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A Test of the Conventional Wisdom
by
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1973-09-20

STRUCTURAL DETERMINANTS OF SWEDISH FOREIGN TRADE:

A Test of the Conventional Wisdom

by

Bo Carlsson and Lennart Ohlsson^{x)}

It is a commonly held view among international trade economists that Sweden's main comparative advantage in foreign trade in manufactures lies in the relative abundance of skilled labor and capital. Several studies indicate this (Keesing (1965) and (1968) and Hufbauer (1970). However, these studies are based on the assumption that U.S. factor intensities are representative also of other industrial countries. Their conclusions regarding Sweden are consequently subject to doubt.

In addition, the conventional wisdom among trade economists holds that the Swedish trade pattern in industrial goods is heavily dependent on certain domestic raw materials, namely iron ore and wooden raw materials. However, this hypothesis has never been tested for Sweden.

One object of this paper, therefore, is to test the hypotheses that have been put forward in the international trade literature on Swedish data. The structure of Swedish foreign trade is represented here by two measures of international competitiveness, namely the export/output ratio and the net exports/consumption ratio. The purpose is to investigate through regression analysis what structural determinants on the production side might explain the Swedish trade pattern; the purpose is not to analyze net flows of factors of production through trade. The data are taken from the most recent comprehensive input-output table for Sweden (Höglund and Werin (1964 a,b)).

x) The authors are research economists at the Industrial Institute for Economic and Social Research, Stockholm, Sweden. Most of the work on this paper was carried out while the authors were graduate student and research associate, respectively, at Stanford University. We would like to thank John Hause, Donald B Keesing, Nicholas Owen, and Tibor Scitovsky, as well as the participants in seminars at Stanford and the Institute for valuable comments on earlier versions of this paper. Most of the data processing was paid for by the Department of Economics at Stanford, and this we gratefully acknowledge.

Another object of this study is of a more methodological nature. Most empirical studies of foreign trade are concerned only with exports from the last link in the production chain, the exporting industry. But if the supply of raw materials is thought to play a crucial role in determining the trade pattern in manufactures, it is interesting to investigate whether the structural determinants of foreign trade remain the same when account is taken also of backward linkages in the production chain. By regarding the economy as made up alternatively of a number of separate activities (i.e., considering only direct input requirements) or of integrated processes (i.e., taking account of both direct and indirect inputs) it is possible to throw light upon the interrelationships of inputs of natural resources, labor and capital and to show some significant differences in the importance of these inputs when one looks at separate activities as opposed to when chains of processes are the units of observation. It will be shown that in the former case, inputs of forest products, skilled labor and capital are important determinants of the Swedish export structure. In the integrated case, inputs of forestry raw materials, skilled labor, and iron raw materials turn out to be the most important, while the capital intensity seems distinctly less important.

Section I below describes the methodology. The regression results are presented in section II, and section III provides a summary and interpretation of the results.

I. Methodology

Generally speaking, our methodology can be described as one in which certain indexes of Swedish competitive performance are related to a number of determining factors, mostly from the production side, but in which some consideration has been given to the influence of the demand side in choosing the indexes. Among the possibilities at hand we have chosen to represent the international competitiveness of various

sectors by two alternative indexes, namely the export/output ratio (X/Q) and the net exports/consumption ratio $(X-M)/C$ ¹⁾. Deflating exports and net exports by output and consumption, respectively, normalizes differences in market size among sectors²⁾.

These two indexes of international competitiveness are the dependent variables in the regressions. The independent variables include the three classical factors of production, namely capital, labor, and raw materials (land). All variables (including the dependent ones) are computed from the input-output table. The capital variable in this table has been obtained residually after the services of the other production factors have been subtracted from value added. The capital measure is thus expressed in terms of a flow, not a stock, and includes real capital services, interest, profits, etc.^{2a)} Since the raw material producing sectors are treated separately in the input-output table, land rent in these sectors would enter into the capital measure. But since these sectors are excluded in the present study, land rents should not influence the capital measure used.

1) Perhaps a more desirable index would have been the Swedish share of total world exports for each industry. But to obtain this variable according to the industry definitions used here would have been practically impossible. Another index which was tried but not reported here is the imports/consumption ratio.

2) Although it is usually assumed in international trade theory that commodities are homogeneous, it is impossible in practice to obtain commodity groups meeting this requirement. This is one of the reasons why both imports and exports take place within the same commodity group. But it must be assumed that homogeneity with respect to production technology as well as product characteristics is greater within the given commodity groups than between them; otherwise the factor proportions theory is not applicable. Given this assumption, the advantage of the index $(X-M)/C$ over X/Q is that the differences among sectors in the degree of international tradability are partly eliminated due to the fact that this factor influences X and M in the same direction.

Baldwin (1971) also used net exports as a measure of export performance but did not normalize for differences in market size.

2a) In the absence of perfect competition, successful export industries might be thought to have high profits and would therefore be observed to be capital intensive. On the other hand, it can also be argued that in small countries profits ought to be higher in non-competing industries than in those exposed to foreign competition. Results similar to ours have been obtained with other capital variables which are not subject to this criticism. See e.g. Gary C Hufbauer (1970), Tables 2-4, and Keesing (1965).

Two labor variables are included in the regressions, namely technical personnel and foremen (L_E) and production workers (L_W). Both are expressed in physical terms. Further disaggregation of labor into skill categories would perhaps have been desirable and was tried, although unsuccessfully³⁾. Unfortunately, the input-output table does not permit disaggregation of labor into more meaningful categories for the analysis of trade patterns. For this purpose, judging from the results of Keesing (1965) and (1968) and others, it would have been desirable to have data on at least research and development personnel, engineers and technicians, skilled workers and unskilled workers. The data employed have aggregate the former two into L_E and the latter two into L_W .

Three kinds of natural resource inputs are included in the regressions, although a few more were tried unsuccessfully. Following Vanek (1963), natural resource inputs were computed as the outputs of the natural resource producing sectors in the input-output table. Based on both a priori judgment and early regression results, the three selected variables are inputs from the timber and wood, iron ore and other ores industries. Since Sweden has large domestic supplies of the former two but not of the latter, these are expected to influence the Swedish trade pattern in opposite directions. A similar variable included in the regressions in input of non-competing imports which are expected to influence exports

3) The input-output table distinguishes between male and female workers and also gives data for office personnel and other administrative personnel. All of these variables (although not all at the same time in order to avoid perfect collinearity with the constant term) were tried in various regressions but without interpretable results. The sum of office personnel, other administrative personnel, technical personnel and foremen and production workers equals L , the total number of employees.

negatively. Finally, the nominal and effective tariffs in each sector are among the explanatory variables.⁴⁾ The reason for including tariffs is that they may affect the tradability of the goods involved.

All of the explanatory variables, except the tariffs, are deflated by L, the total number of employees in each sector. For each variable except the tariffs, two sets of figures were used, one representing direct input requirements, the other representing total (direct + indirect) requirements. In accordance with the theory of effective protection, the effective tariff was used in conjunction with direct inputs and the nominal tariff in conjunction with total inputs.

II. Regression results

The main regression results, presented in Table 1, show three sets of regressions, each with 104 observations⁵⁾. The independent variables in regressions 1 and 2 represent direct inputs, whereas in regressions

4) In calculating effective tariffs, non-tradable goods were treated as inputs into the production process rather than as value added.

5) The production system in the input-output table consists of 127 sectors. Of these, the raw material producing sectors (1-5) and the service sectors (117-127) had to be excluded due to lack of labor data divided into the desired skill categories. In addition, the non-tradable goods sectors (19, 24, 59-63) were excluded.

In addition to linear regression, the log-linear form was tried but without any substantial differences in results.

4 and 5 they represent total inputs. Regression 3 uses direct inputs, but here the dependent variable is the ratio of total (direct + indirect) exports to output. If regressions 4 and 5 may be said to take account of all "backward linkages" between foreign trade and the producing sectors, regression 3 may be interpreted as taking account of all "forward linkages" from the producing sectors to those which finally export the goods.

Most of the regression coefficients are significant at the 0.05 level or higher, and all the F-values are very highly significant. As expected, the coefficients for capital, labor and natural resources are mostly positive, while the coefficients for non-competing imports and tariffs are negative throughout⁶⁾. Looking first at the coefficients for each variable, the following observations may be made:

1. The coefficient for capital (K/L) is significantly positive if direct inputs are used but insignificant with negative sign if total inputs are used. This may be explained as follows. The total capital input variable has higher positive correlation coefficients with all dependent variables than does the direct capital input variable. But at the same time total capital has considerably higher positive correlation coefficients with its respective natural resource variables than does direct capital.^{6b)} An analysis of the regression coefficients for total capital at each step of regression 4 shows that although initially the

⁶⁾ In one set of regressions, one extreme observation was eliminated, namely "Gas lamps and cooking apparatus for liquid fuel" (associated with the world-famous brand names Primus and Optimus), an industry whose output is the smallest in the sample and whose residuals are greater than three times the standard error of estimate in all the regressions presented in Table 1 except (3), even though it is not an extreme observation with respect to any of the independent variables. Eliminating this observation led to substantially higher R^2 's (0.3505, 0.4755, 0.4413, 0.5156 and 0.6926, respectively) for all the regressions than in Table 1 but with no significant changes in the coefficients. This result indicates that there are some important explanatory variables left out of the analysis.

^{6b)} If land rents did enter into the capital measure used, the correlation coefficient ought to be higher between direct capital inputs and natural resources than between total requirements of the same inputs.

coefficient would have been positive if the variable had entered the regression, it becomes negative after NR_W , L_E and NR_I have entered. In other words, we are observing here a certain amount of multicollinearity between the capital, natural resource, and labor variables. The conclusion, at least in conjunction with the observations below, seems to be that the capital variable should be seen primarily as a complement to the natural resource variables with which it has stronger positive correlation than with L_E . We interpret this to mean that Sweden has (or at least has had) comparative advantage in certain natural resource and skilled labor intensive products which also happen to require large capital inputs.

2. The coefficients for skilled labor (L_E/L) are highly significant and positive if the dependent variable is either X_d/Q or X_t/Q , but they are distinctly less or not at all significant if the dependent variable is $(X_d-M)/C$. Whereas the correlation coefficients between direct skilled labor inputs and X_d/Q and X_t/Q are 0.21 and 0.22, respectively, compared to 0.34 and 0.33 between total skilled labor and the same dependent variables, the correlation coefficients between direct and total skilled labor on one hand and $(X_d-M)/C$ on the other are almost zero and slightly negative: -0.05 and -0.06, respectively. In other words, the sectors where Sweden has large net exports tend not to be very skilled labor intensive, even though exports in general are relatively skill intensive.

Apparently both exports and imports are skill intensive in Sweden ⁷⁾.

This may have something to do with international tradability: commodities requiring relatively large inputs of skilled labor may be inherently more tradable than other commodities. Engineering products are cases in point. Also, even though Sweden has a relatively abundant supply of skilled labor in international comparisons, the small absolute supply requires a more narrow specialization on only certain skilled labor intensive goods than otherwise would have been the case.

3. As in the case of skilled labor, the regression coefficients of inputs of workers tend to be more highly significant if the dependent variable is the export ratio than if it is the net export ratio, although here the coefficients are positive throughout. The correlation coefficients are weakly negative with capital and somewhat positive (up to 0.18) with natural resources in both the direct and the total input cases. The consequences of the failure of our labor variable to distinguish between skilled and unskilled workers become especially apparent here. The positive coefficients of L_W/L are probably due primarily to the large share of skilled workers (in the iron and steel and engineering industries) in the total number of workers as well as to the high export ratios of the forest-based industries which use relatively unskilled workers. The results obtained by Keesing in both (1965) and (1968) indicating that Sweden has comparative advantage in skilled workers as opposed to unskilled are

7) This is confirmed by the result obtained by Keesing [(1965), p. 291] that Sweden has a high skill content of both imports and exports. However, judging from the results of both Keesing (1968) and Ohlsson (1971), it does not appear that either exports or imports are especially intensive in research and development personnel. If such a category could have been singled out, it probably would not have received a significant coefficient, while the remaining skilled labor categories would probably have received a more strongly positive coefficient in runs (1), (3) and (4), mainly because of the importance of relatively skill intensive engineering products in Sweden's trade structure.

neither confirmed nor disconfirmed by the present results. But it is the authors' belief that Keesing's results with respect to Sweden are essentially correct and that the inputs of skilled workers are determined historically by the availability of iron raw materials and certain technical innovations made in Sweden in the late 19th and early 20th centuries.

4. The input of forestry products turns out to be the strongest explanatory variable in the regressions in the sense that it entered first in all but one of the regressions and received a highly significant positive sign throughout, as expected. The influence of this variable seems to be even more important if the total input requirements are considered rather than direct inputs.

5. The input of iron raw materials receives highly significant positive coefficients if total inputs are considered but very insignificant coefficients with fluctuating sign if direct requirements are used. This indicates that the Swedish export structure is still fundamentally dependent upon certain raw materials, namely forest products and iron, although the exporting sectors may be far removed in the chain of production processes from the natural resource base. This latter remark is more relevant to iron-based than to forest-based industries: the engineering industry is less dependent on direct natural resource inputs than the paper industry.

6. The input of other ores enters into only two of the regressions. In contrast to all other variables, it was not forced into the regressions⁸⁾. The sign is insignificantly negative if net exports is the dependent variable and positive at the 0.10 level of significance if X_t/Q is the dependent variable. The relative insignificance of this variable is not surprising, since Sweden is not particularly well endowed with non-ferrous ores. The variable was included in the regressions primarily on the supposition that there might be a strong relationship with iron inputs via alloys. The results do not indicate that this is the case - if anything, the contrary. The partial correlation coefficients between NR_I/L and NR_O/L are 0.06 and -0.02 for direct and total inputs, respectively. This variable does not seem to be an important determinant of the Swedish export structure.

7. As expected, the coefficients for non-competing imports of raw materials are negative everywhere although significant only if direct inputs are considered.

8. The coefficients for the effective and nominal tariffs are insignificant and negative throughout. But their significance is somewhat greater when total than when direct inputs are used. This lends some, though admittedly weak, support to the hypothesis of effective protection theory that tariffs have a distorting effect on production. But a problem which cannot be analyzed here is the direction of causation.

⁸⁾ The variables which would not have entered into the regressions, had they not been forced, are: the effective tariff in regression (1); L_E/L , NR_I/L and the effective tariff in (2); and NCM/L in regression (4).

III. Summary and interpretation of results

If only direct inputs are taken into account, the competitiveness of Swedish exports seems to be determined by (a) the availability of forest products in combination with (b) high capital intensity and (c) large inputs of technical know-how. These results confirm the conventional wisdom. Looking at integrated processes (i.e., taking account of both direct and indirect inputs) instead, the availability of natural resources in the form of both forest products and iron and the supply of technical personnel seem to be the main determinants of Swedish export competitiveness. However, the capital intensity is of little consequence in the integrated analysis, probably due to collinearity with the natural resource variables. This is interpreted as support for the notion that the ultimately exogenous variables, natural resources, determine the need for capital inputs. This differs from the conventional view that capital intensity in itself constitutes a competitive factor.

Comparing the R^2 's of the regressions, the regressions using total inputs have higher explanatory values than those using only direct inputs. Also, the regression using the total exports/output ratio as the dependent variable has higher R^2 than the corresponding regression using only direct exports. The natural resource, skilled labor, and capital intensities therefore seem to explain more of the Swedish export structure if forward and backward linkages in the production system are taken into account than if they are not.

The results are largely the same whether the dependent variable is the exports or net exports ratio, although the explanatory value is higher for the latter and the skilled labor intensity is weaker, probably due to both a narrow Swedish specialization in certain technically advanced commodities and a greater international tradability in such commodities than in others.

TABLE 1 STRUCTURAL DETERMINANTS OF SWEDISH FOREIGN TRADE. REGRESSION RESULTS

Regr. No.	Dependent Variable	Constant	K/L	L_E/L	L_W/L	NR_W/L	NR_I/L	NR_O/L	NCM/L	Tariff	R ²	F-value Degrees of Freedom
Direct Requirements												
1	X_d/Q	-0.460	0.005*	1.206*	0.684*	0.000*	-0.000		-0.002*	-0.001	0.3333	6.857
			(2.294)	(3.771)	(3.961)	(3.328)	(0.727)		(1.922)	(0.462)		(7;96)
			4	2	3	1	6		5	7		
2	$(X_d-M)/C$	-0.731	0.027*	-0.078	0.796*	0.000*	-0.000	-0.000	-0.006*	-0.001	0.3945	7.738
			(4.987)	(0.095)	(1.829)	(4.562)	(0.000)	(1.146)	(1.929)	(0.190)		(8;95)
			2	5	3	1	7	8	4	6		
3	X_t/Q	-53.680	0.585*	144.739*	85.034*	0.001*	0.000	0.003**	-0.214*	-0.124	0.4301	8.961
			(2.541)	(4.250)	(4.640)	(3.581)	(0.885)	(1.600)	(1.784)	(1.054)		(8;95)
			4	2	3	1	7	8	5	6		
Total Requirements												
4	X_d/Q	-0.322	-0.003	2.198*	0.429*	0.019*	0.009*		-0.002	-0.002	0.4829	12.808
			(0.834)	(6.313)	(2.262)	(5.318)	(3.267)		(0.749)	(1.078)		(7;96)
			7	2	4	1	3		5	6		
5	$(X_d-M)/C$	-0.465	-0.003	1.295**	0.531	0.057*	0.037*		-0.002	-0.006	0.5812	19.032
			(0.420)	(1.573)	(1.184)	(6.614)	(5.951)		(0.414)	(1.205)		(7;96)
			6	4	5	2	1		7	3		

Notes: Numbers in parentheses are t-values. * indicates coefficient significant at 0.05 level or higher; ** indicates significance at 0.10 level or higher. Numbers below t-values indicate order of entry in stepwise regression. 104 observations in all regressions.

Legend:

X_d = Direct exports, f.o.b., from a certain sector
 X_t = Direct + indirect exports, f.o.b., from a certain sector
 Q = Gross output at ab-sector prices
 M = Imports, c.i.f., competing with the output of a certain sector

Tariff = Effective tariff in regr. 1, 2, and 3 and nominal tariff in regr. 4 and 5.

C = Total consumption, i.e. $Q-X+M$
 K = Real capital, services in million Skr.
 L = Total labor in thousands
 L_E = No. of technicians and foremen in thousands
 L_W = No. of workers, thousands

NR_W = Domestic forest raw materials, M.Skr.
 NR_I = Domestic iron raw materials, M.Skr.
 NR_O = Dom. non-ferrous ores, M.Skr.
 NCM = Non-competing imports of raw materials, M.Skr.
 Skr. = Swedish kronor

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List of Symbols

X_d = direct exports, f.o.b., from a certain sector

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C = total consumption, i.e. $Q-X+M$

K = real capital services in million Swedish kronor

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NR_W = domestic forest raw materials, million Swedish kronor

NR_I = domestic iron raw materials, million Swedish kronor

NR_Q = domestic non-ferrous ores, million Swedish kronor

NCM = non-competing imports of raw materials, million Swedish kronor

Skr = Swedish kronor

CORRELATION MATRIX

	X_d/Q	$(X_d-M)/C$	X_t/Q	K/L DIR	$L_E/L D$	$L_W/L D$	$NR_W/L D$	$NR_I/L D$	$NR_O/K D$	NCM/L D
	1	2	3	4	5	6	7	8	9	10
1 X_d/Q	1.000									
2 $(X_d-M)/C$	0.693	1.000								
3 X_t/Q	0.939	0.631	1.000							
4 K/L DIR	0.225	0.420	0.267	1.000						
5 $L_E/L D$	0.210	-0.052	0.219	0.160	1.000					
6 $L_W/L D$	0.244	0.187	0.293	-0.075	-0.413	1.000				
7 $NR_W/L D$	0.315	0.423	0.341	0.062	-0.128	0.137	1.000			
8 $NR_I/L D$	-0.004	0.069	0.141	0.131	-0.050	0.131	-0.018	1.000		
9 $NR_O/L D$	0.100	-0.045	0.204	-0.008	0.063	0.015	0.137	0.057	1.000	
10 M/L D	-0.146	-0.081	-0.119	0.212	-0.047	-0.006	-0.034	-0.011	0.022	1.000
11 EFFTAR	-0.181	-0.188	-0.255	-0.292	-0.061	-0.093	-0.128	-0.056	-0.101	-0.059
12 K/L TOT	0.281	0.433	0.334	0.894	0.090	-0.047	0.212	0.168	0.064	0.284
13 $L_E/L T$	0.345	-0.056	0.329	0.104	0.918	-0.330	-0.117	-0.052	0.055	-0.079
14 $L_W/L T$	0.079	0.229	0.156	0.002	-0.380	0.863	0.141	0.147	0.052	0.026
15 $NR_W/L T$	0.378	0.519	0.414	0.175	-0.201	0.140	0.756	-0.033	0.064	-0.059
16 $NR_I/L T$	0.283	0.529	0.293	0.548	-0.065	0.175	-0.019	0.240	-0.012	-0.027
17 $NR_O/L T$	0.088	-0.041	0.236	0.095	0.067	0.100	-0.016	-0.016	0.274	-0.004
18 NCM/L T	-0.188	-0.107	-0.155	0.248	-0.072	-0.030	-0.046	-0.008	0.028	0.971
19 NOMTAR	-0.160	-0.210	-0.240	-0.263	0.017	-0.069	-0.137	-0.070	-0.105	-0.101
P										
	EFFTAR	K/L TOT	$L_E/L T$	$L_W/L T$	$NR_W/L T$	$NR_I/L T$	$NR_O/L T$	NCM/L T		
	11	12	13	14	15	16	17	18		
11 EFFTAR	1.000									
12 K/L TOT	-0.285	1.000								
13 $L_E/L T$	-0.047	0.124	1.000							
14 $L_W/L T$	-0.107	-0.063	-0.490	1.000						
15 $NR_W/L T$	-0.098	0.294	-0.198	0.176	1.000					
16 $NR_I/L T$	-0.084	0.535	-0.047	0.165	-0.035	1.000				
17 $NR_O/L T$	-0.114	0.093	0.067	0.111	-0.028	-0.016	1.000			
18 NCM/L T	-0.082	0.339	-0.096	0.013	-0.073	-0.036	-0.006	1.000		
19 NOMTAR	0.787	-0.317	0.020	-0.103	-0.161	-0.091	-0.121	-0.136		

ABSTRACT

This paper tests some hypotheses common among international trade economists but never before tried on Swedish data concerning the structure of Swedish foreign trade^{in manufactures}. The results confirm the hypothesis that Swedish export competitiveness is determined by the availability of domestic forest raw materials in combination with high capital intensity and large inputs of technical knowhow.

In addition, by taking account not only of the exporting industries but also of the backward linkages in the production process, the paper throws light upon the interrelationships of inputs of natural resources, labor and capital. Among other things, the results show that the Swedish trade structure is considerably more dependent on the availability of domestic forestry and especially iron raw materials if both direct and indirect inputs are considered than is apparent if only direct inputs are included. A high capital intensity does not seem to be a competitive factor if integrated processes are the units of observation and if raw materials are included in the analysis.