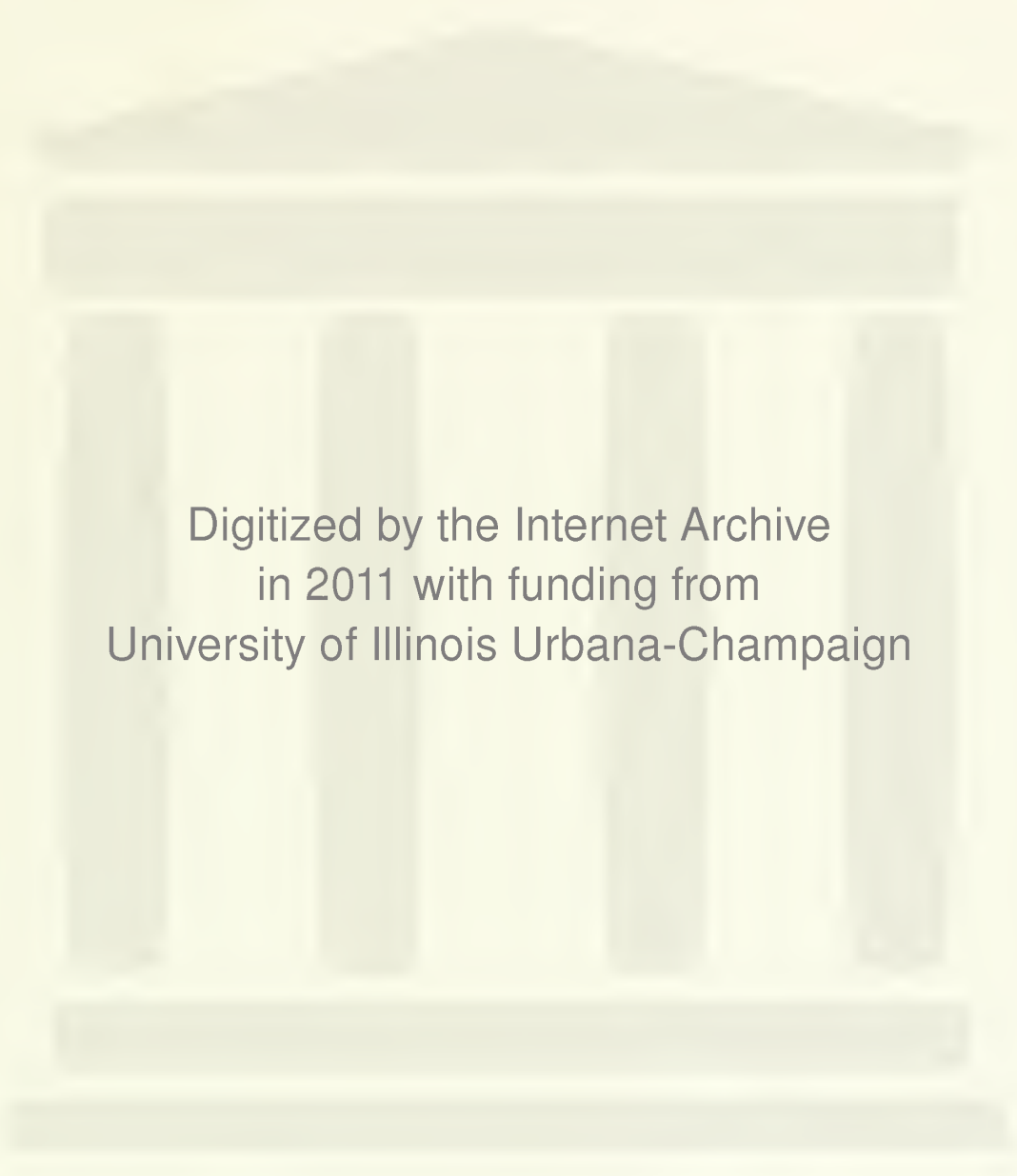


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Factors Affecting Foreign Direct Investment
in the Brazilian Manufacturing Sector: 1955-1980

Geraldo M. Vasconcellos

College of Commerce and Business Administration
Bureau of Economic and Business Research
University of Illinois, Urbana-Champaign

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Geraldo M. Vasconcellos, Visiting Assistant Professor
Department of Finance

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SUMMARY

Factors Affecting Foreign Direct Investment in the Brazilian Manufacturing Sector: 1955-1980

by

Geraldo M. Vasconcellos

This paper attempts to look beyond the current Brazilian foreign debt problems and focuses on some local variables which in the past seemed to have affected the ability of that economy to attract foreign direct investment (FDI). Accordingly, this work examines empirically some macroeconomic factors which influenced foreign direct investment in the Brazilian manufacturing sector in the period 1955-1980, during which most of the industrialization drive in that country took place.

The results suggest that local macroeconomic variables, although far from being the only factor, seemed to have been an important causal factor for the capital investment decisions of U.S.-based corporations. The findings also confirm some results of the previous studies. Some implications are suggested for policies based on tax incentives. Finally, several possibilities for future research are outlined.

Abbreviated Heading: Foreign Direct Investment in Brazil, 1955-1980

FACTORS AFFECTING FOREIGN DIRECT INVESTMENT IN
THE BRAZILIAN MANUFACTURING SECTOR: 1955-1980

INTRODUCTION

This work deals with the following question: is it possible to identify and measure the impact of certain local economic variables on the capacity of Brazil to attract direct foreign investment in manufacturing, at least in the last three decades?

One can think of the question above as inserted in a more general research area, namely, the implications of the growth of multinational firm for the determinants of fixed investment.¹

A number of researchers worked through the problem in a predominantly descriptive fashion. The writings of authors such as Vernon (1977), about the multinational problem in general, and Evans (1979), about the Brazilian case, have increased considerably our understanding of the subject. However, insofar as they bring to the analysis many noneconomic variables (e.g., social and political), a more rigorous approach seems to be difficult.

However, the multinational corporations (MNC's) are likely to employ analytical models in their investment decisions, especially towards the process of establishing and/or expanding affiliates abroad.

Root and Ahmed (1978) presented a different approach. In addition to economic variables, they considered several social, political and policy factors. Because they had many categorical rather than continuous variables, multiple discriminant analysis of the data was used instead of multiple regression.

Given that stream of received knowledge, it seems to be appropriate to focus on a more specific question: to what extent local economic factors have been influencing multinational investment in the Brazilian manufacturing sector, as opposed to local noneconomic variables, home country factors and global strategies of the MNC's?

This empirical work, thus, will be restricted to U.S. based multinationals operating in the Brazilian manufacturing sector in the period 1955-1980. The model specified relates capital expenditures by majority-owned foreign affiliates of U.S. companies to some macroeconomic explanatory variables.

The results present solid evidence with respect to the direction and magnitude of the influence of local economic factors on direct foreign investment in Brazilian manufacturing in the period under study. In addition, some suggestions for future research are presented.

CONCEPTUAL FRAMEWORK

Earlier studies on the subject suggested several possible economic explanatory variables.² It would not be possible to bring all of them to this study; indeed, some of them were fairly similar. The main criteria for reducing the number of explanatory variables were the following: (a) concern about degrees of freedom, e.g., too many independent variables as compared to the sample size; (b) obvious similarity between variables, as suggested by previous studies. In this case, the variable with the most complete data available was selected;

(c) existence and consistency of data, a criterion that proved somewhat hard to meet. The economic model was specified as:

$$\text{CAPEXP}_t = f(\text{GROWTH}, \text{MPROD}, \text{EXIMP}, \text{MANUF}) + e_t \quad (1)$$

where: CAPEXP = capital expenditures by majority-owned affiliates of U.S. companies in the Brazilian manufacturing sector in millions of 1972 U.S. dollars; GROWTH = annual rate of change of real GDP, e.g.,

$$(\text{GDP}_t - \text{GDP}_{t-1}) / \text{GDP}_{t-1}; \quad (2)$$

MPROD = imports/GDP ratio; EXIMP = export/import ratio; MANUF = manufacturing/GDP ratio, e.g., income generated in the manufacturing sector/GDP.

Some prior beliefs existed for the direction of the above relationships. In particular, all the explanatory variables were supposed to be positively related to the dependent variable, with the possible exception of EXIMP. The reason is as follows: a decreasing export/import ratio may be an indication of the development of an import-substitution process, meaning that the structure of imports changes in the direction of capital goods and thus the value of imports increases with respect to that of exports. This process is often related to increasing investment in manufacturing by multinationals.

However, an increasing export/import ratio may be the result of an export-promotion program, a policy that developing countries usually choose to mitigate the problems of Balance of Payments created by the import-substitution process. Because the governments of these countries, and Brazil in particular, frequently rely upon multinationals

for their export-promotion schemes, a positive relationship is expected between the export/import ratio and the dependent variable.

As Brazil experienced both an accelerated import-substitution process and an export-promotion phase during the period concerned, it was difficult to have prior beliefs based on theory and/or received research for the relationship of the export/import ratio to the dependent variable.³

STATISTICAL MODEL

The statistical model specified below, insofar as it uses time-series data (see next section), is liable to have problems of autocorrelation (Judge et al., 1982, p. 289).

In an effort to reduce the potential impact of this problem upon the inferences based on the model, and also due to the belief that capital expenditure decisions should be based on past values of some observable variables, the matrix X of explanatory variables was lagged with respect to the dependent variable (Judge, et al., 1982, p. 434). The following statistical model resulted:

$$\begin{aligned} \text{CAPEXP}_t = & \beta_1 + \beta_2 \text{GROWTH}_{t-1} + \beta_3 \text{GROWTH}_{t-2} + \beta_4 \text{MPROD}_{t-1} \\ & + \beta_5 \text{MPROD}_{t-2} + \beta_6 \text{EXIMP}_{t-1} + \beta_7 \text{EXIMP}_{t-2} \\ & + \beta_8 \text{MANUF}_{t-1} + \beta_9 \text{MANUF}_{t-2} + e_t \end{aligned} \quad (3)$$

and the error process was therefore assumed to be $e \sim N(0, \sigma^2 I_T)$.

The above assumption about the error process is a strong one. As a consequence, tests for autocorrelation are certainly necessary. It

is also assumed that X is nonstochastic matrix of known values and CAPEXP is a vector of capital expenditures measured without error. Those are also fairly strong assumptions; however, testing them is beyond the scope of this paper.

In line with these assumptions, the proposed empirical relationship was estimated by ordinary least squares (OLS).

Finally, there is no a priori reason to believe that a linear relationship is the one that best describes the way the data were generated. The above specification reflects my judgement with respect to the simplest way to specify the model.

THE DATA

The data are composed of annual time series, comprising the period 1957/81 for U.S. data and 1955/80 for Brazilian data.

U.S. nominal data⁴ were transformed to constant values, using 1972 as a base year. An appropriated deflator was employed.⁵

The problems with the Brazilian data were more serious.⁶ The time series of Brazilian data comprises the period 1955/80. For that span of time, actually two series existed: a revised series and a previous one.⁷ The revised series goes back only up to 1965; from 1964 backwards, we are forced to rely on unrevised data.

Therefore, the idea of employing ratios for the independent variables was imposed mainly by the need to avoid those mounting problems with the data. Ratios are dimensionless; there is no reason to suppose that the rate of nominal values of, say, imports to GDP, will

change after the series is revised, unless different factors of correction are employed.

Another advantage of using ratios as explanatory variables is to avoid the complicated and probably arbitrary choice of an exchange rate. In the period under study (1957/81) Brazil adopted different exchange rate policies, e.g., fixed exchange rates, differential exchange rates, and minidevaluations.

All of this must be viewed as a warning signal: whatever conclusion emerges from the estimation and subsequent inference, should be qualified because of the quality of the data used. No conclusion can be better than the data upon which it is based. The problems of accuracy of economic observations in general and national income statistics in particular have been extensively studied.⁸

EMPIRICAL RESULTS

1. The Basic Model

The results for the "basic model," i.e., the model outlined in the sections above, are summarized in Table 1. The number below the corresponding b_i are the values of the t statistics. The degree of explanation is also reported, as well as the value for the Durbin-Watson statistic.

Although the model seems to be fairly successful in explaining the variability of the sample, as measured by adjusted R^2 , actually only the coefficients of the variable $MANUF_{t-2}$ and the constant proved to be significant. These results seem to suggest some important explanatory variables may have been left out the model.

Table 1. Estimated Coefficients for the Basic Model

Variable	Constant	GROWTH _{t-1}	GROWTH _{t-2}	MPROD _{t-1}	MPROD _{t-2}	EXIMP _{t-1}	EXIMP _{t-2}	MANUF _{t-1}	MANUF _{t-2}
Coefficient	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9
Estimated Value	-1097.4	7.99	-3.19	24.79	-2.25	.61	1.69	1.25	44.10
(t-value)	(3.746)	(1.351)	(.535)	(1.818)	(1.575)	(.437)	(1.154)	(.113)	(3.855)

R² Unadjusted .9372 Durbin-Watson Stat. = 1.536

Adjusted .9058

Moreover, the result for the test for autocorrelation is situated in the inconclusive region of the Durbin-Watson test. It is not entirely satisfactory, but at this point we cannot reject the null hypothesis of no serial autocorrelation.

2. An Alternative Model

Since the original specification proved to be unsatisfactory, an alternative model was attempted. For this model, the explanatory variables selected were: $GROWTH_{t-1}$, $MPROD_{t-1}$, $MPROD_{t-2}$, $EXIMP_{t-2}$, and $MANUF_{t-2}$. Thus, the alternative model estimated was:

$$\begin{aligned} CAPEXP_t = & \beta_1 + \beta_2 GROWTH_{t-1} + \beta_3 MPROD_{t-1} + \beta_4 MPROD_{t-2} \\ & + \beta_5 EXIMP_{t-2} + \beta_6 MANUF_{t-2} + \varepsilon_t \end{aligned} \quad (4)$$

Again, the model was specified in linear form mainly for the sake of simplicity. The results for this alternative model are presented in Table 2, for which the same observations made for Table 1 to apply.

As we can see, using the alternative specification we were able to improve the model's performance, as measured by t-values and adjusted R^2 , although only the estimated coefficients b_3 and b_6 , in addition to the constant, proved to be significant.

However, it seemed desirable to try another specification, possibly nonlinear in the variables. But before we proceed in this direction, let us examine the problem of autocorrelation more closely.

As before, the value for the Durbin-Watson statistic is situated in the inconclusive region. An alternative test for autocorrelation

Table 2. Estimated Coefficients for the Alternative Model

Variable	Constant	GROWTH _{t-1}	MPROD _{t-1}	MRPOD _{t-2}	EXIMP _{t-2}	MANUF _{t-2}
Coefficient	β_1	β_2	β_3	β_4	β_5	β_6
Estimated Value	-1054.7	5.91	20.46	-21.09	2.03	45.28
(t-value)	(5.044)	(1.249)	(2.033)	(1.650)	(1.574)	(9.451)
R^2 Unadjusted	.9352	Durbin-Watson		1.3793		
Adjusted	.9181					

was performed, using Box-Jenkins estimates. The test is for first and second order of autocorrelation in the residuals and the results are in Table 3.

In view of the above results, it seems that we can safely accept the hypothesis of no autocorrelation in our model and, as a consequence, the results for the t-values shown before.

3. The Alternative Model With Logarithmic Specification

As explained above, one possible alternative for the estimation of the empirical relationships under study might involve a change in the model's specification.

However, the following is still a linear statistical model, in the sense of being linear in the parameters, but both the dependent and the explanatory variables were put in log form.

Thus, we have

$$\begin{aligned} \text{CAPEXP}_1 = & \beta^1 \cdot \text{GROWTH}_{t-1}^{\beta^2} \cdot \text{MPROD}_{t-1}^{\beta^3} \cdot \text{MPROD}_{t-2}^{\beta^4} \\ & \cdot \text{EXIMP}_{t-2}^{\beta^5} \cdot \text{MANUF}_{t-2}^{\beta^6} \cdot e^t \end{aligned} \quad (5)$$

or, in log form,

$$\text{LY}_t = \beta_1 + \beta_2 \text{LX}_2 + \beta_3 \text{LX}_3 + \beta_4 \text{LX}_4 + \beta_5 \text{LX}_5 + \beta_6 \text{LX}_6 + e^t \quad (6)$$

where LY, LX₂, LX₃, LX₄, LX₅ and LX₆ are the natural logarithms of the variables shown above, to avoid cumbersome notation.

Results for the alternative model in log form are presented in Table 4. Tests for autocorrelations using Box-Jenkins estimates are shown in Table 5.

Table 3. Autocorrelation Coefficients of Residuals for the
Alternative Model
(Box-Jenkins Estimates)

Order	Auto-Correlation	S.E. Random Model
1	.051	.189
2	.008	.185

Table 4. Estimated Coefficients for the Alternative Model in Log Form

Variable	Constant	LX ₂	LX ₃	LX ₄	LX ₅	LX ₆
Coefficient	β_1	β_2	β_3	β_4	β_5	β_6
Estimated Value	-4.792	.111	.0898	-1.204	.463	5.131
(t-value)	(3.736)	(1.113)	(.256)	(2.880)	(.938)	(11.152)

R ²	Unadjusted	.9356	Durbin-Watson	1.4374
	Adjusted	.9186		

Table 5. Autocorrelation Coefficients of Residuals for the
Alternative Model in Log Form
(Box-Jenkins Estimates)

Order	Auto-Correlation	S.E. Random Model
1	.199	.189
2	.098	.185

It can be seen that changing the specification form does not seem to have improved the results significantly. Instead, some mixed results appeared. In particular, the significance of the explanatory variables decreased in general. Also, the results for the test of autocorrelation based on Box-Jenkins estimations show considerable increase in both the estimated first and second-order coefficients.

The main points that emerge from the results are: the model that best describes the phenomenon under study is the alternative model with linear specification, given the impossibility of incorporating more relevant explanatory variables into the analysis. The inferences and implications that follow in the sections below will consider only the alternative model.

SOME INFERENCES

With the limitations of our model in mind, let us examine what we can learn from the estimates.

First, and to make the point very clear, we have a high negative intercept, which is highly significant. The message seems to be clear: we need to incorporate in this model one or more relevant explanatory variables that are expected to have a positive relationship with the dependent variable. Ideally, we would expect the intercept to be non-significantly different from zero.

But we can see this problem from another viewpoint: if we confine ourselves to the use of host country economic variables as explanatory variables, leaving aside important home-country economic variables and an array of noneconomic variables, including global strategies of the

multinational firms, we should expect to find out a significant intercept, in the sense that it represents the combined impact of all the variables outside the model on the dependent variable.

Second, it is possible to derive some insights after a closer look to the model's results. The variable $MANUF_{t-2}$ is the most significant; its estimated coefficient tells us that a 1 percent increase in the Brazilian manufacturing/GDP ratio is related to U.S. \$45 million in capital expenditures by U.S. affiliates, after a two-year lag. This result is not surprising: as industry becomes more and more the leading sector in the economy, new investments are needed to keep market shares and newcomers are attracted. The length of the lag could be discussed, but we will refrain from doing that, because that discussion is beyond the scope of this paper.

The ratio imports/GDP with one and two year lags also makes a good contribution to the model. However, the coefficients of the variables $MPROD_{t-1}$ and $MPROD_{t-2}$ appear with opposite signs; from theory, we would expect both to be positive. This result can be discounted to sample hazards: in particular, we observe that the coefficient of $MANUF_{t-2}$ is nonsignificant. But it is still an unsettling result.

From theory, we would expect to observe a positive relationship because multinational corporations often set up production locally to substitute for previously imported goods. A closer look to recent developments in the Brazilian economy, though, tells us that imports are strongly biased towards capital goods and some raw materials, particularly crude oil. The oil industry in Brazil is a state monopoly and the capital goods industry is carefully "reserved" to local private

capital. Therefore, multinationals cannot exploit new opportunities in those industries. The same argument applies to the computer industry, especially microcomputers.

The export/import ratio with two years lag ($EXIMP_{t-2}$) appears with a positive coefficient. We observed before in the analysis that this variable was negatively correlated with the dependent variable. Also, it seems to be risky to make inferences based on it; perhaps its effects can be better evaluated with more recent data, when the effects of the manufactured exports drive that began in the mid-70's will be felt in the dependent variable.

Finally, we observe with some surprise the low and also nonsignificant estimated coefficient for the rate of change of real GNP ($GROWTH_{t-1}$). One could argue that, because GDP is present in two of the remaining ratios, the impact of this variable is dampened. But the level and the rate of change of the economy's GDP are distinct phenomena and one would expect the rate of change of GDP to have a separate and positive impact on the dependent variable. Perhaps this variable should be better defined in the sense that it should capture the trend of past rates of growth.

METHODOLOGICAL AND ECONOMIC IMPLICATIONS OF THE RESULTS

1. Methodological Implications

When we described the estimation method, we observed some consequences of assuming that the error process has a scalar identity covariance matrix, when that is not the case.

Our chief concern in this paper was in detecting the presence of autocorrelation, a problem that occurs frequently when we have time series data. The model passed the test for autocorrelation; thus, the results and inferences seems to be valid.

As far as the linear form in the variables is concerned, we found no compelling reason, theoretical or otherwise, that indicated it should be different. In particular, a log form was tested, and the results do not qualify it as a good substitute for the linear form.

2. Economic Implications

The main economic implication that emerges from the analysis is that local economic variables, although far from being the only factor, can explain a good deal about capital expenditures by U.S. affiliates in Brazil.

Two of these variables deserve closer attention. First, the manufacturing/GDP ratio seems to have a positive and fairly strong impact. This variable was suggested by Stobaugh (1969), in a study of location theory applied to multinational investment.

Second, the imports/GDP ratio, although with mixed results, also influences considerably the independent variable. Its use as an explanatory variable was suggested by Business International (1970) and Leff and Netto (1966), this latter study dealing with the Brazilian case. In subsequent studies, this variable could be further refined to represent the manufactured imports/GDP ratio.

The positive relationship of this manufacturing/GDP ratio to capital expenditures by multinationals brings about some complex consequences. If the government continues to make use of incentives to

attract direct foreign investment to the manufacturing sector, it is likely that this will imply further investment, according to the model. But this is also likely to raise cries of "excessive" penetration of foreign capital in some sensitive industries. This delicate balance of power among local capital, foreign capital, and the government is described in Evans (1979).

As far as the imports/GDP ratio is concerned, it is likely that the government will continue to try to keep it to a minimum dictated by the needs in capital goods and energy. Thus, if we stick with the model, multinational investment is likely to be reduced, as U.S. affiliates are barred from potentially profitable industries. Political reasons make it very difficult that foreign capital be allowed in the energy industry, in particular the oil industry, at least in the foreseeable future. In the capital goods industry, the political leverage of local capital has been in the past the chief factor influencing the government to maintain the capital goods industry closed to direct foreign investment, unless in the form of joint ventures with local capital. As far as the microcomputer industry is concerned, the frictions with the U.S. government are well known.

SUGGESTIONS FOR FUTURE RESEARCH

1. Redefinition of Variables

Some improvement seems to be possible in the model if we redefine the variable MPROD to represent manufactured imports/GDP. Unfortunately, with the data available such refinement was not possible.

Also, the variable GROWTH could somehow be redefined to represent a trend in past rates of growth and GDP. By such a modification, its

impact on the dependent variable could be better estimated. Both theory and previous research suggest that it does influence the level of direct foreign investment.⁹

2. Inclusion of New Local Economic Variables

Although this suggestion is constrained to the availability and quality of data, some promising variables could be incorporated to the model: rate of profit or return on investment (ROI) of U.S. affiliates operating in the Brazilian manufacturing sector; local credit, represented by the ratio of banking system claims on economy to GDP (unfortunately, the series available of banking series claims in Brazil goes back only to 1970); a variable to capture the international liquidity of the host country; and a variable to capture the effects of existing infrastructure, perhaps the ratio of commerce, transport and communication to GDP. In the Brazilian case, again the series available representing income generated in the various sectors of economic activity goes back only to 1970.

3. Extensions of the Model

a. European and Japanese Direct Investment, Brazilian Case

Another possible direction to further research is to pick up as the dependent variable the level of capital expenditures by affiliates of companies based on EEC countries and Japan, respectively. Such comparative studies could provide an indication of the variability of the parameters according to the origin of direct foreign investment, in the Brazilian case.

b. Investment by U.S. Affiliates, Argentine and Mexican Cases

Finally, still another possible future research is to keep the same dependent and independent variables in the model, but apply it to different Latin American countries.

The cases of Argentina and Mexico appear to be obvious candidates, insofar as those countries, besides Brazil, receive most of direct investment by U.S.-based companies. Such estimates could improve our understanding about how differences in local economic variables affect direct foreign investment.

NOTES

¹An extensive survey of the relevant research in this area is presented by Stevens (1974). Essentially, Stevens concludes that "the growing importance of the multinational firm does not yet compel any changes in the way we now conduct the theoretical or empirical analysis of investment" (Stevens, 1974, p. 77). However, he also suggests some new required research and points out the need for the collection of some new data.

²See Root and Ahmed (1978), p. 83, Table 2. The table includes literature references.

³For an analysis of post-war developments in the Brazilian economy, see Baer (1983), Ch. 4 and 5.

⁴Collected from U.S. Department of Commerce, Survey of Current Business, several issues.

⁵Implicit price deflator, gross private domestic investment, non-residential fixed investment. See Council of Economic Advisors, Economic Report of the President, 1982, Table B-3.

⁶It is no accident that Stevens (1974) pointed out that research about multinational enterprises in developing countries depends on improvements on the quality of host country's data (Stevens, 1974, p. 83).

⁷See Fundacao Getulio Vargas, Conjuntura Economica, Vol. 34, No. 12, Dec. 1980, for an explanation of the revised series.

⁸See Morgenstern (1963), especially Ch. II, III, IX, and XIV.

⁹Among a handful of works that suggest the inclusion of this variable, see Scaperlanda and Mauer (1969).

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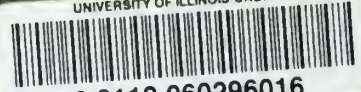
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