of competition among suppliers also must be examined. For example, suppliers competing on the basis of price will respond differently to an exchange-rate change than if they competed on quality, service, or delivery. In general, the location of suppliers, their cost structures, and the types of demand they face will affect their customers' exposures. This is clearly true for traded inputs such as steel or energy, and it may be true for non-traded ones as well, such as labor. Recall from above that a real appreciation of the US$ relative to the DM appeared to make German labor relatively cheaper than U.S. labor. However, this simple conclusion ignores the fact that

laborers are affected directly by the exchange-rate shock; i.e., it ignores the impact of the suppliers' (laborers') exposures. If a lower real DM lowers the relative cost of German labor, both employers and employees feel the effect of this, and the latter may be expected to demand higher pay if they are in a position to do so. Once again, the nature of the relationship between the firm and its suppliers and between competing suppliers will help determine the outcome.

Public sector reactions Finally, politicians and governments react to real macroeconomic shocks and this is no less true for exchange-rate changes than for oil price changes. Following the oil shocks, governments taxed "windfall" profits on "old" oil, introduced incentives for exploration and conservation, and invested in the development of alternative energy sources. These actions had significant effects on firms' expected cash flows. Similarly, real changes in exchange rates induce governments to contemplate protectionist trade legislation, to offer tax breaks as incentives to new (possibly foreign) investment, to control currency flows and capital transactions, etc. While the timing of governmental policy changes may be difficult to predict, it is often easy to observe a political consensus developing for one action or another as real exchange rates change. For example, during 1985-86 the value of the US$ against a number of currencies, primarily the yen, was widely regarded as a barometer of the likelihood of protectionist trade legislation in the U.S. While it may be argued that changes in expected cash flows resulting from shifts in government policies is really "political exposure" more than exchange-rate exposure, this distinction seems academic if the policy changes were motivated by the exchange-rate shock and were, to some degree, predictable.

So far, two basic points have been made about the responsiveness of operating cash flows to real exchange-rate changes. First is the fundamental notion that, all other things equal, a real appreciation of the "home" currency makes exports from the home country more expensive for consumers abroad and makes goods from abroad relatively cheaper for consumers in the home country. This characteristic of relative prices is at the root of changes in corporate cash flows. Second, the traditional view that a home currency depreciation helps home country firms is complicated by changes in behavior by consumers, suppliers, competitors, governments, and the firm itself. Thus, understanding operating exposure requires a thorough understanding of how a business works; namely, where output is produced and sold; where competitors produce and sell; where suppliers produce and sell; and how each of these actors will respond to a real exchange-rate shock.

Some Further Extensions

In addition to the considerations described above, there are some which may be less obvious. First among these are the macroeconomic relationships among interest rates, inflation rates and exchange rates. Recent empirical evidence from the U.S. and Japan suggests that changes in real exchange rates tend to be accompanied by changes in real interest rates. This implies that while a real exchange-rate shock changes expected future operating cash flows, a concurrent shift in real interest rates changes the discount rate applicable to those cash flows. To the extent that real exchange rates and real interest rates move together, effects on cash flows should not be viewed in isolation; some decisions are made on the basis of present values rather than cash flows per se, so discount rates need to be examined.

Though there are no hard and fast rules, existing evidence indicates that if currency A is appreciating (in real terms) relative to currency B, then A's real interest rate tends to decline relative to B's real interest rate. For example, suppose the U.S. exporter described above realizes a decrease in its expected US$ cash flows following a real rise in the US$ vs. the DM. It may also be the case that the real US$ interest rate has declined relative to the real DM interest rate, and that the discount rate applicable to future US$ cash flows has decreased. If so, then the decrease in cash flows is offset to some extent (perhaps even more than offset) by the decrease in the discount rate. In this sense, the exposure of the *value* of the cash flows depends on their timing and on the relationship between real interest and exchange rates in addition to the factors outlined above.

Next, as the foregoing discussion made clear, the reactions of various economic actors are important determinants of a firm's exposure. Such reactions are often very difficult to anticipate. It is usually helpful to bear in mind that the response of say, a competitor, to an exchange-rate shock depends not on the exposure of the competitor's *total* cash flows, but rather on the exposure of its *marginal* cash flows. The distinction is an important one because total exposure and marginal exposure can have opposite signs. For example, revenues may be slightly positively exposed to a given exchange rate and costs highly negatively exposed, resulting in an overall negative exposure; however, if a substantial portion of costs are fixed, marginal cash flows may be positively exposed. The firm will respond differently depending on whether marginal cash flows are positively or negatively exposed. In short, to determine the effect of an exchange-rate shock on a firm's value (its operating cash flows), one looks at (total) operating exposure; to anticipate what the firm will do about it, i.e., what actions it will take in response to the shock, one looks at the exposure of marginal cash flows. Note that as a result, a given firm's total operating exposure depends on its *competitors'* (and suppliers') *marginal* exposures.

These competitive relationships are especially important and difficult to analyze in a setting of global competition. Global competitors pursue business strategies designed to coordinate and optimally exploit interdependent positions in multiple markets. As a result, actions taken by a firm in one market have significant spillover effects on both its own and its competitors' operations in other markets. Hence, a U.S. firm exporting to Germany and facing global competitors will find that the exposure of its US$ cash flows depends on the exposure of its suppliers and competitors' marginal cash flows, not only in Germany, but also in the U.S. and other markets.

Finally, it should be pointed out that by focussing on revenues and costs, the foregoing discussion has largely neglected another type of cash flow, namely investment. While capital budgeting analyses may take into account changes in net working capital and net fixed assets when computing a project's free cash flows, these types of investments are not typically considered cash flows from operations. Nevertheless, they affect future operating cash flows. A firm's expected future operating cash flows may be thought of as follows:

Total operating cash flows	=	Operating cash flows from assets already in place	+	Operating cash flows from future discretionary investments

"Operating cash flows from future discretionary investments" refers to cash flows the firm is expected to realize, but for which the necessary investments have not yet been made. For example, IBM is expected to have access in the future to projects that have positive net present values. Access to such projects is valuable and comprises part of IBM's value now. The access may arise from IBM's position as a market leader, from new technologies in the computer business, etc. Essentially, IBM owns a call option on some operating assets. At some future date, the option may be exercised by making the necessary investment, in return for which IBM would receive the assets, which then have a value equal to the present value of the cash flows they are expected to produce. Alternatively, the option may never be exercised, but it is still valuable until it expires.

A real exchange-rate shock may change the terms on which a firm can make such investments in the future; i.e., the terms on which the "option" may be exercised. This may affect the firm's decision about when or even whether to exercise the option. Thus, operating cash flows from assets not yet in place, i.e., from future discretionary investments, are subject to this additional effect of the exchange-rate change, and it forms part of their exposure.

Once again, competition further complicates the possibilities. Just as competitors' pricing and output behavior affects exposure, so does their investment behavior. Many investments have a competitive aspect to them; for example if one firm invests in a new technology, its competitor may be forced to follow or, alternatively, may be prohibited from following by patents. Either way, one firm's investment expenditures affect another's. A shift in real exchange rates changes the terms on which firms compete for some kinds of investments. When a firm's home currency appreciates, it

may be able to make investments (exercise options) on more favorable terms than a particular competitor because the relative purchasing power of its currency has increased. This can be so even if cash flows from assets already in place are reduced, and even if the future cash flows from newly acquired assets are reduced. The same exchange-rate shock may also speed up or slow down investment plans and it may cause some investments to be undertaken which previously seemed unattractive. A good recent example of this phenomenon is the greatly increased pace of investment by Japanese firms following the rapid appreciation of the yen in 1985-86.

Managing Operating Exposure

There are three steps to managing operating exposure: understanding how it works; estimating its signs and magnitudes; and doing something about it. This Note has emphasized the first of these and has comparatively little to say about the other two. Estimating exposures is very difficult, because they are complex, because they may change from year to year or even quarter to quarter, and because they depend on variables that are largely unobservable.

One approach to the estimation problem is strictly qualitative and takes the form of an exposure "audit". An audit consists of a careful examination of the separate elements of a firm's operating cash flows, and an attempt to anticipate the effects of a particular type of real exchange-rate change. This exercise is especially useful to line managers whose responsibility it will be to respond to an exchange-rate shock when it arrives.

A second approach is to appeal to the judgement of the capital markets. When exchange rates change, investors are faced with the task of assessing the effects on the value of firms' public securities. A regression of changes in firm value on changes in exchange rates gives a statistical estimate of operating exposure. The advantages of this approach are that all the necessary variables are observable, the data are of reasonably high quality for many firms, and securities prices respond very quickly to shocks which makes it unnecessary to worry about the nature of the lag between an exchange-rate change and its effect on cash flows. The primary drawback of this statistical approach is that it measures aggregate exposure and so does not afford a view of the different elements of operating exposure the way an audit does.

Once a firm has an estimate of its operating exposure, what should be done about it? This is a question on which there is little agreement among either academics or managers. Much of the debate concerns whether or not exposures should be hedged, and if so, by whom. On the one hand, such exposures are very difficult to measure and hedge and, in any event, could be hedged by investors rather than firms to the extent that hedging is desirable. On the other hand, firms should have much better information about their operations and hence, about the nature of the exposure, than do individual investors. Firms also may be able to hedge at a lower cost than investors could.

By comparison, there is less debate about how a firm should respond internally to an exchange-rate shock. In short, it should continue to maximize value. This requires certain operating responses, including, for example, changes in pricing, sourcing, and product mix. One way to train managers to take such actions in a timely fashion is to conduct "rehearsals". This involves asking line managers to walk through the specific steps they would expect to take in response to a hypothetical exchange-rate change. It provides potentially valuable information about how the organization as a whole is likely to perform, and where bottlenecks and misunderstandings are most likely to appear. The direct involvement of line, as opposed to staff, managers makes such rehearsals a useful training exercise within firms that have significant operating exposures.

Summary

Operating exposure should be thought of as the response of a firm's expected future operating cash flows to a real macroeconomic shock, i.e., a real change in exchange rates. Real exchange rates change when changes in nominal exchange rates fail to reflect Purchasing Power Parity. As a result, the relative prices of goods and services change, and consequently, so do firms' operating cash flows.

A real change in exchange rates leads to the following fundamental type of change in relative prices: the real appreciation of a currency, say the US$ vs. the DM, makes exports from the U.S. to Germany relatively more expensive for German consumers and imports from Germany to the U.S. relatively less expensive for U.S. consumers. Under many plausible scenarios, this results in a reduction of US$ cash flows to a firm producing goods in the U.S. for sale in Germany. The US$ operating cash flows of the firm are said to be negatively exposed to the DM/US$ exchange rate. The magnitude of the exposure is equal to the amount by which the value of the cash flows changes following a given shift in the exchange rate, and it is typically measured in the foreign (DM) currency. This simple relationship underlies the traditional view of operating exposure, namely that a home currency appreciation reduces the cash flows of home country firms engaged in exporting or competing with imports.

There are many complicating factors which can make this traditional conclusion misleading. A significant change in relative prices represents a real macroeconomic shock to which many people will respond. It is important to examine the reactions of consumers, suppliers, competitors, and governments and to assess the impact of these reactions on the particular firm's operating cash flows. It is also necessary to consider possible changes in the investment behavior of a firm and its competitors in addition to the more obvious changes in production and consumption decisions. Finally, the effects of real exchange-rate changes should not be taken out of their proper macroeconomic context. In particular, if real interest rates change simultaneously, the appropriate discount rate for future operating cash flows may change as well. The complications just described are capable, separately or together, of either offsetting or reinforcing the firm's basic operating exposure. Note that if they completely offset it, the traditional view predicts both the wrong sign and the wrong magnitude of actual operating exposure.

Appendix

Purchasing Power Parity and Real Exchange-Rate Changes

The term "real exchange rate" is widely used in business and economics, but unfortunately is not very precise. It typically refers to a nominal exchange rate that has been adjusted to reflect deviations from Purchasing Power Parity (PPP). However, this still leaves some doubt about its meaning.

PPP can be stated in two forms: absolute and relative. Its absolute form is given by:

$$S = P_f/P_d$$

where S denotes an equilibrium exchange rate stated in terms of foreign currency per unit of domestic currency and P_f and P_d denote price levels in the foreign and domestic country, respectively. The condition simply states that a given unit of currency should have the same purchasing power around the world. If a certain value for an exchange rate is accepted as an "equilibrium" or "parity" value, then subsequent changes in price levels in the two countries imply a new level for the exchange rate in accordance with PPP. To the extent that this level is not realized, PPP is violated and the *real* exchange rate is said to change. Note that this conception of a real exchange rate depends on the particular value chosen to represent parity.

Exhibit 1 presents data from the period 1974-90 for the ¥/US$ exchange rate and for consumer prices in the U.S. and Japan. The exchange rates predicted by PPP and the price level data are shown in Columns 5 and 6 of the exhibit, using base ("parity") years of 1974 and 1984-I, respectively. For example, using the 1974 value of ¥300.95/US$ as a base, absolute PPP suggests that the dollar was undervalued for most of the decade 1974-83, returned to parity in mid-1984, was briefly overvalued in 1985, and has been undervalued since. By comparison, if 1984-I is deemed to represent equilibrium for the ¥/US$ rate, a somewhat different story emerges (Column 6): the dollar appears to have been overvalued until the third quarter of 1985, and has been undervalued since, though less seriously than if 1974 is used as a base.

A real exchange rate may be formally defined and computed as the ratio of the actual exchange rate and the rate predicted by absolute PPP for a given base value. So for example, if Column 4 is divided by Column 6, the result is a "real" exchange rate, which is equal to 1.0 when PPP holds. If it is greater than 1.0, the dollar is overvalued (the actual ¥/US$ is higher than PPP predicts); if less than 1.0, the dollar is said to be undervalued.

Because it is difficult to decide whether a given level of the exchange rate represents parity, a *relative* form of PPP is commonly used. Relative PPP applies to changes in the exchange rate rather than absolute levels of the rate. It states that regardless of the level of the exchange rate, changes in the rate should be driven by differences in inflation rates. This can be expressed as:

$$S_{t+1}/S_t = (P_{f,t+1}/P_{f,t})/(P_{d,t+1}/P_{d,t})$$

where the subscripts t and t+1 refer to time periods t and t+1. In words, the fractional change (from t to t+1) in the exchange rate is equal to the fractional change in foreign prices divided by the fractional change in domestic prices. Note that numerator and denominator of the right hand side of this expression are just: {1 + inflation rate} for the foreign and domestic countries, respectively.

The exchange rates predicted by relative PPP are given in Column 7 of **Exhibit 1** and they tell yet a different story about real movements in the ¥/US$ rate. In particular, they suggest that the dollar was mostly overvalued from 1981 through 1985-I, but since then it has not deviated from

relative PPP one way or the other for more than three quarters in a row. Note that the 1990-IV level of ¥133.55/US$ is close to the level predicted by relative PPP and that, in general, all of the figures in Column 7 are closer to actual exchange rates than are the predictions in Columns 5 and 6. This is because relative PPP does not rely on a particular base as an equilibrium value for the exchange rate.

It is not possible to state with confidence that any one of these conflicting sets of predictions is "right." It depends on what version of PPP (if any) is deemed most appropriate and what level of the exchange rate is adopted as an equilibrium value. The conflicting data clearly illustrate the difficulty of defining "the real exchange rate" in a useful way.

Fortunately, for the purpose of analyzing operating exposure, it is not necessary, and may even be misleading to focus on "the real exchange rate". Firms cannot observe a real exchange rate per se; they can observe changes in currency values and try to determine whether these have effected changes in relative prices of goods and services. "The real exchange rate" as conventionally defined is an artificial construct devised by economists to measure the extent to which PPP holds. This does not make it a perfect way to determine the extent to which relative prices have changed for a given firm.

As stated in the text of this Note, operating exposure should be thought of as the response of operating cash flows to a real exchange-rate shock, where "real" refers more properly to "shock" than to "exchange rate". In other words, cash flows are exposed to real macroeconomic shocks, meaning shocks that change relative prices. Sometimes, changes in exchange rates are "real" in this sense. Violations of PPP give an indication of whether a given change in exchange rates merely reflects changes in price levels or whether relative prices have changed as well. It is still necessary for the firm to understand which relative prices have changed, how they have changed, and how the changes affect expected cash flows.

Exhibit 1 The Yen/Dollar Exchange Rate and Violations of PPP

1	2	3	4	5	6	7
				Exchange Rate Predicted by:		
			Actual Exchange	Absolute PPP		Relative PPP
Year/ Quarter	Japan CPI	U.S. CPI	Rate (¥/US$)	1974 base	1984-I base	
1974	100.00	100.00	300.95	300.95		300.95
1975	111.85	109.14	305.15	308.42		308.42
1976	122.23	115.44	292.80	318.66		315.28
1977	132.07	122.88	240.00	323.43		297.19
1978	137.12	132.30	194.60	311.92		231.46
1979	142.01	147.19	240.30	290.36		181.15
1980	153.42	167.10	203.00	276.33		228.69
1981	160.98	184.43	219.90	262.68		192.98
1982	165.27	195.73	235.00	254.11		212.72
1983	168.32	202.03	232.20	250.73		231.87
1984-I	172.01	210.63	224.70	245.77	224.70	227.61
1984-II	173.40	213.01	237.50	244.99	223.99	223.99
1984-III	173.25	215.38	245.50	242.07	221.32	234.67
1984-IV	175.25	216.91	251.10	243.15	222.31	246.60
1985-I	175.56	218.27	252.50	242.07	221.32	249.98
1985-II	177.11	220.98	248.95	241.20	220.52	251.59
1985-III	177.42	222.51	217.00	239.96	219.39	247.67
1985-IV	178.03	224.55	200.50	238.61	218.15	215.78
1986-I	178.19	225.06	179.60	238.28	217.85	200.22
1986-II	178.65	224.55	165.00	239.44	218.91	180.48
1986-III	177.72	226.24	153.60	236.41	216.14	162.91
1986-IV	177.72	227.43	159.10	235.17	215.01	152.80
1987-I	176.18	229.98	145.80	230.55	210.78	155.97
1987-II	178.96	233.03	147.00	231.12	211.30	146.16
1987-III	178.61	235.69	146.35	228.07	208.51	145.06
1987-IV	178.96	237.69	123.50	226.59	207.16	145.40
1988-I	178.07	239.24	125.40	224.00	204.80	122.09
1988-II	179.31	242.12	132.40	222.88	203.77	124.77
1988-III	179.67	245.45	134.55	220.30	201.41	130.87
1988-IV	180.91	247.89	125.85	219.63	200.80	134.15
1989-I	180.02	250.77	132.05	216.04	197.52	123.79
1989-II	184.27	254.76	144.10	217.68	199.02	133.05
1989-III	184.45	256.98	139.30	216.01	197.49	142.99
1989-IV	185.69	259.41	143.45	215.43	196.90	138.92
1990-I	186.04	263.85	157.20	212.20	194.01	141.30
1990-II	188.70	266.51	152.90	213.08	194.32	157.86
1990-III	189.53	271.17	137.80	210.40	192.36	150.97
1990-IV	189.08	271.17	133.55	209.84	191.86	137.44

Source: *International Financial Statistics* (Washington, D.C.: International Monetary Fund, 1978, 1982, 1987, 1991)