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DIRECT INVESTMENT, RESEARCH INTENSITY, AND PROFITABILITY

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The large amount of foreign direct investment by U.S. firms in recent years suggests that such firms had a high internal rate of return on investment abroad. In this paper we attempt to provide an explanation for this high rate of return. Our conclusion is that direct investors tend to be in research-intensive industries and that their profitability is associated with research and development, rather than with direct investment itself. By investing abroad, they spread the fixed cost of research activity, thereby increasing the return to such activity. Thus, the internal rate of return on foreign direct investment exceeds average rates of return observed in foreign economies. Combined with the fact that direct investors in manufacturing are typically research-intensive, this result suggests why capital may flow from countries with high rates of return to those with lower observed rates of return.[1/]

We first examine the interrelationships between research and development, direct investment, and reported profitability. We then adjust our results on reported profitability from an accounting basis to an economic basis, so that we can compare returns on R&D to returns on other assets.

1/ This rationale complements the argument that international capital flows occur because the investor can thereby achieve a given rate of return with lower risk. See H. G. Grubel, "Internationally Diversified Portfolios: Welfare Gains and Capital Flows," American Economic Review 58 (December, 1968), 1299-1314.

The relationship between direct investment and R&D has been discussed by many economists. Caves postulates that horizontal direct investment will occur only if the firm possesses some special asset which satisfies two conditions. "First, the asset must partake of the character of a public good within the firm, such as knowledge.... Second, the return attainable on a firms' special asset in a foreign market must depend at least somewhat on local production."2/ Aliber writes in a similar vein, and raises the question of why the asset is exploited by means of direct investment, rather than by exporting or licensing.3/ Hymer and Rowthorn view direct investment as a function of elements of imperfect competition (which includes proprietary knowledge within firms).4/

Empirical support for these ideas is given at a high level of aggregation by Gruber, Mehta and Vernon. They found that research-intensive industries collectively had much higher direct investment than did other manufacturing industries as a whole.5/ Wolf found R&D and international involvement to be strongly associated, with the choice between exporting and investment being determined by characteristics of

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2/ R.E. Caves, International Corporation: The Industrial Economics of foreign Investment," Economica NS 38 (February, 1971), p.5.

3/ Robert Z. Aliber, A Theory of Direct Foreign Investment, in C.P. Kindleberger, ed., The International Corporation (Cambridge: MIT Press, 1970), pp. 17-34.

4/ Stephen Hymer and Robert Rowthorn, Multinational Corporations and International Oligopoly, in Kindleberger, op. cit., pp. 57-94.

5/ William Gruber, Dileep Mehta, and Raymond Vernon, "The R&D Factor in International Trade and International Investment of United States Industries," Journal of Political Economy 75 (February, 1967) 20-37.

the technology within a given industry. He also found a weaker association between profitability and international involvement.[6/] Horst found that "once interindustry differences are washed out, the only influence [on direct investment] of any separate significance is firm size."[7/]

At this point, we must emphasize that we are studying only the association between profitability, on the one hand, and R&D and direct investment, on the other. All three characteristics of the firm are jointly determined -- in particular, by the industry in which the firm is located. We have already suggested that a strong effort in R&D may create a special incentive to invest abroad. Furthermore, the higher the firm's existing level of foreign (as well as domestic) investment, the higher the prospective return to R&D activity, since the results can be spread over more markets. In addition, profitability has a positive effect on direct investment[8/] and probably on R&D also.[9/] All we argue is that direct investment tends to be associated with R&D in

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6/ Bernard M. Wolf, "Internationalization of U.S. Manufacturing Firms: A Type of Diversification," Unpublished doctoral dissertation, Yale University, 1971. Wolf's study is based on industry data, though at a finer degree of disaggregation than that used by Gruber, Mehta, and Vernon.

7/ Thomas Horst, "Firm and Industry Determinants of the Decision to Invest Abroad," Review of Economics and Statistics 54 (August, 1972) 258-266 at 261 (emphasis in original).

8/ For evidence on this effect in the short run, see Alan K. Severn, "Investment and Financial Behavior of American Direct Investors in Manufacturing," in F. Machlup et al., eds., Conference on International Mobility and Movement of Capital, Columbia University Press, 1972, pp. 367-396.

9/ For weak evidence on this line of causation, see Dennis Mueller, "The Firm Decision Process: An Econometric Investigation," Quarterly Journal of Economics 81 (February, 1967), 58-87.

industries and in firms, and that the interaction of the two is usually found in conjunction with higher profitability. We ask whether firms require a higher return on foreign investment than on comparable domestic investment, or whether returns are similar, with direct investment merely being an instrument which causes a high return to R&D.

We study the profitability of the firm as a whole, rather than its reported profit on foreign assets alone. The reason for this approach is that horizontal direct investment involves joint production of "foreign goods" and "domestic goods", and thus there is a large degree of indeterminancy, "economic" as well as accounting, in the concept of foreign versus domestic profits. We use two measures of the profitability of the firm as a whole. The first is earnings before interest, dividends on preferred stock and taxes (EBIT), divided by total assets.[10/] This measure resembles total return on assets, and serves as a proxy for the social rate of return. The second measure is earnings before interest and dividends on preferred stock but after taxes (EBIAT), as a ratio of total assets. This measure is a proxy for the private return on assets. Because tax rates differ between countries, pre-tax and post-tax rates

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10/ To the extent that implicit interest cost on accounts payable is included in the nominal price of goods purchased, EBIT and EBIAT are understated. But as Weston and Mansingka point out, the percentage of non-interest bearing liabilities is generally small for manufacturing firms. See J.F. Weston and S. Mansingka, "Tests of the Efficiency Performance of Conglomerate Firms," Journal of Finance 26 (September, 1971), 925. EBIAT is biased upward for leveraged firms, because all of interest is added back to net after-tax profits, rather than only interest less the tax saving.

of return will not necessarily produce the same pattern of results.[11/] Both measures, however, are free of the effects of financial leverage, and therefore do not need to be adjusted for differences in financial risk, as would rates of return based on shareholders' equity. Because expenditures on R&D may have a different cyclical pattern than expenditures on other assets, our empirical tests are carried out on data for a recession year (1960) and for a year of strong economic activity (1965).

Our first empirical tests involve comparisons of direct investors with firms which have little or no direct investment.[12/] Our sample of of direct investors consisted of U.S. manufacturing firms listed in the Fortune 500, all of which did at least ten percent of their business abroad in 1965.[13/] This sample is compared to either of two control samples of domestically-oriented firms. The latter samples, of 38 and 40 firms, respectively, were selected by a random process, from those firms in the Fortune 500 which did less than ten percent of their business abroad in 1965.[14/]

11/ In addition, the U.S. Revenue Act of 1962 did not have the same effect on all firms, because of the restriction on "unreasonable accumulations" of earnings. See L.B. Krause and K.W. Dam, Federal Tax Treatment of Foreign Income, (Washington: Brookings Institution, 1964).

12/ "Direct investment" is defined as the median of the percentage of total firm sales, earnings, assets, employment and production outside the U.S. See Nicholas K. Bruck and Francis A. Lees, "Foreign Investment, Capital Controls, and the Balance of Payments," The Bulletin, Institute of New York University, Graduate School of Business Administration, April 1968, No. 48-49, p. 69 and p. 17 for details of this definition.

13/ This sample was drawn from the sample of firms described in Severn, "Investment and Financial Behavior," by omitting those which did not meet the ten percent criterion and those which were not in the Fortune 500.

14/ Since the two control samples were selected independently, there is some overlap; eight firms appear in both control sample 1 and control sample 2.

Data on earnings (before and after taxes) and interest were taken from Moody's; these data were divided by year-end total assets. Our original data on R&D were the ratio of company-financed R&D expenditures to sales, both lagged three years, as an average for the appropriate SIC 3-digit industry.15/ 16/ But we are interested in R&D as a quasi-asset, so we must express both profits and R&D in the same units. Therefore we multiply the R&D sales ratio (of the industry) by the sales/asset ratio (of the firm). This procedure builds in a potential bias, since the book value of assets in an imperfect proxy for the market value of such assets. When two variables are normalized, i.e., divided by, a variable containing a random error, the resulting ratios may be correlated even if the two original variables are uncorrelated.17/ To test for normalization bias, we calculated a) the homogeneity of the dollar amount of profits and of R&D expenditures with respect to assets, and b) the coefficient of variation of assets. The results were acceptable if we removed one firm from the original sample of 49 direct investors, thereby leaving a sample of 48 firms.18/

15/ These ratios were obtained from National Science Foundation, Basic Research, Applied Research, and Development in Industry, 1962, (Washington: U.S. Government Printing Office, 1963), p. 120. While the use of industry averages may cause the results to be suspect, limited tests based on company-level data are shown below, and cause no important changes in the interpretation of the results.

16/ A lag of three years was used because a previous study has suggested such a lag between R&D and peak results in profitability. See F.M. Scherer, "Corporate Inventive Output, Profits, and Growth," Journal of Political Economy 73 (June, 1965), 290-297.

17/ See John R. Meyer and Edwin Kuh, The Investment Decision (Cambridge, Mass.; 1959), pp. 258-267, for an extensive discussion of normalization bias.

18/ Our results were virtually unchanged when the offending firm was added back to the sample.

Inspection of the data suggested that direct investors were concentrated in industries which have high R&D, and tended to be more profitable than firms in the control groups.[19/] Thus, profitability may be associated with either direct investment or R&D, or both. To assess the relative importance of these two factors, we regress profitability on R&D and a dummy variable for direct investment (1 for direct investors, 0 for firms in either control group). Since the control samples were drawn independently, regressions are computed for the direct-investor sample and one control group at a time.

The results (Table 1) show a strong association between R&D and profitability. But the coefficient of the dummy for direct investment is also large, and frequently significant. The latter result may occur because of imperfect measurement of R&D or because of omitted variables associated with both direct investment and profitability. Alternatively, profitability might be higher for foreign than for domestic operations, even if firms equate expected profits at the margin; differences in risk and in demand elasticities are two possible reasons.

In order to resolve the question of whether direct investment as such is associated with profitability, we next use a somewhat different sample. To our basic sample of direct investors, we add 5 firms which has less than ten percent of their operations abroad in 1965, and 9 firms which were not in the Fortune 500. Within this sample, we replaced the

19/ Firms in our control groups were not concentrated in research-intensive industries; out of the 70 control firms and 48 direct investors in our samples, we were able to find only 13 pairs (of one direct investor and one control-group firm) which were in the same 3-digit industry.

Table 1: Profitability of Domestic and International Firms

Dependent Variable	Constant	R&D/Assets	Dummy for Direct Investment	$\bar{R}^2$, N
Control Group 1 and Direct Investors				
Pre-tax π^a, 1960	10.265 (7.618)	1.384 (3.145)	2.199 (1.421)	.143 86
Pre-tax π^a, 1965	10.708 (7.337)	1.148 (2.873)	3.124 (1.844)	.151 86
After-tax π^a, 1960	5.775 (8.397)	.705 (3.140)	1.123 (1.422)	.142 86
After-tax π^a, 1965	6.782 (8.940)	.498 (2.399)	1.496 (1.699)	.113 86
Control Group 2 and Direct Investors				
Pre-tax π^a, 1960	10.677 (8.253)	.991 (2.282)	2.901 (1.857)	.112 88
Pre-tax π^a, 1965	10.260 (8.234)	1.054 (2.789)	3.906 (2.589)	.205 88
After-tax π^a, 1960	5.880 (9.113)	.512 (2.362)	1.566 (2.010)	.126 88
After-tax π^a, 1965	6.379 (9.731)	.470 (2.363)	2.001 (2.521)	.172 88

dummy variable with the proportion (in 1960 or 1965) of gross fixed assets which were located outside the United States. Thus, the focus of our investigation now shifts to the extent of direct investment, rather than a classification of firms as either direct investors or domestic producers. Regressing profitability on the proportion of assets abroad and on the R&D/Assets ratio, we obtained the results shown in Table 2. Here, we find no positive association whatever between profitability and the amount of direct investment.[20/] Thus, once the firm has made the initial venture abroad, increases in the amount of direct investment are no longer associated with higher profitability.

Before drawing conclusions about the relationship between direct investment and profitability, we must consider a possible bias arising from our use of industry-average data on R&D. Since this variable is an imperfect proxy for R&D intensity at the firm level, the coefficients in Table 2 may be biased toward zero.[21/] As a test of the possible magnitude of this bias, we obtained firm-level data on R&D expenditures in 1963 for 33 of the 62 direct investors. For this sub-sample, the mean R&D/Assets ratio was 4.5 percent for firm-level data, and 3.7 percent for industry-average data. We computed regressions similar to those in Table 2, for 1965 profitability of this subsample.[22/] For pre-tax profitability, the

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20/ A negative coefficient would be plausible, since international diversification may reduce the variance of a firm's earnings and thereby improve the well-being of its stockholders. Note that after 1963, the Interest Equalization Tax prevented them from obtaining international diversification directly.

21/ See J. Johnston, Econometric Methods (New York, McGraw-Hill, 1963), Chapter 6.

22/ In this test, R&D expenditures were lagged only two years, rather than three as before, because of data availability. However, fuller data for a handful of firms suggested that the relationship of a firm's R&D/Assets ratio to the ratio for the industry tended to be quite stable over time.

Table 2: Accounting Profitability of Direct Investors

Dependent Variable	Constant	R&D/Assets Ratio	Direct Investment	$\bar{R}^2$
Pre-tax π^a, 1960	11.956 (4.734)	1.857 (3.543)	-.040 (0.531)	.164
Pre-tax π^a. 1965	12.602 (4.843)	1.942 (3.940)	-.056 0.799	.195
After-tax π^a, 1960	6.276 (5.039)	0.964 (3.728)	-.008 (0.214)	.173
After-tax π^a, 1965	7.534 (5.835)	0.943 (3.856)	-.032 (0.901)	.191

Notes: t-values in parentheses. Sample consists of 62 firms, including those with less than 10% abroad and those not in the Fortune 500. Profitability is measured as percentages, not decimals.

coefficients of R&D were 1.970 for firm-level data and 1.940 for industry-average data. For after-tax profitability the respective coefficients were .944 and .984. Since these coefficients are quite similar, we conclude that errors-in-variables bias is offset by the fact that direct investors tend to have higher R&D intensity than do other firms in the same industries. At the same time, there is no reason to expect that our control-group firms have higher R&D than is typical of firms in the same industries; if anything, one would expect the opposite to be the case. Firms are not completely homogeneous, even within a 3-digit industry; just as direct investors are concentrated in industries with high average R&D, so they are also likely to be concentrated in that part of a 3-digit industry which has higher R&D than does the rest of the source industry. Therefore this bias in our industry-average R&D data causes part of the superior profitability of direct investors to be mistakenly attributed to the fact that they are direct investors, rather than to the fact that they do more R&D than is typical for their industries.

However, errors in our industry-average R&D data undoubtedly account for only part of the size of the coefficient of the direct-investment dummy in Table 1.[23/] This dummy variable is a proxy for inter-

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23/ Our test of firm-level R&D data suggests that the R&D coefficients in Table 2 approximate the true effect of a firm's R&D effort on its profitability. The data for this test suggested that firm-level data averaged 0.8 percent higher than industry average data. Let us assume that industry-average R&D data is an unbiased proxy for firm-level data in the control groups. Then the coefficients of the direct-investment dummy in Table 1 should be reduced by 0.8 times the coefficients of the R&D variable in Table 2. With this adjustment, the coefficients of the direct-investment dummy in Table 1 are still positive, though not significant.

national involvement, which involves both exporting and direct investment. The two activities are related by the well-known "product cycle" hypothesis, whereby the results of recent R&D may be entirely exported, while older products may undergo final processing abroad.24/ Foreign sales of the newest products are not reflected in the direct-investment variable, which is based on fixed assets. Yet such products are likely to be marketed through the firm's network of foreign affiliates.25/ Further confirmation of this hypothesis is provided by the fact that in our 33-firm subsample, firm-level R&D has a negative and significant correlation with the proportion of gross fixed assets which are located abroad.26/

Thus, we conclude that internationally-involved firms are able to obtain a higher return from R&D, but that they do so by a combination of exporting and investment.

Our results thus far have been in terms of accounting profits, which only approximate true economic profitability. In particular, R&D is a form of "quasi-investment," undertaken in a given year to produce returns in subsequent years, while accounting practice and tax laws cause firms to treat R&D costs as a current expense. When R&D expenditures grow over time,

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24/ See Raymond Vernon, "International Investment and International Trade in the Product Cycle," Quarterly Journal of Economics 80 (May, 1966), 190-207.

25/ These conclusions are not invalidated by the use of a direct-investment variable which is defined as the ratio of foreign sales to total sales. While non-significant, this variable has an algebraically higher bivariate correlation with R&D, consistent with exporting of new products.

26/ This finding confirms and strengthens Horst's finding that R&D is uncorrelated with direct investment, once firm size and industry are taken into account. In other words, our direct-investor sample had higher R&D because firms in that sample were in different industries than those firms in our control groups.

reported future income is increased at the expense of reported current income. Therefore, we would expect the measured profitability of research-intensive firms to exceed that of firms with little R&D effort, even if the rate of return to R&D did not exceed that on other assets. In steady-state growth of all assets and earnings at the rate g, we can derive "economic" profitability (Π^e) from accounting data (Π^a) as follows.

We define economic profits to be reported profits, plus that part of current R&D expenditures not written off during the current year, less allowance for depreciation of the stock of knowledge. The stock of knowledge consists of all R&D expenditures which have not yet been written off. Economic assets are defined as reported assets plus the stock of knowledge. The ratio of economic profits to economic assets gives the economic rate of profit.

We start by assuming a firm in steady-state growth, with assets, knowledge, and earnings all growing at the rate g. In each year, total R&D expenditures are some fixed proportion r of total assets at the beginning of the year, A_{t-1}. Thus, for the current year, R&D expenditures are rA_{t-1}. However, we have defined accounting profitability as reported profits divided by assets at the end of the year in question.[27] Since $A_t = (1+g)A_{t-1}$, it is convenient to define current R&D expenditures as: as:

$$rA_t/(1+g).$$

[27] This practice was followed merely in order to eliminate the effect of mergers made during the year, and does not affect our substantive conclusions.

Similarly, R&D expenditures i years ago were $1/(1+g)^{i+1}$ times current R&D expenditures.

We next obtain an expression for the stock of knowledge by assuming that the economic value of R&D expenditures depreciates in a declining-balance fashion at the rate d per year. We assume that depreciation occurs during the year in which the expenditures were made, as well as in subsequent years. Therefore the depreciation charged, in a given year, for R&D expenditures made in that year is:

$$drA_t/(1+g).$$

Expenditures made during the previous year were $rA_t/(1+g)^2$, but d times this amount was written off at the end of the preceding year. Therefore this year's depreciation of such expenditures is:

$$d(1-d)rA_t(1+g)^2.$$

Similar expressions hold for the current year's depreciation of expenditures made in earlier years, with the exponents of the terms in parentheses rising as we go back in time. Adding together the expressions for the current depreciation of the present year's expenditures, plus those of n previous years, gives:

$$\frac{d}{1+g}\sum_{i=0}^{n}\frac{(1-d)^i}{(1+g)^i}\,rA_t.$$

Finally, the stock of knowledge at the end of the current year -- after the year's depreciation charges have been deducted -- is:

$$\frac{1-d}{1+g}\sum_{i=0}^{n}\frac{(1-d)^i}{(1-g)^i}\,rA_t.$$

Putting it all together, we obtain an expression for economic profits divided by end-of-year economic assets:

$$\Pi^e = \frac{\Pi^a A_t + \frac{rA_t}{1+g} - \frac{d}{1+g}\sum_{i=0}^{n} \frac{(1-d)^i}{(1+g)^i}\, rA_t}{A_t + \frac{1-d}{1+g}\sum_{i=0}^{n} \frac{(1-d)^i}{(1+g)^i}\, rA_t}.$$

Note that if we assume a depreciation rate of 100 percent for R&D expenditures, this expression simplifies to $\Pi^e = \Pi^a$.28/ For any d, $0 < d \leq 1$, we can take the limit as $n \Rightarrow \infty$ and obtain an expression which simplifies to:

$$\Pi^e = \frac{\Pi^a + \frac{r}{1+g} - \frac{dr}{d+g}}{1 + \frac{(1-d)r}{d+g}}. \qquad \underline{29/}$$

Under existing U.S. tax treatment of R&D, this formula applies to either before-tax or after-tax income. As long as $d < 1.00$, $r > 0$, and $g > 0$, $\Pi^e < \Pi^a$. The difference between Π^e and Π^a is greater (both in absolute and relative terms) in the case of before-tax income. This occurs because the net addition to the stock of knowledge, and the year-end stock, are the same for both before-tax and after-tax income, while the higher before-tax Π^a is divided by a denominator which exceeds unity.

28/ This statement relies on the usual convention that zero raised to the power zero equals unity.

29/ Letting $n \Rightarrow \infty$ requires the assumption of a constant proportion between knowledge and reported assets; otherwise we would have no firms possessing both knowledge and assets. This assumption in turn implies that the ratio of knowledge to assets is equal to $r(1-d)/(g+d)$ at all times, as can be observed from the denominator of this equation.

While we assume a constant proportion, r, between R&D expenditures and reported assets, this formula can be modified to allow for a rise in this proportion; one merely need add a finite number of terms to both numerator and denominator. For example, an increase in r in a given year, with II^e constant, will lower II^a, thereby increasing the difference between II^e and II^a. Since r appears to have increased prior to 1965, 30/ our estimates of the difference between II^a and II^e may be understated.

With this caveat, we now proceed to compute the economic profitability of the typical firm in our sample, i.e., one with R&D activity at the mean of the direct-investor sample, and compare it to a hypothetical firm which has no R&D at all. For the latter firm, $II^e = II^a$. Any such comparison requires assumptions about growth, depreciation rates, and R&D expenditures. For g we use .075, the sample-average growth rate of total assets, 1959-65. 31/ For r we use values ranging between .026 and .040. 32/ We use depreciation rates as low as .08. 33/

30/ See National Science Foundation, Basic Research, and Securities and Exchange Commission, Quarterly Financial Report for Manufacturing Corporations, various issues.

31/ See Martin M. Laurence and Alan K. Severn, "The Relative Growth Performance of American Multinational Manufacturing Firms, 1959-1965," Paper prepared for delivery at the meetings of the American Academy of Management, Boston, Mass., August 20-22, 1973.

32/ These are, respectively, the 1960 sample mean of industry-average data, and our best guess as to the true, firm-level data for 1965.

33/ This would represent a service life of 25 years with double declining balance, or 18.75 years with 150% declining balance -- far longer even than the nominal patent protection of 17 years.

With extreme assumptions (low d, high r), Π^e of our average firm was no more than two percentage points less than Π^a and clearly exceeded Π^e of the hypothetical firm with no R&D. With less extreme value of d and r, the difference between Π^e and Π^a was smaller. We also reduced the R&D coefficient by two standard errors and computed the implied profitability of a firm with no R&D. Again, the economic profitability of the typical, research-intensive, direct investor exceeded the economic profitability of the firm with no R&D.

We conclude that the true return, as well as the measured return, on R&D activity exceeds the return on other assets. Direct investment has no observed impact on profitability, suggesting that firms had invested so as to equalize marginal (and average) rates of return on domestic and foreign investment. At the same time, a firm can spread the cost of R&D over many national markets, by means of direct investment in both marketing and manufacturing affiliates. That is, the availability of foreign as well as domestic investment causes the marginal efficiency of R&D expenditures to be higher than it would be in a closed economy.