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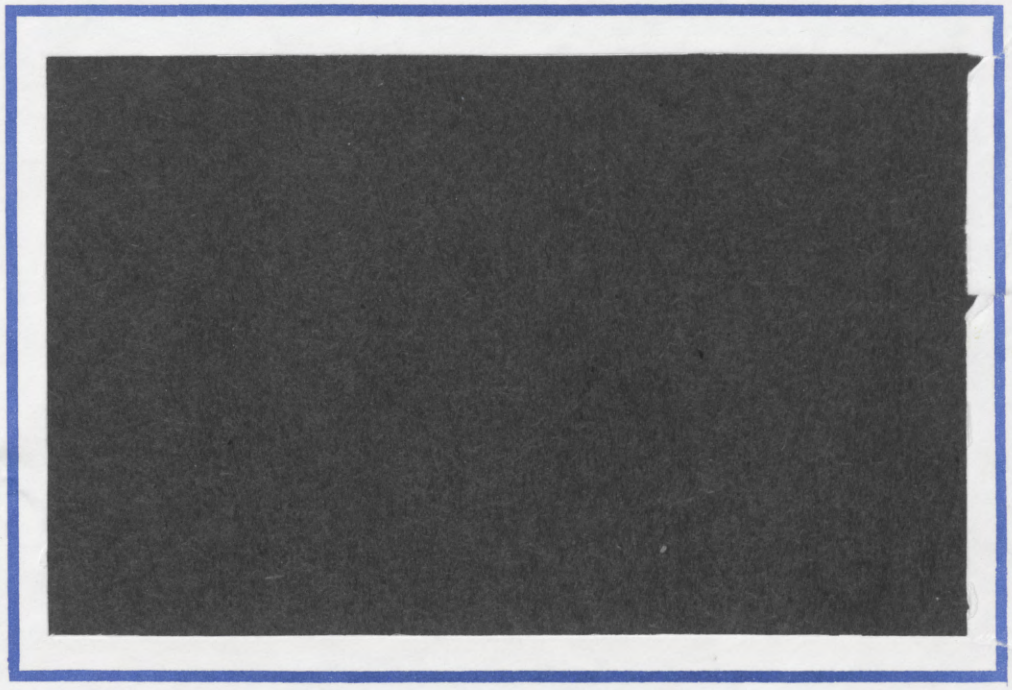

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DIRECT FOREIGN INVESTMENT AND THE CHOICE OF TECHNIQUE UNDER UNCERTAINTY

By

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I. INTRODUCTION

It is often claimed that foreign-owned firms operating in less developed countries (LDC's) utilize systematically different techniques of production than do their locally-owned counterparts. Recent empirical research offers some support for these allegations, by providing evidence of several cases in which the production techniques of foreign-owned firms are generally more capital intensive than those of locally owned firms, as well as some cases where just the opposite is true.[1] At the same time, various theoretical hypotheses have been advanced to explain why techniques of production should, in fact, vary as a function of nationality of ownership. Potential explanations of the relative capital intensity of foreign-owned firms include: differential access to cheap sources of capital in the international capital market; bias created by the subsidization policies of LDC governments aimed at encouraging direct foreign investment; differences between the technologies available to local and foreign-owned firms; and the unwillingness or the inability of multinational firms to adapt the technologies they employ in the developed countries to the conditions encountered in LDC's. On the other hand, it has been argued that foreign-owned firms may be more labor intensive, because their superior managers are better able to adapt the standard production technologies developed in the industrialized world for application in a labor-rich environment.

In this paper, we wish to put forth and investigate an alternative (but possibly complementary) theory of systematic variations in choice of technique related to nationality of firm ownership. Our explanation rests on the

existence of country-specific production uncertainties and the absence of international equity markets. It also requires, as we shall see, that capital and labor be different types of factors in some economically relevant sense.

In a world of incomplete equity markets, foreign-owned and locally-owned firms operating in LDC's are likely to differ substantially in their attitudes toward risk, even when underlying preferences of individuals are identical within and across countries. This may be so for one (or both) of two reasons. First, if the foreign-owned firms are "multinational" (i.e., have production bases in more than one country), then the mere fact of such diversification implies that their profit streams are influenced relatively less by the specific uncertainties associated with any one production facility. Second, shares of ownership of foreign firms from developed countries are likely to be tradeable on stock markets there, so that even if these firms have operations only in a single location (e.g. in the given LDC), their owners can hold a diversified portfolio of equities. In contrast, locally-owned firms in LDC's are unlikely to be internationally diversified in their production operations, and their owners are more likely to hold a large fraction of their wealth in a single firm, due to imperfections in or the complete absence of a local equity market in most LDC's.

Will such asymmetries in susceptibility to country-specific risk give rise to systematic biases in the choice of technique? We find that if capital and labor are treated as completely symmetric factor inputs, then the answer is no. But under some realistic institutional situations common in LDC's, capital and labor may not be entirely symmetric. For example, capital goods must generally be installed in a production plant prior to the resolution of uncertainty. However, in many LDC's, difficulties with enforcement of long-term wage contracts precludes the ex ante hiring of labor. As another

example, labor is generally immobile internationally, whereas capital may be importable. Finally, a spot labor market can safely be assumed to exist in any LDC, but it is not always the case that capital can be traded on a local market. We will show how each of these potential asymmetries impinges on the relative choice of technique of locally-owned and foreign-owned firms under uncertainty.

We consider below a simple general equilibrium model of direct foreign investment (DFI) with one good, three factors, and two countries. The model is constructed to capture a number of the "stylized features" of DFI in LDC's. All firms in the home (LDC) and foreign countries produce the same good with the input of capital, labor and "entrepreneurial" or "managerial" services. In order to focus sharply on the consequences of asymmetric susceptibility to country-specific risks, we assume that all firms have access to the same technology, and that technology is independent of location. Actual output, however, is affected by a location-specific, multiplicative shift term, that is less-than-perfectly correlated across countries. Thus, a firm which employs inputs K of capital, L of labor, and M of managers, attains an output of $\theta F(K,L,M)$ if the plant is located in the LDC, and $\theta^* F(K,L,M)$ if production takes place in the foreign country.[2] We assume that the function F is homogeneous of degree one in its three arguments, and that it can be written as $F(K,L,M) \equiv G[H(K,L),M]$ for some homothetic function, H.

The managerial input, M, plays several important roles in our analysis. First, we assume that it is the entrepreneur who bears the production risk, if there is no equity market in the LDC. Second, we wish to distinguish between direct foreign investment and international trade in capital goods. Direct foreign investment, in our terminology, is the establishment of a production

plant in the LDC by a foreign-owned firm. Such investment occurs in our model, because the assumed absence of international trade in equities prevents foreign individuals from gaining access to an internationally diversified portfolio in any other way. We then answer the question of what it is that moves when DFI occurs by assuming that the owners of any production facility must provide entrepreneurship to it, and must bear the associated risks. Thus, our notion of entrepreneurship is such that a foreign firm is precluded from hiring local entrepreneurs in the LDC, and DFI of necessity involves the international reallocation of managers. Note that DFI might also, but need not, involve the movement of physical capital or labor. We entertain below alternative assumptions regarding international capital mobility, but always assume that labor is completely immobile.

The chief asymmetry we introduce between home and foreign firms is that, whereas foreign firms engage in DFI and thereby achieve diversification, home firms may not do so. The LDC firms' inability to invest abroad may be explained by a lack of information, or with appeal to some diseconomies of scope.[3]

Finally, we simplify our analysis by assuming that all home country residents are equally endowed with the three factors, as are residents of the foreign country (although across countries endowments are not necessarily the same). This, together with the assumption that all individuals share identical preferences, allows us to study the "representative consumer" in each country who maximizes the expected utility of income derived from factor payments and profits. In the case of foreign residents, this includes profits earned in both locations, since the existence of an equity market there ensures that all individuals will own equiproportionate shares of all firms.

We proceed now to the main body of the analysis. In Sections II through IV, we compare the techniques of production chosen by foreign-owned firms operating in an LDC with those chosen by locally-owned firms, under a variety of institutional arrangements. Then, in Section V, we consider the welfare implications for LDC's of inward direct foreign investment under uncertainty for each of the institutional setups described in the earlier sections.

II. DIRECT FOREIGN INVESTMENT IN THE ABSENCE OF CAPITAL MOBILITY

Direct foreign investment need not be accompanied by the international movement of capital, provided that foreign firms can contract for the services of capital locally. In this section, we study DFI that occurs when capital is internationally immobile. Here, as in all subsequent analysis, we assume that DFI (i.e. the international allocation of managers) and the installation of capital must be conducted prior to the resolution of uncertainty.

Suppose, to begin with, that labor is also hired ex ante,[4] and consider the equilibrium in the LDC factor markets for a given level of DFI.[5] Let α represent the state of nature, i.e., a given realization of $(\theta(\alpha),\theta^*(\alpha))$, and let V and V^* denote the aggregate endowments of factor V (for $V = K, L, M$) of the LDC and foreign country, respectively. We denote by V_i and V_i^* the amount of factor V owned by LDC and foreign residents, respectively, that is employed in the LDC by a firm originating from country i, where $i = h$ for a locally-owned firm and $i = f$ for a foreign-owned firm. Consumption in any state α is equal to income, which comprises factor income and profits. Thus, consumption of home country residents is given by:

$$C(\alpha) = rK + wL + [\theta(\alpha)F(K_h, L_h, M) - rK_h - wL_h] \qquad (1)$$

where r and w are the rental rate and wage rate that prevail in equilibrium in the LDC. The representative home consumer, in his role as manager, seeks to maximize $E_\alpha U(C(\alpha))$ with respect to the ex ante choice of inputs K_h and L_h, where $U(\cdot)$ is his von Neumann-Morgenstern utility function (with $U' > 0$, $U'' < 0$). The first-order conditions for this maximization are:

$$F_K(K_h,L_h,M)\ E\theta U'(C) = rEU'(C) \tag{2}$$

$$F_L(K_h,L_h,M)\ E\theta U'(C) = wEU'(C) \tag{3}$$

Similarly, the representative foreign resident consumes, in state α,

$$C^*(\alpha) = r^*K^* + w^*L^* + [\theta^*(\alpha)F(K^*,L^*,M^*-M_f^*) - r^*K^* - w^*L^*]$$

$$+ [\theta(\alpha)F(K_f,L_f,M_f^*) - rK_f - wL_f]$$

where r^* and w^* are the equilibrium rental and wage rates in the foreign country. His problem is to maximize $E_\alpha U(C^*(\alpha))$ with choice variables K_h and L_h. Note that we assume identical preferences for home and foreign residents. The optimal choices of inputs for foreign firms operating in the LDC are given implicitly in the first-order conditions:

$$F_K(K_f,L_f,M_f^*)E\theta U'(C^*) = rEU'(C^*) \tag{4}$$

$$F_L(K_f,L_f,M_f^*)E\theta U'(C^*) = wEU'(C^*) \qquad (5)$$

The model is closed by the factor market clearing conditions for each country.

To compare techniques of production of local and foreign-owned firms operating in the LDC, it is sufficient to divide (2) by (3) and (4) by (5), to find that

$$\frac{F_K(K_h,L_h,M)}{F_L(K_h,L_h,M)} = \frac{F_K(K_f,L_f,M_f^*)}{F_L(K_f,L_f,M_f^*)} \qquad (6)$$

Given our assumption that $F(K,L,M)$ can be written as $G(H(K,L),M)$, with H homothetic, it follows from (6) that $K_h/L_h = K_f/L_f$. When capital and labor are both allocated before uncertainty is resolved, the techniques of production of locally-owned and foreign-owned firms are identical. The asymmetry in susceptibility to risk does not bias the choice of techniques in this benchmark case, because from the point of view of the entrepreneur, capital and labor are entirely symmetrical factors. Whatever influence the introduction of uncertainty has on the demand for one, it will have, in relative terms, the same influence on the demand for the other. It should be clear, then, that biases in the choice of techniques can arise only when factors are treated asymmetrically in some way.

One such asymmetry concerns the timing of allocation. In many LDC's, long-term labor contracts are not easily enforceable. And whereas capital usually must be installed far in advance of production, labor often can be

hired on a spot market very close to the time that production takes place. It is reasonable to consider, therefore, the possibility that the allocation of labor takes place after the resolution of uncertainty.[6] Under this assumption, the consumption of home residents in state α is

$$C(\alpha) = rK + w(\alpha)L + [\theta(\alpha)F(K_h, L_h(\alpha), M) - rK_h - w(\alpha)L_h(\alpha)]$$

and that of foreign residents is given by

$$C^*(\alpha) = r^*K^* + w^*(\alpha)L^* + [\theta^*(\alpha)F(K^*, L^*, M^* - M_f^*) - r^*K^* - w^*(\alpha)L^*]$$

$$+ [\theta(\alpha)F(K_f, L_f(\alpha), M_f^*) - rK_f - w(\alpha)L_f(\alpha)].$$

The first-order conditions for expected-utility maximization with respect to the choice of capital input in the LDC by each type of firm are

$$E\theta U'(C)F_K(K_h, L_h(\alpha), M) = rEU'(C) \tag{7}$$

$$E\theta U'(C^*)F_K(K_f, L_f(\alpha), M_f^*) = rEU'(C^*) \tag{8}$$

where equations (7) and (8) are evaluated at the quantity of labor input that is optimal in each state of nature. These optimal levels are determined implicitly (and as a function of the amount of capital hired ex ante) by the following equations:

$$\theta(\alpha)F_L(K_h,L_h(\alpha),M) = w(\alpha) \tag{9}$$

$$\theta(\alpha)F_L(K_f,L_f(\alpha),M_f^*) = w(\alpha) \tag{10}$$

In order to compare the techniques chosen by each type of firm, let us suppose that the amount of direct foreign investment is small. In other words, we investigate the techniques employed by foreign-owned firms in their initial increment of DFI, and compare them to those utilized by locally-owned firms in autarky. Of course, by continuity, our results will also hold <u>at least</u> for a range of levels of DFI that are not "too" large.

Consider first the case where the country-specific risks are independent random variables. At the point where $M_f^* = 0$, we have $L_h(\alpha) = L$, because the entire labor supply must be fully employed in autarky by locally-owned firms. But with employment non-stochastic, (7) can be written as:

$$F_K(K_h,L_h,M)\,\frac{E\theta U'(C)}{EU'(C)} = r \tag{7'}$$

Recognizing that

$$\frac{E\theta U'(C)}{EU'(C)} = 1 + \frac{Cov[\theta,U'(C)]}{EU'(C)}$$

and that $Cov[\theta,U'(C)] < 0$, it follows from (7') that $F_K(K_h,L_h,M) > r$.[7] Capital is not hired by local firms up to the point where its expected marginal product is equal to the rental rate, because non-diversifiable risk is involved for LDC entrepreneurs in the installation of capital, and all

entrepreneuers are risk averse. Turning to the input decision of the foreign-owned firm, note that the independence of θ and θ^* implies that $Cov(\theta, U'(C^*)) = 0$ when M_f^* is small. Also, since $L_h(\alpha)$ tends towards state-independence in the limit, $F_K(K_f, L_f(\alpha), M_f^*)$ must do so as well.[8] Taking these facts into account, (8) becomes

$$F_K(K_f, L_f(\alpha), M_f^*) = r \tag{8'}$$

When income earned in the LDC is a very small fraction of total income for the foreign country, and when the uncertainties in the two countries are uncorrelated, an implication of the diversified portfolio of foreign residents is, evidently, risk neutrality with respect to its choice of capital input in the LDC.

It can now be seen immediately that the technique employed by foreign-owned firms (in every state of nature) is more capital intensive than that chosen by locally-owned firms. Divide (7') by (9), and (8') by (10), and note that, under the restrictions we have placed on the production function, F_K/F_L is a (decreasing) function of the capital-labor ratio, alone. Thus, $K_h(\alpha)/L_h(\alpha) < K_f(\alpha)/L_f(\alpha)$. The asymmetry in susceptibility to LDC-specific risk creates a systematic difference in the relative input of the productive factors.

If the random shocks in the LDC and abroad are not independent, then the rental of capital in the LDC is risky for foreign-owned, as well as locally-owned, firms. Since general results are hard to come by in this case, we concentrate on a specific example. Suppose the utility function of all

individuals is of the form $U(C) = C^{1-R}/(1-R)$, i.e. exhibits constant relative risk aversion (CRRA). Suppose, further, that θ and θ^* are distributed jointly-lognormal, with variances σ^2 and σ^{*2}, and with covariance γ. Then, near $M_f^* = 0$,

$$\frac{E\theta U'(C)}{EU'(C)} = \frac{E\theta^{1-R}}{E\theta^{-R}} = (1+\sigma^2)^{-R} \tag{11}$$

where the latter equality is derived using the properties of the lognormal distribution.[9] Similarly, we evaluate $E\theta U'(C^*)/EU'(C^*)$, which enters into the first-order condition for the foreign-owned firms' choice of capital input, in equation (8).[10] Again, using the properties of the joint-lognormal distribution, it can be shown that

$$\frac{E\theta U'(C^*)}{EU'(C^*)} = \frac{E\theta\theta^{*-R}}{E\theta^{*-R}} = (1+\gamma)^{-R} \tag{12}$$

It follows that $F_K(K_h, L_h(\alpha), M) < F_K(K_f, L_f(\alpha), M_f^*)$, and therefore that the foreign-owned firms are more capital intensive if and only if the covariance between the two random variables is less than the variance of the LDC-specific risk term. Note that a sufficient condition for $\gamma < \sigma^2$ is that the LDC be the riskier of the two investment environments.

To summarize, we have studied in this section the relationship between choice of technique and nationality of ownership, when DFI does not involve any movements of capital. We found that when capital and labor are both

allocated prior to the resolution of uncertainty, techniques of production are the same for locally-owned and foreign-owned firms. Techniques will differ systematically, however, if one factor (e.g. capital) must be installed prior to the resolution of uncertainty, while the other (labor) is hired after the state of nature is known. In this case, if the amount of DFI is small, foreign-owned firms will normally employ more capital-intensive techniques than their locally-owned counterparts.

III. DIRECT FOREIGN INVESTMENT WHEN LDC CAPITAL MARKETS ARE ABSENT

The multinational firm is, in may instances, a significant importer into the LDC of capital goods produced in its home country. Indeed, when the foreign firm is unable to trade in the capital market of the LDC, then international capital mobility is a prerequisite for direct foreign investment. In this section, we study DFI that is accompanied by capital movement in cases where a market for capital is absent from the LDC.

As in the previous section, we begin with the assumption that both capital and labor must be hired ex ante and derive equilibrium factor allocation for given M_f^*. Since the representative, local entrepreneur consumes, in state α,

$$C(\alpha) = rK + wL + [\theta(\alpha)F(K,L_h,M) - rK - wL_h]$$

he chooses his labor input to satisfy

$$F_L(K,L_h,M)\ E\theta U'(C) = wEU'(C) \tag{13}$$

The representative foreign resident has state-dependent consumption:

$$C^*(\alpha) = r^*K^* + w^*L^* + [\theta^*(\alpha)F(K^*-K_f^*,L^*,M^*-M_f^*) - r^*(K^*-K_f^*) - w^*L^*]$$
$$+ [\theta(\alpha)F(K_f^*,L_f,M_f^*) - r^*K_f^*-wL_f]$$

The manager of a foreign firm operating in the LDC hires labor locally, but rents capital abroad, and imports it for use in his LDC operations. The first-order condition governing labor demand is:

$$F_L(K_f^*,L_f,M_f^*)E\theta U'(C^*) = wEU'(c^*) \tag{14}$$

The existence of the stock market in the foreign country ensures that the equilibrium allocation of the foreign country's capital endowment is such that expected utility of the representative individual is maximized. This requires

$$F_K(K^*-K_f^*,L^*,M^*-M_f^*)E\theta^*U'(C^*)=F_K(K_f^*,L_f,M_f^*)E\theta U'(C^*) \tag{15}$$

We again address the choice-of-techniques question for M_f^* small, and for the special case of jointly-lognormal random variables and CRRA utility functions. Then, using (11) and (13), we find that the capital-labor ratio in locally-owned firms (near $M_f^* = 0$) is governed by:

$$\frac{F_K(\frac{K}{M},\frac{L_h}{M},1)}{F_L(\frac{K}{M},\frac{L_h}{M},1)} = \frac{F_K(\frac{K}{M},\frac{L}{H},1)(1+\sigma^2)^{-R}}{w} \tag{16}$$

where F_K/F_L is a (decreasing) function of K/L_h alone. The analogous expression for the foreign-owned firms is:

$$\frac{F_K(\frac{K_f^*}{M_f^*},\frac{L_f}{M_f^*},1)}{F_L(\frac{K_f^*}{M_f^*},\frac{L_f}{M_f^*},1)} = \frac{F_K(\frac{K^*}{M^*},\frac{L^*}{M^*},1)(1+\sigma^{*2})^{-R}}{w} \tag{17}$$

Thus, the foreign-owned firms will be more capital intensive than the locally-owned firm if:

$$F_K(K,L,M)(1+\sigma^2)^{-R} > F_K(K^*,L^*,M^*)(1+\sigma^{*2})^{-R}$$

and they will be less capital intensive if the inequality runs in the opposite direction. This condition has the following intuitive interpretation. In autarky, the rental rates for capital in each country are given by the products of the marginal products of capital and risk-adjustment factors. These risk factors are, in the case of log-normal disturbances and CRRA utility, given by $(1+\sigma^2)^{-R}$ and $(1+\sigma^{*2})^{-R}$, respectively. Thus, the foreign-owned firms will be more capital intensive if, and only if, they have "access to cheaper capital." Note that when production is risky, it does

not follow from a consideration of relative factor endowments alone, that the autarky rental rate for capital will be higher in the LDC than abroad. It is true that if $K/M = K^*/M^*$, then $K^*/L^* > K/L$ implies that the autarky marginal product of capital will be higher in the LDC. But if the LDC is a riskier investment environment (i.e., if $\sigma^2 > \sigma^{*2}$), as is likely to be the case in reality, the autarky rental rate might nonetheless be lower in LDC's. It seems, however, that the empirically most relevant case is one where the autarky rental rate for capital is higher in the LDC, implying that less capital intensive techniques will be chosen by the locally-owned firms.

Consider once again the scenario in which labor is only hired after the state of nature is known. Proceeding as before, we have

$$C(\alpha) = rK + w(\alpha)L + [\theta(\alpha)F(K,L_h(\alpha),M) - rK - w(\alpha)L_h(\alpha)]$$

and

$$C^*(\alpha) = r^*K^* + w^*(\alpha)L^* + [\theta^*(\alpha)F(K^*-K_f^*,L^*,M^*-M_f^*) - r(K^* - K_f^*) - w^*(\alpha)L^*]$$

$$+ \theta(\alpha)[F(K_f^*,L_f(\alpha),M_f^*) - r^*K_f^* - w(\alpha)L_f(\alpha)].$$

The condition governing the allocation of the foreign country's capital stock, evaluated for small DFI (where F_K is once again state-independent in the limit) is:

$$F_K(K^*,L_f(\alpha),M_F^*) = \frac{E\theta^*U'(C^*)}{E\theta U'(C^*)} F_K(\frac{K^*}{M^*},\frac{L^*}{M^*},1) \qquad (18)$$

Since the marginal products of labor in home-owned and foreign-owned firms operating in the LDC are equal state-by-state (each is set equal to the wage rate), any bias in the choices of technique are revealed simply by comparison of $F_K(K^*,L_f(\alpha),M_f^*)$ in (18) with the autarky marginal product of capital in the LDC. If θ and θ^* are independent random variables then $E\theta^*U'(C^*)/E\theta U'(C^*) = E\theta^*U'(C^*)/EU'(C^*) < 1$, and a sufficient condition for foreign-owned firms to be more capital intensive than locally-owned firms is $F_K(K^*,L^*,M^*) < F_K(K,L,M)$. This will be satisfied, for example, if the capital-manager endowment ratios are the same in both countries, and the LDC has a larger relative endowment of labor.

For insight into those situations where the two uncertainties are not independent, we return to the special case of CRRA utility and jointly - lognormal distribution of (θ and σ^*). With these added restrictions, it can be shown that

$$\frac{E\theta^*U'(C^*)}{E\theta U'(C^*)} = \left(\frac{1+\gamma}{1+\sigma^2}\right)^R$$

A necessary and sufficient condition for the foreign-owned firms to use more capital intensive techniques of production than the locally-owned firms is:

$$(1+\sigma^2)^R F_K(K,L,M) > (1+\gamma)^R F_K(K^*,L^*,M^*)$$

The choice of technique is affected by both the scarcity of capital and the susceptibility to risk. If the marginal product of capital is higher in the LDC than abroad, and if trade in capital does not take place, then there is a tendency for local firms to conserve relatively more on their capital usage.

As in the previous section, we find that exposure to risk is an additional contributing factor leading to more capital intensive techniques for foreign-owned firms, whenever the variance of fluctuations in the LDC exceeds the covariance between LDC and foreign disturbances.

IV. DFI WITH PERFECT CAPITAL MOBILITY

The final regime we wish to consider is one in which capital is perfectly internationally mobile and freely traded in the LDC. In such a world, the source of capital installed by foreign firms in their LDC operations is not determined, unlike in the previous sections. However, it is also immaterial, because international capital movement equalizes the rental rate for capital in the LDC and abroad.

Our intent is to show, very briefly, that the arguments of the previous sections remain intact when capital is mobile. In particular, when capital and labor are both hired ex ante, techniques of production are the same for local and foreign-owned firms, for much the same reasons as when capital is completely immobile. When the factors are hired at different times, then the asymmetry in susceptibility to risk again becomes an important factor in the choice of technique decision.

Recognizing that $r = r^*$ is now the rental rate in both countries, the consumption levels of LDC and foreign residents, when labor is allocated ex ante, are given by:

$$C(\alpha) = rK + wL + [\theta(\alpha)F(K + K_h^*, L_h, M) - r(K_h + K_h^*) - wL_h]$$

and

$$C^*(\alpha) = rK^* + w^*L^* + [\theta^*(\alpha)F(K^* - K_h^* - K_f^*, L^*, M^* - M_f^*) - r(K - K_h - K_h^*) - w^*L^*]$$

$$+ [\theta(\alpha)F(K_f + K_f^*, L_f, M_f^*) - r(K_f + K_f^*) - wL_f]$$

We assume, for definiteness only, that the LDC will be an importer of capital in the cum-DFI equilibrium. By reasoning that is by now familiar, the following conditions are required for utility maximation by the respective entrepreneurs:

$$F_K(K_h + K_h^*, L_h, M) = \frac{rEU'(C)}{E\theta U'(C)} \tag{19}$$

$$F_L(K_h + K_h^*, L_h, M) = \frac{wEU'(C)}{E\theta U'(C)} \tag{20}$$

$$F_K(K_f + K_f^*, L_f, M_f^*) = \frac{rEU'(C^*)}{E\theta U'(C^*)} \tag{21}$$

$$F_L(K_f + K_f^*, L_f, M_f^*) = \frac{wEU'(C^*)}{E\theta U'(C^*)} \tag{22}$$

Dividing (19) by (20), and (21) by (22), we find that the ratio of the marginal product of labor to the marginal product of capital is independent of nationality of ownership, and therefore the capital-to-labor ratio is as well. When local and foreign managers face the same prices for all factors,

and when all factors are treated symmetrically, techniques of production will be the same for both types of firms.

Without presenting the expressions formally, it should be clear that such will not be the case when labor is not hired until after the uncertainty is resolved. For small amounts of DFI, the foreign firms will always use more capital intensive techniques, if the LDC and foreign-risks are independent. For the non-independent case, analysis of the example of joint-lognormal random variables and CRRA utility yields the same critical condition as before; namely, if $\gamma < \sigma^2$, the techniques of the foreign-owned firms will be more capital intensive. The proofs of these statements are analogous to those above, and will not be repeated.

Essentially, the regime of free capital mobility is the same as that of no capital mobility, as far as choice of technique is concerned. In each case, the relative factor prices faced by managers of home-owned and foreign-owned firms operating in the LDC are the same. What is important to the choice of techniques then, given the difference in the extent of diversification, is the relative riskiness of employment of the alternative inputs to production.

V. A SUMMARY OF THE FINDINGS AND THEIR WELFARE IMPLICATIONS

To this point we have been concerned only with the positive issue of whether or not a bias in the choice of technique as a function of nationality of ownership can be explained theoretically on the basis of stylized facts concerning the exposure to risk of the various entrepreneurs. To a large extent, our theoretical findings lend support to the view that foreign-based firms will usually be more capital-intensive than otherwise similar locally-owned enterprises.

$$C(\alpha) = \theta(\alpha)F(K_h+K_h^*,L_h(\alpha),M) - rK_h^* + rK_f + w(\alpha)L_f(\alpha).$$

Of course, some of the elements of this expression are necessarily zero under some regimes (e.g. $K_h^* = 0$ if capital is immobile), and $L_h(\alpha)$ and $w(\alpha)$ must be state-independent if labor is allocated ex ante.

Let $\tilde{C}(\alpha) = \theta(\alpha)F(K+\tilde{K}_h^*,L,M) - \tilde{r}\tilde{K}_h^*$ be LDC consumption when DFI is absent, where $\tilde{K}_h^*$ represents capital imports (possibly restricted to zero), and $\tilde{r}$ is the world rental rate when capital is mobile. Then

$$E[U(\tilde{C}) - U(C)] \leq EU'(C)\{\theta[F(K+\tilde{K}_h^*,L,M) - F(K_h+K_h^*,L_h(\alpha),M] \tag{23}$$

$$+ rK_h^* - \tilde{r}\tilde{K}_h^* - rK_f - w(\alpha)L_f(\alpha)]\}$$

by the concavity of the utility function. Similarly, the concavity of the production function in capital and labor alone implies

$$F(K+\tilde{K}_h^*,L,M) - F(K_h+K_h^*,L_h(\alpha),M) \leq [F_K(K_h+K_h^*,L_h(\alpha),M)][K + \tilde{K}_h^* - K_h - K_h^*]$$

$$+ [F_L(K_h+K_h^*,L_h(\alpha),M)][L - L_h(\alpha)] \tag{24}$$

Substituting (24) into (23), noting that $K - K_h = K_f$ and that $L - L_h(\alpha) = L_f(\alpha)$ and recalling the various first-order conditions for optimization by LDC entrepreneurs, we find

$$E[U(\tilde{C}) - U(C)] \leq (r - \tilde{r})\tilde{K}_h^*$$

This proves that when either capital is physically immobile, or the market for capital is absent in the LDC (so that $K_h^* = 0$), the equilibrium with DFI yields expected utility to the representative consumer in the LDC that is no less than that achieved without DFI. This result is independent of the assumption concerning the time at which employment decisions are made.

Our results are summarized in Table 1. It is clear from the table that neither assumptions about the existence or non-existence of capital mobility, nor those about the existence or non-existence of uncertainty (with differences in access to opportunities for diversification) are sufficient to determine whether techniques of production will vary with nationality of ownership. What is essential to the argument in favor of such a bias is either an asymmetry in the price paid for capital, or the confluence of unequal risk exposure and an asymmetry in the way uncertainty impinges upon the demand for the various factor inputs.

Positive statements about choice of techniques are often accompanied by implicit or explicit normative conclusions about the lack of benefit for LDC's of inward direct foreign investment. As a final aspect of our analysis, we consider the welfare implications for the LDC of DFI under uncertainty and the imperfect market conditions that we have described. Might it be the case that asymmetry in access to risk-sharing opportunities puts local entrepreneurs at such a disadvantage that LDC resident's utility would be higher in the total absence of DFI? The answer is that DFI need not confer gains on the LDC, but for familiar reasons that are not at all related either to uncertainty or to the bias that we have identified in the choice of technique of foreign-owned (relative to locally-owned) firms.

We compare the expected utility of a representative LDC resident without DFI to his expected utility with DFI at some exogenous level M_f^*, under all six of the institutional arrangements discussed above (i.e. the cells of Table 1). A general expression for the (state-dependent) consumption of an LDC resident, which holds for all the various regimes under which DFI can take place, is:

When capital imports do take place, DFI may be immiserizing for the residents of the LDC. The reason is that DFI may cause the terms of trade on prior capital imports to deteriorate, as would be the case if $r > \tilde{r}$.[11] Note that such is true in the absence of uncertainty, and can occur both when techniques of production are identical (as when labor is hired ex ante) and when they differ (when labor is hired ex post). We conclude, therefore, that the conditions that might give rise to a bias in the choice of technique of foreign-owned firms relative to that of locally-owned firms have no particular bearing on whether or not the observed direct investment is likely to be beneficial.

TABLE 1

A COMPARISON OF CHOICE OF TECHNIQUE BY LOCALLY OWNED AND FOREIGN-OWNED FIRMS[1]

	Labor Hired Ex Ante	Labor Hired Ex Post
Capital Immobile	Same Techniques	Foreign Firm more capital intensive iff $\sigma^2 > \gamma$
Capital Mobile, No Capital Market in LDC	Foreign Firm more capital intensive iff $F_K(K,L,M)(1+\sigma^2)^{-R} > F_K(K^*,L^*,M^*)(1+\sigma^{*2})^{-R}$	Foreign Firm more capital intensive iff $F_K(K,L,M)(1+\sigma^2)^{R} > F_K(K^*,L^*,M^*)(1+\gamma)^{R}$
Free International Capital Movements	Same Techniques	Foreign firm more capital intensive iff $\sigma^2 > \gamma$

1 Tabulations correspond to the special case of jointly-lognormal random disturbances, CRRA utility functions, and a "small" amount of direct foreign investment. Notation is defined in the text.

FOOTNOTES

1 Studies which report findings of generally greater capital-intensity of techniques in foreign-owned firms than in locally-owned firms include Mason (1973), Morley and Smith (1977) and Forsyth and Solomon (1977a, 1977b). Pack (1976) offers casual evidence that foreign firms are more labor intensive, while the evidence in Cohen (1973) is mixed. Finally, Chung and Lee (1980) found no significant effect of nationality of ownership on the production technique.

2 We abstract from the existence of firm-specific uncertainty which, if included, would only serve to strengthen our argument. Without loss of generality, let us choose units so that $E\theta = E\theta^* = 1$, where E is the expectation operator.

3 For a discussion of diseconomies of scope, and the limits they impose on the horizontal integration of the firm, see Panzer and Willig (1981).

4 This corresponds to the assumption employed by Helpman and Razin (1978) in their study of international trade under uncertainty. It implies that an enforceable long-term wage contract can be concluded between management and laborers.

5 Throughout our analysis, we take the level of DFI as exogenous, to reflect the fact that foreign investment in LDC's is very often regulated or limited by the policies of the host government. We assume, in all cases, that the parameters are such that the equilibrium level of DFI in the absence of government control would be positive, and that it would equal or exceed our exogenously specified level.

6 Eaton (1979) and Eaton and Grossman (1981) have investigated aspects of international trade under uncertainty when capital must be allocated ex ante, and labor is hired ex post.

7 To prove directly that $E_\theta U'(C)/EU'(C) < 1$, write the left hand side as the ratio of two integrals, integrate the numerator and denominator by parts, and make use of the fact that $U''(C) < 0$.

8 As $M_f^* \to 0$, $L_h(\alpha) \to L$ and from (9), $w(\alpha)/\theta(\alpha)$ is, in the limit, non-stochastic. Then, (9) implies that $F_L(K_f/M_f^*, L_f(\alpha)/M_f^*, 1)$ tends towards state-independence as the exogenously given value of M_f^* becomes small, and therefore $F_K(K_f/M_f^*, L_f(\alpha)/M_f^*, 1)$ does as well.

9 See, for example, Johnson and Kotz (1972).

10 Recall that $F_K(K_f, L_f(\alpha), M_f^*)$ in (8) is non-stochastic near $M_f^* = 0$.

11 This is similar to the case of immiserizing factor movements in the presence of free trade in goods, which is discussed in detail in Grossman (1982).

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