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Which Foreign Investors Worry About Foreign Exchange Risk in South Asia and Why?

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In the long run, competitive forward exchange markets are better than government guarantees against exchange risk. They benefit both host-country and foreign firms and increase investment from both sources.

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Summary findings

Bond and Estache show that the potential benefits to a
host country of forward markets or of foreign exchange
guarantees depend on the investor's country of origin
and on specific characteristics of the investment. They
show this in terms of the effects on foreign-exchange
risks and on the amount of foreign direct investment
taking place.

Their main lessons for foreign investors:
- The benefits of hedging exchange risks through
forward markets vary substantially, depending on the
investor, the type of investment, and, for foreign direct
investment (FDI), the direction of the market supplied.
- For short-lived investment or FDI targeted to the
host country market, the potential for gain from forward
contracts is substantial because in the short run, *nominal*
exchange rate fluctuations tend to be larger than *real*
exchange rate fluctuations.
- For long-lived investments or export-oriented FDI,
the gains from forward contracts will be much smaller.
Firms investing in long-lived assets or in activities
targeted to exports get natural insurance from the
correlation between the nominal exchange rate and the
firm's earnings in host-country currency.
- The evidence on exchange rate and price
fluctuations between 1975 and 1991 suggests that the
demand for coverage is likely to be stronger in South
Asia than in Latin America. In East Asia, the evidence is
mixed.

Their main lessons for host country governments:
- In the short run, if there are no private forward
markets, the optimal policy for a risk-neutral host
country is to provide the firm with forward contracts at
the expected spot exchange rate. This government
insurance has the same effects as allowing trading in
forward markets. But these contracts can have fiscal
consequences, as they did in Latin America.
- Forward markets do not discriminate against host-
country firms. Those engaged in international trade can
also benefit from the presence of forward markets.
- In the medium run, as exchange controls are being
liberalized, forward markets may be slow to develop
because of participants' uncertainty about their ability to
get foreign currency to cover forward commitments. In
this transitional period, contracts offered by the
government are likely to be the most efficient means of
reassuring foreign investors. These contracts should also
be made available to host-country firms during the
transitional period, in order not to discriminate against
domestic investors.

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Which Foreign Investors Worry About Foreign Exchange Risk in South Asia and Why?

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I. Introduction

Foreign direct investment (FDI) can involve substantial risk for firms. In addition to the normal risks of doing business (eg. uncertainty about productivity of factors, input costs, and demand for the firm's product) the firm faces additional uncertainty because its investment is located abroad. In particular, FDI leads to risk due to: (i) fluctuations in the currency value of the returns earned abroad and (ii) changes in government policy in the host country after the firm's entry into the foreign country. Since these highly country specific risks tend to deter investment, their level is important in determining how successful a host country is likely to be in attracting FDI. To reduce these risks, some developing host country governments, in particular those with closed capital accounts, have relied on or considered programs offering hedging mechanisms to foreign investors. In South Asia, Pakistan already covers some specific types of foreign investments and India and Bangladesh have also recently discussed coverages for foreign investors, similar to those available to importers or to public entreprises in many Latin American countries--e.g. Argentina, Ecuador, Venezuela-- during the 1980s. [1]

The paper examines the potential benefits to the host country of insurance programs in terms of their effects on risks and on the amount of FDI taking place. It focuses on foreign exchange guarantees to foreign investors as a means of hedging foreign exchange risk. It ignores the quasi-fiscal consequences of foreign exchange guarantees although they have proven to be critical in their rejection in Latin America. It compares the benefits of these programs with the benefits obtained by liberalizing financial markets to allow hedging of exchange risk in forward markets.

Why focusing only on the foreign exchange risk? Guarantees against elements of risk such as productivity, output price, etc, faced by a foreign investor are likely to be very costly to the government because of the presence of moral hazard and adverse selection problems--the firm can affect the probability of losses. The fact that private insurance markets for these risks do not exist suggests that information problems make this type of insurance too costly to provide. One would not expect the government to have the information about the firm's business and effort levels necessary to insure these risks. Foreign exchange risks, however, represent a source of uncertainty that cannot be altered by the firm's actions. Morevover, the existence of forward markets in industrialized economies suggests that insurance against exchange losses can be profitably provided.[2]

There are two issues that are involved in government guarantees concerning this exchange risk. The first is a pure insurance motive. It arises when risk averse investors want to hedge the risk due to uncertainty about the future value of a currency. The argument for government provision of insurance in this case relies on the government being less risk averse than the firm, so that the insurance improves efficiency by having the risk being borne by the less risk averse agent. The issue then is to derive the benefits obtained from contracts between the foreign investor and the host country regarding exchange risk, and to compare these benefits with those obtained by the use of forward markets.

The second issue concerns the possibility that the government has private information about future policies which will affect the value of the exchange rate or the ability of the firm to convert its host currency into foreign currency. The benefits from provision of guarantees in this case arise from the difference in beliefs about future rates between the firm and the government, and

do not rely on the presence of risk aversion. Guarantees in this case may be used by the government to provide credibility to announcements of policy reform, by altering the firm's beliefs about the government's future policy.

The paper focuses on the insurance motive for provision of guarantees. The policy credibility motive is discussed in a companion paper. Section II focuses on the perspective of the firm. It presents a model of investment decisions by a risk averse multinational firm, and derives the effect of uncertainty on the amount of investment the firm places in the host country. Section III derives the optimal policy for the host country in dealing with a foreign firm. Section IV concludes. Througout these sections, the empirical relevance of the theoretical results is tested for a sample of 12 countries representing South Asai, East Asia and Latin America.

II. Exchange Risk and Foreign Investment with Convertible Currency

This section presents a model of a risk averse multinational firm choosing its optimal level of investment in a risky investment project. In order to focus on the benefits to the firm and the host government of using forward markets to insure against exchange rate risks, the firm and the government are assumed, in this section, to have the same expectations about future exchange rate movements. [3]

First, the section considers a multinational firm's optimal level of investment in the case where there are no forward markets for shifting risk. It shows that increases in the level of real exchange rate risk lead to less direct foreign investment by the firm. The impact of the introduction of forward contracts on the firm's investment decision is analyzed next. It shows that risk averse host country firms can also benefit from the introduction of forward

markets when their host country returns are correlated with the nominal exchange rate. The availability of forward markets has the potential to increase investment by host country firms in export-oriented industries as well as encouraging multinational investments in host country projects.

The emphasis in this section is on the importance of the relationship between nominal exchange risk and real exchange risk in determining the benefits of forward markets. The gains from hedging in forward markets for the multinational firm are shown to be smallest when purchasing power parity holds, and where the firm is primarily engaged in production for the export market. Data on correlations between nominal exchange rate changes and relative price level changes for a number of countries are presented to illustrate the magnitude of gains from hedging. The section concludes with a simulation illustrating how the level of investment responds to the presence of markets for hedging risk under alternative assumtpions about the correlation between nominal exchange rate changes and relative price level changes across countries.

A. Investment Levels with No Forward Markets

Consider a risk averse multinational firm that is allocating investments between its home country and a host country.[4] The host country is BAPAIN and the source country (home of the multinational) is JAPAUS. The firm has an initial stock of capital, W, which it must allocate between home country and foreign country projects. The stock of capital is measured in terms of the JAPAUS consumption good, which is the deflator for source country nominal income. The real return from source country projects is assumed to be a certain return, r, which is constant and independent of the quantity invested.[5]

An investment in BAPAIN of amount K^* yields a return $\alpha\phi(K)$, where ϕ is a

strictly concave function and α is a random variable. The units of measurement for the host country capital stock and project returns is the BAPAIN consumption good, which is the deflator for host country consumption. The random variable α captures the stochastic element of real returns in the host country, and includes factors such as the relative price of output (measured in terms of the foreign consumption good), relative input prices, and productivity levels that affect the real profits of the firm. The strict concavity of ϕ captures the diminishing returns to the investment in the host country.

Two factors distinguish the risks captured by α. First, a large share of these risks are uninsurable. Firms may be able to mitigate the effects of price fluctuations to some degree through long term contracting relationships. But moral hazard and adverse selection problems prevent firms from being able to insure firm-specific risk elements such as the productivity of inputs and the market's taste for the product. Firms cannot purchase insurance against losses from macroeconomic fluctuations because losses resulting from shifts in aggregate demand are difficult to distinguish from losses due to inefficiency of the firm. Private insurers would expect that if they made insurance against losses available, the average profitability of firms would decline because of the weakening of incentives to produce efficiently. Since in general the government has no particular advantage over the private sector in dealing with moral hazard problems of this type, government attempts to insure firms against losses would encounter similar problems and would be inefficient.

The second factor is that the risks included in α are faced by both host country and source country investors. BAPAIN investors may have a superior knowledge of the local market, and thus have a lower variance associated with productivity and taste factors, but they still are subject to these risks. The

random variable α captures the uncertainty of the project in terms of the BAPAIN consumption good, and the riskiness of α indicates the degree of risk faced by a BAPAIN firm that invests in the project.

The calculatation of the risk to the multinational requires the conversion to units of the JAPAUS consumption good. We will refer to the JAPAUS currency as dollars, and the BAPAIN currency as rupees. Letting P be the dollar price of the JAPAUS consumption good at the end of the period, P^* the rupee price of the BAPAIN consumption good, and E the nominal exchange rate (dollars per rupee), the return to the JAPAUS based multinational from the investment project will be $EP^*\alpha\phi(K)/P$. Defining $e = EP^*/P$ to be the real exchange rate between units of the JAPAUS consumption good and the BAPAIN consumption good and choosing units such that both the price levels and the exchange rate at the beginning of the period are unity, the profits of the multinational in dollars at the end of the period will be[6]

$$\pi(K^*,\alpha,e) = ea\phi(K^*) + (W-K^*)r \tag{1}$$

If the multinational firm is risk neutral, it will choose K^* to maximize expected profits. The optimal capital level under risk neutrality, $\tilde{K}^*$, will be the value at which the expected marginal rate of return in the foreign country equals r.

A risk averse firm chooses K^* to maximize the expected utility of profits,

$$V(K^*) = \iint u(\pi(K^*,e,\alpha))g(e,\alpha)d\alpha de \tag{2}$$

where U is a strictly concave function and $g(\alpha,e)$ is the joint probability density function for α and e. The first order condition for optimal choice of K^* is

$$v'(K^*) = \iint U'(\pi)(\alpha e\phi'(K^*)-r)g(\alpha,e)d\alpha de = 0 \tag{3}$$

The optimal choice of K^* occurs where the expected marginal utility of the difference between marginal return to capital and its cost equals zero. Since the utility function is strictly concave, U' is decreasing in π. This implies that the risk averse firm puts relatively less weight on favorable states $(\alpha e \phi'(K^*) > r)$ than does the risk neutral firm, and relatively more weight on the unfavorable states $(\alpha e \phi'(K^*) < r)$. It then follows that if V' is evaluated at $\bar{K}$, where expected profits equal zero, we have $V'(\bar{K}) < 0$. Also, $V''(K)$ is negative U and ϕ are concave. So the value of K that satisfies (3) is less than $\bar{K}$ and an increase in the riskiness of the real exchange rate will further reduce investment.[7]

In the presence of real exchange rate uncertainty, the fact that the firm reduces its investment means that the expected marginal revenue product of capital in the host country exceeds r. The difference between the expected marginal product of capital and r can be thought of as the risk premium that is associated with investment in BAPAIN for a JAPAUS investor. If BAPAIN is risk neutral, the reduction in multinational investment that results from the presence of this risk premium lowers national welfare. To see this, suppose that the government of BAPAIN could borrow at rate r and run the investment project itself. Assuming that $\alpha e \phi'(K^*)$ is the marginal social product of capital, BAPAIN would choose an investment level of $\bar{K}$ in the project, since that is the level of investment at which the expected marginal social product equals r. BAPAIN national income is lower when the investment level is below $\bar{K}^*$.

It is not a practical policy for the government to run the investment project, since the presence of multinational investment normally reflects the fact that the firm has superiority in its technology or products that give it an advantage over local investors. However, the government could induce the firm

to invest up to $\bar{K}$ if it could insure the firm's return. The discussion above suggested that it is also impractical for the country to attempt to insure the firm for risks associated with α, because this would almost certainly lead to a decline in the expected return from the project. However, the country may be able to partially insure the investor by offering insurance against exchange rate risks. This has the potential to benefit both the firm and the country, since the firm reduces the risk of its profit stream and the country obtains a greater level of investment.[8]

B. Optimal Hedging with Forward Markets

(i) When should forward markets be attractive to foreign investors?

This section examines; (i) how the presence of forward markets will affect the level of risk faced by the multinational firm, and (ii) the relationship between hedging and the optimal level of investment. It also compares the value of hedging for the JAPAUS firm with that obtained by a BAPAIN firm.

One way of assessing how the introduction of forward markets affects the riskiness of the multinational firm is to examine how the variance of the rate of return of the investment is affected by hedging. The real rate of return to a JAPAUS investor, denoted r^*, can be approximated by taking the log of $\alpha E q \phi(K)/K$, where $q \equiv P^*/P$. Since the beginning of period price levels and exchange rate were normalized to unity, the inflation differential between JAPAUS and BAPAIN approximated by $\ln q = \ln P^* - \ln P$ and the rate of depreciation of the nominal exchange rate by $\ln E$. The real rate of return will then be

$$r^* = \ln\left(\frac{\alpha \phi(K)}{K}\right) + \ln E - (\pi - \pi^*)$$

(4)

The real rate of return risk thus decomposes into three components: (i) the real rate of return (α) risk in the host country, (ii) the nominal exchange rate (E) risk, and (iii) the relative price level (q) risk. A BAPAIN firm that invests in a local project faces only the first component of risk, since this is the real rate of return risk in terms of the host country consumption good. As noted above, this form of risk is uninsurable. The sum of the second two components constitutes the real exchange rate risk, which is the additional risk faced by the JAPAUS firm when it repatriates its host country returns.

Even though a BAPAIN firm faces only the real rate of return risk α (since it produces for the BAPAIN market), it is not necessarily a less risky investment for the BAPAIN firm than for the JAPAUS firm. Suppose that the output from project in the host country is exported to the foreign country. If there are no other sources of uncertainty for the project, the return in units of foreign currency is $P\phi(K)/E$. Comparing this with the case above, this is equivalent to having $\alpha = P/(EP^*)$, so that there is perfect correlation between α and the rate of depreciation of the real exchange rate. In this case, the JAPAUS investors are perfectly hedged against exchange rate fluctuations because they receive returns that are linked to dollar prices. BAPAIN investors in such a project, on the other hand, would face rate of return fluctuations in terms of rupees and would benefit from access to forward exchange markets. Therefore, in evaluating the effects of forward markets it is necessary to consider correlations between q, α, and E.

As an example, suppose that the JAPAUS firm completely hedges its exchange rate risk with a contract which allows it to sell units of foreign currency at the end of the period for F units of home country currency. This contract hedges the entire return (capital investment plus profits) of the multinational. The

returns of the JAPAUS investor in this case will be

$$r^* = \ln(\alpha\phi(K)) + \ln F - (\pi - \pi^*).$$

(5)

Consider the effects of hedging on the JAPAUS firm under the assumption that $\ln \alpha$, $\ln E$ and $\ln q$ are all normally distributed. The comparison of (4) and (5) shows that hedging may affect both the mean and variance of the foreign investor's rate of return on investments in BAPAIN. The mean rate of return with hedging will be less (greater) than that without hedging if the forward rate is greater (less) than the expected spot rate. We will concentrate on the case in which the BAPAIN government is risk neutral, so that it is willing to offer a forward rate which is equal to the expected spot rate.

The effect of forward hedging on the variance of the rate of return depends on the correlation between α, q, and E. For example, consider the case where α and the real exchange rate are stochastically independent, so that the variance of the JAPAUS firm's unhedged rate of return is the sum of the variance of the real return and the variance of the rate of change in the real exchange rate. The variance of the unhedged rate of return, σ_r, can then be written as

$$\sigma_r^2 = \sigma_\alpha{}^2 + (\sigma_q^2 + 2\rho_{qE}\sigma_q\sigma_E + \sigma_E^2).$$

(6)

The term in parentheses is the variance of the real exchange rate, where ρ_{qE} is the correlation between the nominal depreciation of the source currency and the inflation differential.

The variance of the rate of return of the fully hedged investment σ_{rH}^2 will be

$$\sigma_{rH}^2 = \sigma_\alpha{}^2 + \sigma_q^2.$$

(7)

The relationship between the riskiness of the hedged and unhedged

investments will depend on ρ_{qE}. If purchasing power parity (PPP) holds between the dollar and the rupee, then the rate of depreciation of the dollar will equal the difference between the JAPAUS inflation rate and the BAPAIN inflation rate. This implies $\rho_{qE} = -1$, which means that the variance in the real exchange rate is zero. Any increase in the rupee returns to the BAPAIN investment that is caused by inflation will be exactly offset by depreciation of the value of the rupee, leaving the dollar value of the project returns unaffected. In this case, the firm is completely insured against nominal exchange rate risk, since the firm is holding a real asset whose returns change with the price level. Note that the case of purchasing power parity is an extreme one which will certainly not hold at all points in time. However, it does suggest that a negative correlation between E and q should be expected.

Table I illustrates the variance of the rate of return on a fully hedged and an unhedged investment under alternative assumptions regarding ρ_{qE} and σ_E^2. Examples are limited to $\rho_{qE} < 0$, since economic theory predicts a negative relationship between q and E even if full PPP does not hold. The lower is ρ_{qE}, the greater the natural insurance that is provided by the firm's real investment and the smaller are the gains from hedging. Note that when $\sigma_q^2 = \sigma_E^2$, the fully hedged portfolio actually becomes riskier than the unhedged portfolio when $\rho_{qE} < -.5$. The second and third rows show the effect of increases in σ_E^2 on hedging. Since asset prices generally fluctuate more than do goods prices, one would anticipate that the exchange rate would be more variable than the price indexes. An increase in σ_E^2 raises the benefits of hedging for given values of the other parameters. This is reflected in the fact that the hedged portfolio continues to dominate the unhedged portfolio for values of $\rho_{qE} < -.5$ as the variance increases. Note that by setting (6) equal to (7), we can solve for the

correlation at which the risk of the hedged portfolio equals that of the unhedged portfolio, $\rho = -\sigma_E/2\sigma_q$.

Table I Variance of Rate of Return for
Fully Hedged and Unhedged Portfolios

Variances	Fully Hedged	Unhedged Investment			
		$\rho=-.1$	$\rho=-.3$	$\rho=-.5$	$\rho=-.7$
$\sigma_q^2=\sigma_E^2=1$	2	2.8	2.4	2.0	1.6
$\sigma_q^2=1$, $\sigma_E^2=1.5$	2	3.25	2.77	2.28	1.79
$\sigma_q^2=1$, $\sigma_E^2=2$	2	3.72	3.15	2.59	2.02

The results of Table I can be used to derive some predictions regarding the types of investment where hedging will be most valuable. Recent experience has indicated that for industrialized countries there are fairly substantial deviations from purchasing power parity for periods of several years. Thus, in the short run the potential for gains from hedging in forward markets could be substantial.

These results suggest that one factor determining the value of forward markets to the foreign investor is the life of the investment project. For short-lived investments, the ability to hedge exchange risk through forward market transactions may be quite valuable to foreign investors. However, investments in long-lived assets with payoffs in home country currency are likely to go unhedged. With long-lived assets, the cases in which there is a

substantial depreciation of the home currency are likely to be those in which there is a substantially higher rate of inflation in the home currency returns from the project, so the real return to the foreign investor is not affected by the exchange fluctuations.[9]

(ii) In which countries are forward markets or quarantees desirable?

This section focuses on the value taken around the world by the two indicators suggested earlier to assess the desirability of forward markets: (a) the correlation between E and q and (b) the ratio of the variance of E to that of q. The lower is the correlation and the higher is the ratio in any given country, the stronger are the payoffs to hedging. But the value of ρ is only an indicator of the degree of benefit US firms would receive from hedging a one year real investment in the country. An indication of the longer term link is provided by the sum of the mean annual rate of nominal depreciation is given by μ_e, and of the mean inflation differential is μ_q. This sum gives gives an indication of the extent to which the average change over the period is consistent with purchasing power parity, since PPP predicts that $\mu_E + \mu_q = 0$. Table focuses on the short and long terms PPP indicators. Table III focuses on the second indicator of incentive to provide forward protection. Both Tables focuses on a sample of countries of Latin America, South Asia, and East Asia over the period 1975-91.

Table II compares the short term (measured every year) and long term (measured on the average value over the 16 year period) correlation value taken by these indicators for investors from the US, Japan and Germany. For each country, the first set of columns gives the value of the correlation between E

and q from the perspective of the three major foreign investors and the second
sect of columns gives the difference between mean E and mean q). In general the
table shows that the annual movements in E are less consistent with PPP than are
its long run movements. [10]

TABLE II

COUNTRIES	INTERACTION BETWEEN DEPRECIATION (E) AND INFLATION DIFFERENTIAL (q)					
	SHORT TERM (Correlation coef. between E and q)			LONG TERM (Difference between mean E and mean q)		
	US	JAPAN	GERMANY	US	JAPAN	GERMANY
LATIN AMERICA						
Brazil	-0.978	-0.979	-0.981	-0.061	-0.100	-0.076
Chile	-0.919	-0.915	-0.903	0.000	-0.039	-0.015
Mexico	-0.770	-0.775	-0.722	-0.012	-0.051	-0.026
SOUTH ASIA						
Bangladesh	-0.715	-0.506	-0.502	-0.054	-0.085	-0.060
India	-0.546	-0.504	-0.388	-0.055	-0.086	-0.062
Pakistan	-0.414	-0.424	-0.292	-0.032	-0.063	-0.039
Sri Lanka	0.040	0.041	0.047	-0.062	-0.093	-0.069
EAST ASIA						
Indonesia	-0.412	-0.403	-0.347	0.011	-0.079	-0.055
Malaysia	-0.164	0.274	0.355	0.027	-0.064	-0.039
Philippines	-0.596	-0.473	-0.478	0.047	-0.044	-0.020
Thailand	0.167	0.015	0.018	0.046	-0.045	-0.020

For Latin America, the correlation coefficients and the PPP indicators in
Table II suggest that all three types of investors enjoy good short and long run
predictors of exchange rates in their highly inflationary environment--this
statement is much more robust for the US investors than for the other two
investors and less robust for Brazil than for the other two host countries. There
is a high annual correlation between currency devaluation and inflation rates.
Moreover, the sum of μ_E and μ_q is not significantly different from 0 for any of

the countries. In these countries, forward markets would be of much less value for hedging both short run and long run investments than in other countries with lower inflation rates.

In South Asia, the correlation coefficient suggests that a US investor would not benefit significantly from forward markets if he were to invest in short term export oriented activities in Bangladesh or India but if would benefit from it in Pakistan and very clearly in Sri Lanka. Japanese and German investors would much more likely to benefit from forward markets in all 4 countries. For long lived investments, PPP does not seem to hold perfectly in any of the four countries--also of the indicators are clearly significantly different from 0. In practices, the need for exchange risk protection is stronger for German and Japanese investors than it is for US investors. Real exchange rate in the Region have shown substantial depreciation over the period, with the value of host country currencies declining often much faster than would be predicted by the inflation differential.

In East Asia, except for the Philippines, the short term correlations between q and E are weak. In the long run, the real exchange rate with respect to US$ has appreciated while it has depreciated with respect to the Deutsch mark and the Yen. The long run gap between the depreciation and inflation differentials is however lower than for South Asia which suggest a lesser lead for exchange risk protection than in South Asia.

Note that for Malaysia, Sri Lanka and Thailand, the three investors may be facing correlations in the opposite direction of what is predicted by PPP. In each of these cases, the exchange rate had been fixed for periods of several years, with devaluations occurring after the accumulated inflation differentials have gotten sufficiently large. In these countries, the hedging would be very valuable for firms with short-lived investments.

But these correlation indicators only tell part of the story and can in fact be somewat misleading. When the variance of the nominal exchange rate, E, is significantly higher than the variance of the inflation differential, q, there are also strong payoffs to hedging. Table III shows that this second incentive

for forward markets differentiates much more between investors and in general
contributes to make a much stronger case in favor of forward markets for long
lived investments as well.

TABLE III: _Ratios of Variance of E to Variance of g_

COUNTRIES	US	Japan	Germany
LATIN AMERICA			
Brazil	0.935	0.902	0.962
Chile	0.931	1.074	1.101
Mexico	2.352	3.138	3.287
SOUTH ASIA			
Bangladesh	15.214	14.816	13.350
India	3.533	4.806	3.735
Pakistan	4.808	23.833	25.960
Sri Lanka	5.361	8.028	6.430
EAST ASIA			
Indonesia	11.640	80.195	70.544
Malaysia	4.699	20.901	18.224
Philippines	2.214	2.886	2.223
Thailand	1.046	10.193	8.735

The indicators suggest that the lack of forward markets represent a much
stronger risk for investors in South Asia and in Indonesia than in the other
Regions for US investors. The exchange risk is however also very strong for
Japanese and German investors in East Asia. In some countries such as Pakistan,
the exchange risk faced by a Japanese or German investor is about 6 times the
risk faced by a US investors.

C. _Simulation of Optimal Investment and Hedging_

The results of the previous section compared the riskiness of a completely
hedged investment with that of an unhedged investment. In this section we derive

the optimal amount of hedging that will be done by the firm. Moreover simulations illustrate how hedging and the level of investment respond to the correlation between the nominal depreciation of the source currency (E) and the inflation differential (q). Letting Z be the quantity of future foreign currency units that the firm contracts to sell at the end of the period, the firm will earn a profit of (F-E)Z on its sales of foreign currency. The profits of the JAPAUS firm with hedging will be

$$\pi = \alpha E q \phi(K) + (W-K)r + (F-E)Z \tag{8}$$

where $q \equiv P^*/P$. The firm will choose K and Z to maximize the expected utility of profits, given a joint distribution of the random variables $h(\alpha,q,E)$.

The solution to this problem is analyzed in Appendix A. Several major conclusions emerge from this analysis:

(1) if the only uncertainty is due to the fluctuations in the nominal exchange rate (α and q are constants) and if the forward rate equals the expected spot rate, then the firm will fully insure its investment ($Z = \alpha q \phi(K)$) and the level of investment will be equivalent to the one obtained when the firm is risk neutral. In this case, the forward rates lead to full insurance of exchange rate losses and the firm maximizes expected profits;

(2) if the forward rate is less than the expected spot rate, then hedging has a resource cost to the firm and the firm will purchase less than the full amount of coverage. Since the firm still bears some residual risk in this case, it will invest less in the host country than would a risk neutral firm;

(3) if α and q are also uncertain, the firm will be unable to completely hedge risk through the use of forward markets. This is because the return in terms of host country currency is uncertain.

Table III shows simulations of the firm's optimal hedging strategy. It illustrates the magnitude of hedging that will be done and the impact of hedging on the firm's investment for different levels of correlation between E and q, ρ_{qE}. The five correlation levels were picked to correspond to those observed in the countries covered by Table 1 and hence provide a bridge with the country specific concerns of a potential investor—0 for Sri Lanka, -.2 for Bangladesh

and Indonesia, -.4 for Pakistan, Malaysia and Thailand, -.6 for India and Chile
and -.8 for Brazil, Mexico and the Philippines. The table compares the foreign
investment made without (K) and with forward markets (KF). For the simulations
with a forward market, it also shows how much future foreign currency the firm
is interested in selling at the end of the period (Z) and how much revenue is
generated by the project (Revenue). A crude measure of the importance of hedging
in each of the tables is provided by the ratio of Z to Revenue. It can vary from
to 0 (no hedging) to 1 (complete hedging).

Table III has three parts. The parts differ according to the elasticity of
demand for capital or to the degree of risk aversion. In Table III A, the
elasticity is moderate (2) and the firm has the constant absolute risk aversion
utility function $u(\pi) = -e^{-l\pi}$, which corresponds to a low risk aversion. The
simulations assume a production function $\phi(K^*) = 21(K^*)^{1/2}$. The exchange rate and
the random variable αq were each assumed to be lognormally distributed with mean
1. Assuming $r = 1.05$, these assumptions yield $K^* = 100$ and $\pi = 210$ in the case
of risk neutrality. Table III B keeps the same risk aversion as Table A but
illustrates the effect of a higher elasticity of demand for capital (3.33). Table
III C maintains Table A's demand elasticity but doubles risk aversion to 0.2.

(i) Investment levels without forward markets

The second column of Table III shows the firm's optimal investment decision
when there are no forward markets and the firm is no longer risk neutral. When
the nominal exchange rate is uncorrelated with the firm's other risks, the firm's
investment level falls as compared to the risk neutral case. This represents the
impact of risk on investment in the host country noted above. For low levels of
correlation between the nonimal exchange rate and the inflation differential, the
larger the elasticity of demand and the larger the degree of risk aversion, the
larger the loss in FDI--and hence in local tax revenue since the firm local
revenue also drops--as compared to the risk neutral cases. The loss varies from
16.9% for the moderate demand elasticity of capital and low risk aversion to

31.4% in the case of moderate demand elasticity of capital but high risk aversion. In fact, the model suggests that the more risk averse the firm, the larger the negative impact on FDI.

From a practical point of view, two lessons emerge:

(1) when countries do not manage to follow PPP in the short run—say with a correlation coefficient of less than 0.8, FDI can be significantly lower when firms are risk averse and when there are no forward markets to hedge against exchange rate risk. Most South Asian economies follow poorly PPP.

(2) risk aversion is likely to result from imperfect knowledge of host economies; imperfect knowledge is often due to poor previous experience in a specific country. One indicator of the poor market knowledge is a low existing FDI stock in any given country. Once again, the South Asian economies fit the mold. They have the lowest existing stock of FDI and hence are probably the less known by foreign investors. This may contribute to explain the flows.

(ii) **Investment levels and demand for hedging with forward markets**

When the firm is given the option of hedging the exchange rate risk in a forward market where the forward rate equals the expected spot rate, the exchange risk leads to lower investment decline than in the case without forward market as expected. This is illustrated by the last column of the table. The table also shows that this result is stronger for short lived assets as discussed above.

But Table III provides an additional useful insights for the cases in which E is uncorrelated with its other risks. The closer a country is to PPP, the lower is the demand for coverage in the forward market since the stronger the negative correlation between the inflation differential and exchange rate fluctuations provides a natural coverage and thus reduces the demand for hedging. This is illustrated by the column Z/R.

TABLE IV
Optimal Investment and Hedging for a Risk-averse Firm

A. Elasticity of Capital Demand = 2; Risk Aversion = .1

	No Forward Market	Forward Market				
Correlation between depreciation and inflation differential ($\rho_{q\epsilon}$)	FDI without forward market (K)	FDI with forward market (KF)	Quantity of Currency the firm is interested in selling at the end of the period (Z)	Revenue generated by the project (R)	Z/R	K/KF
0.00	85.57	90.87	190.82	200.18	0.95	0.94
-0.20	87.94	91.20	157.16	200.55	0.78	0.96
-0.40	90.53	92.18	116.08	201.62	0.58	0.98
-0.60	93.37	93.88	78.80	203.47	0.39	0.99
-0.80	96.51	96.42	40.45	206.21	0.20	1.00

B. Elasticity of Capital Demand = 3.33; Risk Aversion = .1

	No Forward Market	Forward Market				
$\rho_{q\epsilon}$	K	KF	Z	R	Z/R	K/KF
0.00	84.33	89.39	134.08	138.67	0.97	0.94
-0.20	86.84	89.76	107.66	139.06	0.77	0.97
-0.40	89.60	90.88	81.75	140.29	0.58	0.99
-0.60	92.67	92.83	55.66	142.39	0.39	0.99
-0.80	96.11	95.78	28.79	145.54	0.20	1.00

C. Elasticity of Capital Demand = 2; Risk Aversion = .2

	No Forward Market	Forward Market				
$\rho_{q\epsilon}$	K	KF	Z	R	Z/R	K/KF
0.00	76.11	83.82	176.01	192.26	0.92	0.91

-0.20	79.51	84.34	141.67	192.85	0.73	0.94
-0.40	83.42	85.92	108.23	194.65	0.56	0.97
-0.60	87.97	88.74	74.50	197.83	0.38	0.99
-0.80	93.39	93.19	39.10	202.73	0.19	1.00

Before concluding, note that when the correlation between depreciation and infaltion differentials becomes very high, FDI with forward market tends to become marginally smaller than FDI without forward markets. The first order conditions presented in the appendix show that the uncertainty relating to the forward market (Z) becomes larger than the uncertainty due to sales by the firm. In other words, the risk associated with the forward market become so much larger than the risk to profits that they start dominating the investment decision.

III.   Optimal Host Government Policy

Section II derived the demand for hedging by the multinational firm. In this section, we now analyze the optimal policy for the host country government. We assume that the host country government is risk neutral, and desires to maximize expected national income. We assume that there are no forward exchange markets, but that the host country government can write a forward contract for foreign exchange with the multinational when it makes its investment. As in the case with forward markets, we denote by Z the amount of units of its currency that the government promises to buy from the firm at the end of the period. The government can choose the price, F, at which it will buy its currency.

The government will not want to make open-ended guarantees to the firm, which allow the firm to trade as much as it wants at the rate F. If the country were to make an open-ended guarantee at a particular rate, the firm could make arbitrarily large profits (and the country arbitrarily large losses) in the event that the rate at which it can buy foreign exchange turns out to be lower than the market rate. If the rate were higher than the market, it would choose to buy none. The optimal amount for the country to offer the firm will be derived as part of the optimization problem.

A. The Host Country Optimization Problem

National income for the host country can be written as

$$\iint [Y(\alpha,K) - \alpha\phi(K) - (F-E)Z + T] \, j(\alpha,E) \, d\alpha \, dE ,$$ (9)

where $Y(\alpha,K)$ is the total social value of the investment project, T is the lump sum tax imposed on the multinational, and $j(\alpha,E)$ is the pdf for α and E. The objective of BAPAIN is to maximize (9), subject to the constraint that the firm earn a utility level that is at least as high as that obtained it were to invest all its assets in the home country.

The optimal policy, as shown in the Appendix, is characterized by three conditions. First, if capital is being paid its marginal product in the foreign country, then there is no motive for additional taxes or subsidies linked to the quantity of capital located in the host country. However, a motive for subsidization of capital exists if there are spillovers associated with the quantity of capital located in the host country. The most frequently cited example would be technological spillovers, where the presence of a foreign firm allows domestic firms to lower their costs by observing the methods used by the foreign firms. This conclusion is similar to that obtained in the case without uncertainty, (see for example Corden (1974)).

Second, the level of forward market contracts offered to the firm will be the same as would be obtained if a competitive forward market existed in which the firm could sell foreign currency at the expected spot rate. This suggests that the contract in the case in which the government contracts optimally with the firm is equivalent to that obtained if the government simply allows a competitive forward market to operate, assuming that there are other risk neutral agents who would contract with the firm in the forward market. There are gains to be had from the provision of risk-sharing contracts for the firm, but the

government has no inherent advantage over the private sector in providing these contracts.

Finally, the lump sum tax should be used to make the firm indifferent between entering and not entering the host country. This result comes from the assumption that the foreign country is a monopolist. In a more general setting in which both firm and government have some bargaining power, the tax negotiated with the firm will be used to collect the government's share of the project returns. The lump sum instrument is preferred to capital taxes or forward market taxes for collecting revenue, because it does not distort the firm's choice of inputs or hedging activity.

B. The Timing of Investment Decisions

The above analysis has been carried out in a static model in which the firm's decision is whether or not to invest in the host country. Recently it has been pointed out that an additional role for uncertainty arises in a dynamic model, where the firm is choosing the time at which to invest. Dixit (1989) has shown that increases in the degree of uncertainty will lead to a postponement of investment decisions when investments are irreversible. Chapel (1992) has applied this to the case of a multinational firm choosing between serving a market from a home plant and a foreign plant. The market is assumed to be growing, and the foreign plant has higher fixed costs and lower variable costs than the home plant. As the market grows in size with certainty about costs in each market, an optimal switching point occurs where the firm shifts from serving the market from the home plant to the foreign plant. She shows that the presence of real exchange rate uncertainty, the time at which the firm switches from the home plant to the foreign plant is postponed. The postponement results from the fact that when uncertainty is high, it is more likely that the firm will suffer bad luck in the future (i.e. a reversal of the real exchange rate change) that makes it regret the decision to switch to the foreign market.

Consideration of the timing of decisions leads to effects of real exchange rate uncertainty even for risk neutral firms. As in the previous section, the

availability of forward markets will lead to a reduction in the degree of uncertainty for the firm to the extent that nominal exchange rate changes lead to changes in the real exchange rate.

IV. Conclusions and Policy Implications

These results of sections II and III suggest that the quantity of foreign investment can be increased and the timing of investment decisions accelerated if markets are available in which firms can hedge real exchange rate risk. The magnitude of these benefits depends on the correlation between nominal exchange rate movements and real exchange rate movements, and also on the type of business the firm is engaged in. The theory suggests that the benefits are greatest for investments that are targeted for the host country market. For export-oriented investments, the firm is likely to be naturally insured by the fact that its output price is likely to be highly correlated with movements in the real exchange rate. Empirical evidence suggests that the benefits of hedging nominal exchange risk are likely to be greatest for short-lived investments, since the correlation between real exchange rates and nominal exchange rates is likely to be highest in the short run. In the long run, a tendency to reversion toward purchasing power parity rates is likely to provide insurance for firms against fluctuations in nominal exchange rates.

If countries do not currently have developed forward markets in operation, the question arises of how the insurance against exchange rate fluctuations should be provided for firms. One option is for the government to encourage the formation of forward markets. A second would be for the government to negotiate forward contracts or currency options with the firm as part of the package it offers the firm when it enters the host country.

There are two reasons which suggest that policy of liberalizing financial markets and allowing forward markets to develop is the preferred route. The first is that the policy of providing coverage to multinationals discriminates against domestic firms. As noted above, forward markets will also provide valuable insurance to domestic firms, particularly those that are engaged in

export-oriented activities. If access to insurance of this type is denied to domestic firms, then they will be at a disadvantage in competing against multinationals who do not face real exchange rate risk on export sales from the host country.

A second reason occurs because of the possibility that the government is not risk neutral. If the host country government is constrained in its borrowing in world financial markets, it may be more appropriate to treat the host government as risk averse. The possibility that the host government is also risk averse does not eliminate the possibility of gains from insurance, but it introduces a slightly different test of when mutually beneficial insurance may take place. For example, suppose two agents with equal degrees of relative risk aversion have incomes which depend on the realization of the nominal exchange rate, $y_1(E)$ and $y_2(E)$. It is easily shown that the optimal insurance scheme will be for 1 to make a payment to 2 whenever y_1/y_2 exceeds a critical value, and 2 will insure 1 when relative incomes are less than the critical value.[11]

This suggests that it will make sense for governments to insure firms against real depreciations of the host country currency if the firm is harmed relatively more than the host country government is by a currency depreciation. Since a high percentage of the host country government's assets are likely to be denominated in local currency, it is open to question as to whether this question will be satisfied in general. An alternative way to express this is to say that requiring the government to provide the insurance to firms against exchange risk imposes an unnecessary constraint on who provides the insurance to firms. In some situations (eg. a risk averse government), there may be other agents who are in a better position to supply the insurance in competitive markets. Encouraging the formation of forward markets allows the market to determine who is best able to provide this insurance.

It should be noted, however, that in the process of liberalization of financial markets and currency convertibility, forward exhange contracts between the government and firms may be a useful transitional device. For a country with exchange controls, uncertainty about the ability to obtain foreign exchange in

the future may limit the ability of individuals to sell forward contracts for foreign currency for foreign investors who want to hedge exchange risk. In this transitional period, forward contracts offered by the government would be a useful instrument for reducing uncertainty to firms. The arguments above suggest that these forward contracts should be offered to host country firms as well. As shown in the companion paper, this case for forward contracts as a transitional device is further strenghened in cases where the firm is uncertain whether the country is committed to reform.

Finally, note that there is no motivation for government provision of insurance for other types of risks (eg. insuring firm against risks of doing business in the host country) that are not normally provided by competitive insurance markets. These types of insurance are not provided by competitive markets because of moral hazard and adverse selection problems. Thus, insurance is not available against business losses because if firms are insured against losses, it will reduce their incentive to keep costs down. Since the government has no advantage over competitive markets in dealing with this moral hazard problem, government insurance of this type would be highly inefficient.

Appendix

A. Optimal Firm Hedging with Forward Markets

Utilizing the firm profit expression (5), the expected utility of the firm will be

$$\iiint [U(\alpha qE\phi(K)+(W-K)r+Z(F-E)]h(\alpha,q,E)d\alpha dqdE \qquad (A.1)$$

The first order conditions for optimal choice of K and Z are

$$\iiint U'(\pi)(\alpha qE\phi'(K)-r)h(\alpha,q,E)d\alpha dqdE \qquad (A.2a)$$

$$\iiint U'(\pi)(F-E)h(\alpha,q,E)d\alpha dqdE \qquad (A.2b)$$

In the special case where there is no uncertainty regarding α or q, (A.1b) simplifies to

$$\int U'(\pi)(F-E)f_E(E)dE=0$$

where f_E is the pdf for E. If the forward rate equals the expected spot rate, then (A.2) is satisfied with $Z = \alpha q\phi(K)$, since this fully insures the firm against exchange rate fluctuations and eliminates the variation in π. With full insurance, the first order condition for optimal choice of K is equivalent to that for the risk neutral firm. If the forward rate is less than the expected spot rate, then the firm will purchase less than full insurance against exchange fluctuations ($Z < \alpha q\phi(K)$) because of the higher cost of insurance. The firm's profits will be positively correlated with E under optimal hedging, so the firm will reduce its value of K below that which maximizes expected profits.

In cases where α and q are variable, the firm will be unable to fully insure against exchange fluctuations through the use of forward markets. This is due to the fact that the firm's returns in the host country currency are uncertain and cannot be fully hedged, so $\alpha q\phi(K)-Z$ will be a random variable.

B. Optimal Host Country Policy with Risk Averse Firms

The objective function for the host country is given by

$$\iint [Y(\alpha,K)-\alpha\phi(K)-(F-E)Z+T]j(\alpha,E)\,d\alpha dE, \tag{A.3}$$

where $j(\alpha,E)$ is the pdf for α and E. The host country will be treated as choosing K, Z, and T to maximize (A.3), subject to the constraint that the multinational be willing to invest in the host country,

$$\iint U(\alpha qE\phi(K)+(W-K)r+(F-E)Z)h(\alpha q,E)\,d(\alpha q)dE\geq U(rW). \tag{A.4}$$

This approach can be used to derive the optimal taxes to be imposed on K and Z in the optimal solution. The first order conditions for choice of quantities can be compared with the firm's first order conditions for choice of quantities in (6) to yield the taxes required to achieve the country's optimal levels.

Forming the Lagrangean from (A.3) and (A.4), the necessary conditions for the optimal policy are obtained by differentiating with respect to K, Z, T, and F :

$$\iint [\frac{\partial Y}{\partial K}-\alpha\phi(K)]j(\alpha,e)\,d\alpha de=\lambda\{\iint U'(\pi)(\alpha q\phi'(K)-r)h(\alpha q,E)\,d(\alpha q)dE\} \tag{A.5a}$$

$$\iint (F-E)j(\alpha,e)\,d\alpha de=\lambda\{\iint U'(\pi)(F-E)h(\alpha q,E)\,d(\alpha q)dE\} \tag{A.5b}$$

$$1=\lambda\{\iint U'(\pi)h(\alpha q,E)\,d(\alpha q)dE\} \tag{A.5c}$$

$$Z=\lambda Z\{\iint U'(\pi)h(\alpha q,E)\,d(\alpha q)dE\}. \tag{A.5d}$$

Since home country welfare is increasing in T and firm welfare is decreasing in T, the country will always choose a value of T such that the constraint (A.4) holds with strict equality. Therefore, the Lagrange multiplier λ will be positive and equal to the inverse of the expected marginal utility of income for the firm from (A.5c).

The optimal value of K is determined by (A.5a). If capital is paid its social marginal product, then the left hand of (A.5a) is zero. Therefore, the

optimal value of K° will be one at which the right hand side of (A.5a) equals 0. Comparing with (A.2a), it is seen that the firm's optimal choice of K° coincides with the one that maximizes host country welfare. Therefore, it is optimal to impose no tax on K°. Note that if a subsidy to capital (tax on capital) will be optimal in cases where the marginal social product of capital is greater (less) than the amount that capital is paid.

The optimal forward contracts between the host country and the firm are determined by (A.5b) and (A.5d). Note that condition (A.5d) is automatically satisfied when (A.5c) is satisfied, since an increase in T is equivalent to a reduction in F in effect when Z > 0. A reduction in F reduces the profits the firm receives from its sales of foreign currency (when Z > 0), which has an equivalent effect on profits to an increase in the lump sum tax. Therefore, we can set F equal to the expected value of E, denoted $\bar{E}$, without loss of generality. If $F = \bar{E}$, then the left hand side of (A.3b) equals 0. The optimal value of Z will then be the one for which maximizes the expected utility of the firm (i.e. the right had side of (A.3b) equals 0). From (6b), this is the value of Z that would be chosen by the firm if it were facing competitive forward markets in which the forward rate equalled the expected spot rate. If the country were to choose a rate different than $\bar{E}$, then the right hand side of (A.5b) would not be equal to zero. This would mean that the optimal value of Z would not maximize the firm's expected utility at the chosen value of F, which would imply a tax or subsidy to forward market transactions. Thus, any choice of F other than $\bar{E}$ must be accompanied by a tax or subsidy that is equivalent in effect to having forward market transactions take place at $\bar{E}$.

These results indicate that the choice of an optimal forward contract between the country and the firm can equivalently be achieved by allowing competitive forward markets. This conclusion has been derived under the assumption that the host country is a monopolist, and can thus choose a policy that extract all the surplus from the investment project. However, it can be shown that this conclusion regarding forward markets will continue to hold if the problem is considered as one of bilateral monopoly, with the firm and country

bargaining over the split of the surplus from the project. The efficient frontier for the bilateral bargaining problem is described by maximizing the expected return to the foreign country, given a constraint on expected utility similar to (A.4) with utility exceeding $U(rW)$.

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Endnotes

1. For an overview of forward to cover exchange risks in LDCs, see Quirk, P.J. et alt. (1988), <u>Policies for Developing Forward Foreign Exchange Markets</u>, IMF Occasional Paper 60, June.

2. The framework offered here could be applied to a larger set of issues. In essence, it applies to all firms in the host economy with assets and income whose value depends on "rupee" prices (including traded goods through the exchange rate) and liabilities (or euity) denominated in "dollars".

3. In particular, this assumption rules out any role for forward contracts as providing credibility to government reform policies. This case is considered in a companion paper.

4.   How common are risk averse firms? Taxes, information or transactions costs may lead to a demand for hedging by the firm as it can no longer simply diversify the risk associated with the randomness of its returns by diversifying its portfolio. For instance, a firm often has private information about its actions. Resulting problems of adverse selection and moral hazard lead to agency costs and make external financing of projects more costly than retained earnings. Hence, firms with a low cash flow will have a higher cost of external funding. An increase in the variance of the firm's earnings then raises the probability that the firm enters the region of "financial distress".
    The desire to decrease the variability of their earnings, and hence the expected costs of financing projects, explains why many firms behave as if they were risk averse in a developing country setting. There empirical evidence on the demand for hedging consistent with this explanation. For instance, Nance, Smith, and Smithson (1993) provide tests of the various standard hypotheses in explaining the hedging behavior of a sample of 104 firms for 1986. They find that: (i) firms with more convex tax functions engage in more hedging; (ii) that there is a role for agency costs in explaining hedging. Mayers and Smith (1990) also find a role for diversification of owners in explaining hedging behavior. Therefore, we will use the assumption of risk aversion as the simplest way of capturing the firm's demand for hedging in the static model.

5. Broll and Wahl (1992) present a similar model in which W has the interpretation of being the stock of firm-specific capital which the firm allocates between the home and foreign countries. Their approach is consistent with the approach taken by Caves (19   ), who argues that multinationals arise because of the presence of firm-specific assets developed by the firm. These assets give the firm an advantage in competition with local firms in the host market. Alternatively, W can be set equal to 0 and the home country return R can be interpreted as the rate at which the firm can borrow in the host country markets.

6. If the BAPAIN consumption good and the JAPAUS consumption good are the same (composite) good, then the law of one price will be equivalent to purchasing power parity. If the respective goods are different commodities, then the law of one price is not sufficient to ensure purchasing power parity.

7. First, note that from the concavity of U and ϕ that (2) is decreasing in K^*. The value $\bar{K}^*$ solves (2) for the risk neutral case where U' is a constant. If U is concave, U' is decreasing in π and (2) will be negative when evaluated at $\bar{K}^*$, which means that the optimal K^* is less than $\bar{K}^*$. A similar argument establishes that an increase in the riskiness of αe, as defined by a mean preserving spread, will reduce the optimal K^*.

8. In designing these insurance contracts, the possibility that the firm can make arbitrage profits using the forward contracts, through transactions such as "round-triping" commonly observed in Latin America or in East Asia for instance, should be avoided. For example, suppose that the firm can lend 1 rupee at the beginning of the period at a rate of r. It capital will be 1+r at the end of the period. If the firm can negotiate a forward rate F, the capital becomes (1+r)F at the end of the period. Now assume that the firm is holding dollars which represent capital flight and that the opportunity cost of these dollars is r*. The firm could make a risk free profit on the forward contract if (1+r)F>r*. Then no new investment result from the contract, only a transfer to the firm. In sum, the constraint (1+r)F<r* must be satisfied by the negotiated rate. If the financial markets are restricted in the host country and transaction are costly as in many South Asian countries, this condition is likely to be satisfied.

9. A recent paper by Froot (1993) has examined the potential gains from hedging investments between the US and UK. He finds that for investments with a life of more than several years, hedged portfolios have greater variance than unhedged portfolios.

10. The value of ρ is an indicator of the degree of benefit US firms would receive from hedging a one year real investment in the country. The sum of the mean annual rate of nominal depreciation over the full period μ_E and of the mean inflation differential μ_q would give an indication of the extent to which the average change over the period is consistent with purchasing power parity, since PPP predicts that $\mu_E + \mu_q = 0$.

11. Suppose the utility function is $U = y^\gamma$, which exhibits constant relative risk aversion. The optimal insurance scheme involves choosing $b_1(E)$ to maximize

$$\int_1 u(y_1(E) + b_1(E)) f(E) dE$$

subject to

$$\int u(y_2(E) - b_1(E)) f(E) dE \geq U_2$$

where $b_1(E)$ is the payment by 2 to 1. The solution to this problem has the form $b_1(E) = (\lambda y_2(E) - y_1(E))/(1+K)$. Thus, 2 will make a payment to 1 whenever $y_2/y_1 > \lambda$.

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