Juhl, Paulgeorg

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- Some Cross Section Regression Results -

by

Paulgeorg Juhl

Institut für Weltwirtschaft an der Universität Kiel

Kiel Institute of World Economics
Department IV
2300 Kiel, Düsternbrooker Weg 120

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FIRM SIZE, FACTOR INTENSITIES, PROTECTION AND THE SECTORAL PATTERNS OF WEST GERMAN MANUFACTURING INVESTMENT IN LESS DEVELOPED COUNTRIES

- SOME CROSS SECTION REGRESSION RESULTS -*

It is the purpose of this paper to test the following hypotheses[1] concerning the impact of firm size, factor intensities and protection on the sectoral allocation of West German manufacturing foreign direct investment (FDI) in less developed countries (LDCs):

Hyp.I: The branches' propensity to invest in LDCs is the higher, the higher the average size of firm within the respective branches.

Hyp.II: The higher a branch's human capital intensity, the lower its propensity to invest in LDCs.

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1 Obviously, this approach is confined to supply-determined explanatory variables. It does not consider explicitly the so-called market oriented determinants for the foreign investment decision which - according to a good many analyses - seem to play the dominant role in explaining foreign investment. As to LDCs, for instance trade barriers introduced in connection with import substitution policies often have induced traditional exporters from industrialized countries to build up plants in these LDCs in order either to secure already existing markets or to get access to new markets by local production. Although it can be assumed that the explanatory power of the market oriented determinants is showing certain inter-industry differences, it was unfortunately not possible to consider these determinants explicitly in our empirical analysis because the construction of appropriate indicators (suitable for an international cross section analysis) seemed to be hardly feasible.

Hyp.III: Rising physical capital intensity induces increasing FDI in LDCs.

Hyp.IV: The higher the branches' imported raw material intensity, the lower their propensity to invest in LDCs.

Hyp.V: The higher a branch is protected against competing imports from LDCs, the lower its propensity to relocate production to LDCs.

I. Substantiation of the Hypotheses

Hyp.I: It has been suggested that the process of internationalization of a firm's production requires a set of abilities etc. which is available to larger firms rather than to smaller ones (for detailed discussion cf. Wolf 1977, pp. 178 sq.). Thus, we can hypothesize that there is some sort of a (branch-specific) minimum constraint of size of firm for the establishment of foreign affiliates and, particularly, that - under ceteris paribus conditions - the larger the firm, the more likely (as compared with other firms within the respective branch) it is investing abroad.

Hyp.II: By comparing the competitiveness of West Germany and LDCs as potential locations for human capital intensive production it is obvious - as advanced generally by the neo factor proportion theorem - that Germany's factor endowment as compared with LDCs is offering locational advantages for firms employing production techniques which require large quantities of skilled labor. Though - on the opposite - the fact, that human capital intensive firms are typically characterized by above average innovative and dynamic behaviour, might suggest that such firms are rather prepared to set up locational innovations and to venture into an alien business environment than less human capital intensive firms, it is hypothesized from an a priori point of view that Germany's vis-a-vis LDC's comparative locational advantages

for such firms have on average an higher impact on locational decisions than differences in innovative behaviour do. Thus we will expect that the higher a branch's human capital intensity, the less the firms in this branch will tend to relocate production from Germany to LDCs.

Hyp.III: As far as the relation between a branch's physical capital intensity and its foreign investment position in LDCs is concerned, certain difficulties arise with regard to stating hypotheses. On the one hand the factor proportion theorem suggested that industrialized countries have comparative advantages in (physical) capital intensive production whereas LDCs are more competitive in (unskilled) labor intensive production. Thus, it would be expected that the German branches' propensity to invest in LDCs is negatively correlated with their average physical capital intensity. On the other hand there is some evidence that the semi-developed LDCs' competitiveness in physical capital intensive production has risen since a few years. These countries seem to have become increasingly suitable locations for the production of standardized and mature product cycle goods (physical capital and unskilled labor intensive production). The results of a recent analysis of trade flows between West Germany and LDCs (H. Baumann et al. 1977, p. 89) point to the same way: They tend to indicate a rising explanatory power of physical capital (apart from unskilled labor) intensity for German imports from LDCs. Hence, this might suggest that the branches' propensity to invest in LDCs is positively correlated with the branches' average physical capital intensity - at least insofar as export oriented FDI in semi-developed LDCs is concerned. Whether positive or negative correlationships prevail (or, correspondingly, whether FDI can be explained by the neo factor proportion theorem) probably will depend from the level of development achieved by the most important developing host countries for German FDI. As more than half of the end 1976 stock of total German FDI in LDCs (which is mainly manufacturing, cf. P. Juhl 1977b, p. 177) is located in semi-developed countries like Greece, Portugal, Spain, Israel, Mexico, Argentina and Brazil it might be

meaningful to expect that on the average, the branches propensity to invest in LDCs is positively correlated with their average physical capital intensity[1].

Hyp.IV: Concerning the relation between raw material intensity (imported raw materials only) and FDI again certain difficulties arise with regard to stating hypotheses. Generally, it would be expected that branches with a relatively high content of imported raw materials are likely to have a correspondingly high propensity to invest in LDCs (et vice versa) - pointing to the so-called resource-oriented FDI undertaken in order to secure the firm's resource base by vertical backward integration and to reduce raw material input costs[2]. Moreover, LDCs seem to be increasingly concerned with raw material exports in a way so as to promote rather the export of already processed instead of non-processed raw materials. However, in stating hypotheses some countervailing effects should be considered. First, it has been an increasing issue in LDCs to reserve the raw material sector (production and initial processing stages) for domestic firms, not only because of the now wide-spread rhetorics concerning the 'national control over natural resources' but also because LDCs often are convinced that - as regards technological and managerial know how requirements - they are now in a position to run these parts of their economy by their own. Second, the effects and the structure of West Germany's tariff system should be anticipated: The fact that the duties levied on raw material imports are relatively modest (if there are any duties at all),

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1 It should be noted, however, that this analysis is a static one. A dynamic analysis would have to take into account possible feed--backs between earlier foreign investment inflows and the level of development a country has achieved right now. Such an analysis thus might show that the semi-developed LDCs' comparative competitiveness in physical capital production is a variable strongly reflecting the influences of other determinants not mentioned explicitly.

2 Trade in raw materials is to a great extent intra-firm trade. The residual markets are often oligopolistic with highly instabile prices. - Apart from this, cost reduction policies by foreign investment seem to be particularly important in case of weight-losing products where there are substantial differences in transport cost content between raw materials not yet processed and processed ones.

whereas the effective rate of protection against processed raw material imports is considerable high (J.B. Donges et al. 1973, pp. 27 sqq.) tends to indicate that this system of protection is granting artificial locational advantages for raw material intensive production in West Germany. Additionally, the undervaluation of the DM up to the mid seventies and the DM's continuing upvaluation since the late sixties seem to have favored the processing of imported raw materials in Germany rather than the relocation of these branches to LDCs, particularly in those cases where the production is domestic market oriented. The empirical evidence available seems to suggest that these countervailing effects have been thus far dominant that we can expect that the propensity to relocate production from Germany to LDCs is the lower, the higher the respective branches' raw material intensity.

Hyp. V: Branches the competitiveness of which is dropping, generally will suffer from rising import competition and are thus induced to either relocate production to more competitive locations or to take up product innovation (if economic meaningful reactions are aspired to). Alternatively, if they do not want to do so, they can try to cause their government to grant them import protection, i.e. artificial locational advantages which lower the pressure for economically efficient reactions. If we assume that weak industries are successful in achieving import protection we can thus hypothesize that - at least in the medium run - their propensity to invest abroad is the lower, the higher the effective rate of protection they are favored by (for measurement cf. J.B. Donges et al. 1973).

II. The Test

The sample used to test the above hypothesized relationships concerning the determinants of West German manufacturing FDI consists of 21 branches (Table 1) and includes the following independent variables:

CC_j denotes a branch-specific "size of firm"-indicator measured as the share of employees in firms in branch j with more than 500 employees in total employees (1970)

HCE_{ij} denotes human capital intensity in branch j measured as a capitalized difference between actual yearly wages and wages of unskilled workers per employee

FCE_{ij} denotes physical capital intensity in branch j measured as the value of domestic stock of gross fixed capital per employee.

$MRMI_j$ denotes imported raw material intensity in branch j measured as the value of imported raw materials as share of output (1970)

$EP72_j$ denotes the effective rate of protection of branch j against imports from non-EEC-countries (1972)

The dependent variable is FL_{ij} denoting the stock of West German manufacturing FDI in LDCs.

i = 1971, 1973, 1975

j = 1, ..., 21 branches

The basic data of these variables are given in Table 2.

The statistical method utilized is the multiple stepwise regression. The analysis is confined to simple linear regressions (tests with double-logarithmic regressions brought upon no better results); the functional form of the regression is thus

$$(1) \quad FL_{ij} = b_o + b_1 CC_j + b_2 HCE_{ij} + b_3 FCE_{ij} + b_4 MRMI_j + b_5 EP72_j$$

Although other regressions with modifications of the dependent variables[1] and changes in the sample of industries[2] occasionally yielded statistically significant results, on the whole the results were less satisfactory than (1).

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[1] FL_{ij} was related to the industries' domestic stock of gross fixed capital.

[2] Four branches with extreme data, mainly regarding raw material intensity, (branches 1, 2, 11, 13 in Table 1) were excluded from the sample.

Table 1 : List of Industries in the Sample

1. Chemical industry
2. Mineral oil processing industries
3. Plastics, rubber and asbestos manufacturing
4. Leather and leather manufacturing, footwear industries
5. Sawmills and wood manufacturing
6. Pulp, paper and paperboard, pulp and paper products
7. Printing and related industries
8. Textile industry
9. Stones and earthen goods industries
10. Fine ceramics, glass and glass products industries
11. Iron and steel industry
12. Foundries
13. Non-ferrous metal industries
14. Iron, steel, sheet and metal goods industries, musical instruments, toys and sporting goods industries
15. Mechanical engeneering
16. Electrical engeneering
17. Manufacture of ship and aircraft equipment
18. Road vehicles
19. Structural and light metal engeneering
20. Clothing industry
21. Precision and optical goods, clocks, watches and jewellery industries

Table 2 : Basic Data: Investment Figures and Determinants

No.of industry	FL 71[a]	FL 73[a]	FL 75[a]	CC[c]	HCE 71[b]	HCE 73[b]	HCE 75[b]	FCE 71[b]	FCE 73[b]	FCE 75[b]	MRMI[c]	EP72[d]
1	1384.0	1607.6	2098.0	0.78	82,6956	103,4832	140,6412	112,0388	122,3849	133,2309	1.5507	14,4
2	48.1	334.1	265.8	0.83	102,0447	117,5529	185,7628	350,2793	375,9621	480,0962	23.7858	6,5
3	71.6	81.8	110.0	0.51	40,6738	52,6819	72,9963	40,8443	45,8698	57,3995	0.0092	9,3
4	49.1	68.9	91.2	0.32	34,3438	39,2053	48,3263	24,1405	28,0756	33,7606	0.0107	9,9
5	68.2	139.0	161.5	0.13	33,8335	46,2686	59,4494	39,5603	42,7817	52,0210	1.7361	11,8
6	21.7	29.4	50.0	0.42	39,2717	49,7676	71,4759	68,1937	78,0082	92,0136	0.0513	24,8
7	2.8	2.8	4.5	0.27	46,5134	56,6075	73,0751	43,5000	48,9366	58,7866	0.0000	5,3
8	59.5	84.9	140.0	0.46	28,3740	39,8194	53,7380	49,1900	57,4447	71,0619	0.7716	20,8
9	46.4	47.1	61.5	0.20	38,9962	54,3938	68,0549	88,8089	99,6062	128,0955	0.0433	3,7
10	22.1	31.7	38.1	0.63	40,3418	53,7985	69,0469	40,5931	45,0235	55,8902	0.0113	10,5
11	397.1	440.8	543.4	0.97	58,1617	76,2449	103,0683	103,6907	117,0162	122,6467	4.3364	17,0
12	8.0	20.6	29.9	0.68	45,5248	58,8553	84,6619	48,5430	56,5530	63,8541	0.1563	12,1
13	54.6	64.8	76.8	0.82	43,2209	58,5854	79,7964	76,1006	85,0123	100,6099	3.3041	22,0
14	51.7	67.6	86.1	0.29	34,6333	46,1274	67,4253	33,1736	36,8122	45,0240	0.0112	6,3
15	493.4	550.2	785.7	0.56	55,4641	70,0656	94,5023	36,1603	40,9987	45,7883	0.0029	2,5
16	691.9	842.1	1099.5	0.77	48,9374	64,4283	95,2832	31,9227	35,2162	42,4560	0.0269	4,5
17	4.2	4.9	6.1	0.85	76,3737	97,1019	131,8252	42,7759	48,6094	51,0315	0.0000	(-5,5)
18	850.0	944.2	1119.6	0.71	65,4559	88,4525	117,0092	62,6185	70,2796	82,9875	0.0101	5,8
19	7.3	8.1	14.3	0.30	59,4350	77,6749	98,9995	25,0377	27,5721	32,0418	0.0000	1,4
20	7.5	10.2	14.0	0.46	11,7422	19,4198	25,4093	15,2610	16,5721	20,8082	1.2517	20,7
21	48.5	97.5	58.0	0.47	37,1837	52,5990	80,1743	26,6296	29,6308	32,7434	0.0000	4,5

[a]Mio. DM. - [b]1000 DM. - [c]Ratio. - [d]Per Cent.

Source: See Appendix.

A further refinement of the regression function (1) was, however, carried out in light of certain statistical and theoretical reasons:

- The regressions results of (1) exhibited that CC_j and HCE_{ij} have very similar effects on the variable to be explained, and the analysis of partial correlation coefficients shows a strong positive interrelationship between these variables. Thus it seemed advisable to combine both variables by multiplication in order to avoid multicollinearity problems.

- It was hypothesized that with rising size of the firm, human capital will be used increasingly efficient by rising intra-firm specialization of employees. Over the relevant range it was assumed that this relationship was exponential.

Thus the following functional form resulted:

$$(2)\quad FL_{ij} = b_o + b_1 EX_{ij} + b_2 FCE_{ij} + b_3 MRMI_j + b_4 EP72_j$$

$$\text{with } (3)\quad EX_{ij} = CC_j \cdot HCE_{ij}^2.$$

The results of regression (2) (Table 3) are statistically more reliable than the results of regression (1).

Table 3 - Determinants of Sectoral Allocation of FI.

		CONST	EX_i	MRMI	EP72	FCE_i	$\bar{R}^2$	F
	Coefficient	89.0487	0.0659					
FDI 71	t-Statistics		1.8644**				.1102	3.476
	β-Weight		.3933					
		7.3533	.1646	-55.4166				
			3.7107******	2.9935*****			.3729	6.947****
			.9821	- .7923				
		-143.0373	.1888	-63.3938	12.1593			
			4.0577******	3.3523*****	1.4025*		.4049	5.536****
			1.1260	- .9063	.2605			
		-214.2105	.1650	-92.0464	10.5781	2.7904		
			2.9826*****	2.2946**	1.1798	0.8124	.3927	4.234****
			.9845	- 1.3160	.2266	.5420		
FDI 73		50.1807	.0722					
			2.8247****				.2587	7.979****
			.5438					
		- 7.2427	.1161	-39.9699				
			3.7160*****	2.1286**			.3749	6.997****
			.8742	- .5008				
		-144.9836	.1285	-45.3589	11.1875			
			3.9050*****	2.3573***	1.1269		.3841	5.158****
			.9678	- .5683	.2100			
		-217.5950	.1144	-74.4182	9.6080	2.5168		
			2.9419*****	1.6398*	.9311	.7092	.3656	3.881****
			.8615	- .9323	.1804	.4592		
FDI 75		141.2231	.0321					
			1.9779**				.1271	3.912
			.4132					
		7.8029	.0802	-82.0002				
			3.6053*****	2.7763****			.3549	6.501****
			1.0340	- .7963				
		-222.2108	.0928	-95.7906	18.3056			
			3.9587*****	3.1521*****	1.4068*		.3881	5.229****
			1.1965	- .9302	.2663			
		-311.7511	.0868	-129.4836	17.2718	2.2605		
			3.3773*****	2.0998**	1.2938	0.6317	.3657	3.883****
			1.1189	- 1.2573	.2513	.4065		

The level of significance is indicated as follows:
* = significant at the 10 p.c.-level.
** = " " " 5 p.c.-level.
*** = " " " 2,5 p.c.-level.
**** = " " " 1 p.c.-level.
***** = " " " 0,5 p.c.-level.
****** = " " " 0,05 p.c.-level.

For F-Statistics, only the 1 p.c.- and the 5 p.c.-level are indicated.

Source: Own calculations.

III. The Findings

Taking into account the statistical problems immanent in the data as well as in the measurement, the results of regression (2) are reasonably satisfactory: The independent variables are explaining about 40 p.c. of FL_{ij}'s variations, the regressions are in all but two cases significant at 1 p.c., and in the majority of the regressions all single variables are significant at least at 10 p.c., often even at the 1 p.c.-level. The hypotheses, however, are only partially supported by the regression results. The findings in detail:

Hyp. I and II: Firm size and human capital intensity which are - as mentioned supra - strongly positively intercorrelated, are the most important variables in explaining the sectoral allocation of FL_i. Thereby, as suggested by test runs of equation (1), human capital intensity seems to be the dominant factor. However, whereas a major role of size of firm in positively explaining the sectoral allocation of FL_i was expected (as substantiated earlier), there was virtually no macro-economic theoretical basis to expect human capital intensity being positively (moreover strongly) correlated with the sectoral allocation of West German manufacturing FDI, particularly in LDCs. Just the opposite, the theory is suggesting a negative rather than a positive correlationship.

The striking additional positive explanatory power of human capital intensity (which is independent from influences of size of firm on human capital intensity) might be explained as follows: Human capital intensive branches can be expected to have a relatively high degree of innovativeness, also playing a pioneer role in FDI. By investing in LDCs they probably relocate the production of mature and standardized products (corresponding to the product and investment cycle theory), i.e. physical capital (and perhaps unskilled labor) intensive production processes, whereas their production in Germany remains to be human capital intensive (cf. P. Juhl 1977a, p.8). It is particularly interesting, that very similar results were gained by analyzing U.S. multinationals.

Concerning size of firm Th. Horst 1972 (p. 261) concluded "that once inter-industry differences are washed out, the only influence of any separate significance is size of firm", and more generally, but less clearly it was advanced by R. Vernon 1971 (pp. 11 sq.) that not the labor intensive and weak industries are the leading ones in international spread but those which are human capital intensive, research oriented, highly profitable, and leading in average firm size and concentration (cf. also G.K. Helleiner 1977, p. 110).

Hyp.III: Concerning physical capital intensity no conclusions can be drawn at all due to the insufficient level of statistical reliability of the respective results: In any case, physical capital intensity is (a) entering the regression as last variable, (b) not significant, and (c) worsening the regressions' $\bar{R}^2$ as well as F-value. The result partially may reflect the theoretical difficulties which arose in substantiating the hypothesis as well as the problem of not being able to discriminate between semi-developed and underdeveloped countries within the empirical analysis.

Hyp.IV: In all cases, imported raw material intensity is negatively, in most cases even highly significantly correlated with the branches' foreign investment position. This result seems to indicate that resource orientation is not an important motive for German manufacturing FDI in LDCs - an observation which is supported by numerous panels (cf. H. Baumann et al. 1977, pp. 181 sqq., R. Jungnickel et al. 1976, passim).

As mentioned earlier this result was expected as being mainly caused by the sectoral structure of Germany's effective protection and the undervaluation of the DM up to the mid seventies. Hence, the result might be explained by suggesting that it often seemed to be more profitable to import raw materials and to process them - even in the initial stages - in Germany instead of processing the raw materials in the countries they come from and then exporting the semi-processed products to Germany. This is all the more striking as even products in these stages should be qualified as Ricardo goods (S. Hirsch 1974, p. 66; J.B. Donges and J. Riedel 1977, p. 72).

Hyp.V: This hypothesis could not be confirmed by the empirical analysis. Just the opposite, the rate of effective protection and the branches' foreign investment position in LDCs are positively, occasionally significantly (at the 10 p.c.-level) connected.

A hypothetical explanation might focus on two aspects: (a) The protection granted to weak industries is not high enough so as to abolish import competition and (b) weak industries are, therefore, despite their protection under the pressure to relocate production to LDCs; thereby, the rate of effective protection serves as an indicator measuring the branches' comparative locational disadvantage in Germany, simultaneously signaling the branches' relative relocation requirements. As to (a) a rank correlation between the LDCs' market share in 26 branches (1974) and these branches' rate of effective protection against imports from non-EEC-countries (1972) yielded a significantly positive correlationship (r_s = .33, significant at 5 p.c.) pointing to the fact that the artificial locational advantages created by import protection were virtually not high enough to serve as an effective means against competing imports from LDCs (cf. also U. Hiemenz and K.-W. Schatz 1976, p. 45). With regard to (b) similar explanations were advanced by G. Fels (1972, p. 98) who - in analyzing West Germany's trade patterns - concluded that the effective protective rate "can be interpreted as an indicator representing comparative disadvantages". Thus, the unexpected positive relationship between the protection the respective branches are enjoying and their foreign investment position in LDCs might in fact be explained as suggested: That the German protection does not shelter effectively weak industries from import competition and that these branches, in order to evade that competition, already have started relocating production from Germany to more competitive locations in LDC, i.e. they themselves are not convinced that in the long run import protection can make relocation unnecessary.

IV. Results

Generally, this analysis has raised further questions rather than to answer those we have started with. On the one hand it has been shown that the sectoral allocation of West German foreign manufacturing investment in LDCs is almost always very significantly positively connected with the branches' average size of firm and human capital intensity and negatively with their imported raw materials intensity; furthermore it has been demonstrated that physical capital intensity cannot explain anything much, and that the branches' effective protection seems to indicate the locational weakness of the respective branches and thus the comparative relocation pressure they are subject to rather than to really grant effective and sustainable artificial locational advantages. On the other hand, the discussion has shown that each of the variables is influenced by sets of sub-variables the effects of which presumably are partially countervailing and partially additive; thus it seems advisable for forthcoming research to decompose the aggregated effects into their components. Particularly in case of human capital intensity, a detailed analysis of the interaction between supply and demand determinants of sectoral differences in foreign investment might be of special interest.

APPENDIX: Data sources for the variables

CC_j is computed from Statistisches Bundesamt, Fachserie C, "Unternehmen und Arbeitsstätten; Arbeitsstättenzählung vom 27. Mai 1970", H. 6, Stuttgart-Mainz 1972.

HCE_{ij} and FCE_{ij} are computed from Rolf Krengel et al., Produktionsvolumen und -potential, var. iss., and Statistisches Bundesamt, Fachserie M "Preise, Löhne, Wirtschaftsrechnungen", Reihe 15, Arbeitnehmerverdienste in Industrie und Handel, var. iss.

$MRMI_j$ is calculated from H. Mai (1974).

FL_{ij} is calculated from Bundesministerium für Wirtschaft, Runderlaß Außenwirtschaft betreffend IV 1: Vermögensanlagen Gebietsansässiger in fremden Wirtschaftsgebieten, "Bundesanzeiger", var. iss.

$EP72_j$ is calculated from J.B. Donges et al. 1973, p. 26.

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