CHANGE IN TECHNICAL STRUCTURE OF THE SWEDISH ECONOMY

by

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1 Introduction

The empirical evidence for changes in input-output coefficients over time is substantial. The effect of technical change is somewhat difficult to identify as many other factors also affect coefficients over time. Carter (1970), Forsell (1972) and Sevaldson (1976), however, all found, using different approaches and analyzing different data, that technical change was a dominating factor affecting coefficients over time. Sevaldson found that observed changes in input-output coefficients are the effects of much more complex causes than the simple types of substitution tested in his investigation; causes such as technological change, changes in product mix, changes in product specifications and changes in product distribution over producing establishments. Carter concludes that a significant portion of structural change resulted from the assimilation of new techniques rather than classical substitution. Forsell concludes that among the factors influencing the input coefficients most are the three measures of technical development - degree of electrification, degree of mechanization and time - which are all highly correlated among themselves.

Statistical tests of the hypothesis that technical change has influenced coefficients in any specific direction demand that the influences of all other factors on coefficients are specified. To identify the effects of all the different factors would indeed be an enormous task considering all the statistical data that must be collected, besides the fact that a long series of input-output tables must be at hand. The main purpose of this paper is more limited, as for Sweden only three tables are at hand on a comparable level of aggregation.[1] On the basis of the kind of change we expect to follow from the various causes of coefficient change, the hypothesis of random change in technical structure is set up against the alternative hypothesis: that coefficients have changed in the direction expected to be caused by technical change. The differences in the coefficient matrices of 1957, 1975 and 1980 for Sweden are then analyzed with these hypotheses in mind.

Intertemporal comparisons of changes in the structure of the Swedish economy by application of input-output analysis have been performed by Östblom (1986), (1989a) and (1989b). Differences in individual

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[1]The tables used here were prepared by Östblom (1986)

coefficients were, however, not examined in these works. The examination here is carried out for input-output tables in 1968 prices and with 72 sectors. Domestically produced quantities and imported quantities of commodities are separated in the analysis. Details of data and aggregation scheme are given in the appendix.

2 Causes of coefficient change

From a theoretical standpoint, technical progress would be the only reason for coefficients not to be stable over time in an economy producing homogeneous commodities with Leontief techniques. The direction of coefficient changes is also clear from the definition of technical progress. If technical progress is neutral, we should expect coefficients to diminish, and biased technical progress would diminish at least some of the coefficients.

If production functions, contrary to the assumption made in input-output analysis, are not linear, the scale of operation or capacity utilization will also follow affect coefficients. The years involved in the present study are all in the downswing of the business cycle and thus the technical structures compared reflect the same phase of the business cycle. All products do not follow the same cycle, as some are leading while others are lagging in the business cycle. These factors do not point in any particular direction for the years compared here.

The level of aggregation also affects the stability of coefficients over time. Sevaldson (1970) found that the stability of coefficients increased with the degree of aggregation due to substantial stability in the shares of individual detailed sectors contributing to aggregate sectors. This finding implies that product mix is not subject to great changes in aggregate tables. Sevaldson's finding contradicts what we in general would expect to be the effect of aggregation on the coefficient stability. The higher the level of aggregation, the more severe is the problem of product mix and thus also coefficient instability. Aggregation may in some cases contribute to coefficient stability since it can cancel out the impact of substitution among related materials. We cannot conclude that product mix should affect coefficients in any specific direction over time and this conclusion is also valid for the level of aggregation.

Competitive imports are often handled with very crude conventions which are adopted for the construction of the basic input-output tables. This can have considerable influence on the stability over time of individual input coefficients. In the tables used for the present study, imported quantities are separated from domestic quantities, and thus changes in coefficients of imported quantities are analyzed as well as changes in coefficients of domestic quantities.

Finally, it should be pointed out that some of the differences in technical coefficients reflect random factors, such as differences between the various tables in the data sources and statistical methods for estimating the technical relationships. The input-output structure of the Swedish economy was investigated for the first time for the year 1957.

[2] Input-output tables based on new statistical information exist also for the years 1968, 1975 and 1980. For the latter tables, compiled by the Central Bureau of Statistics, the statistical information about production activities was organized according to the Swedish Standard of Classification of Economic Activities (SNI)[3]. Without this alternative for classification, Höglund and Werin (1964), in preparing the 127-order input-output table of 1957, classified commodities differently and there is no possibility of establishing a direct correspondence between their system and that of SNI. A common grouping of goods for the table of 1957 and the tables of 1975 and 1980 into 72 commodity groups was made mainly by aggregating the original input-output tables. The 1968 table of 34 sectors was not included in the present study.

In order to obtain comparable input-output tables, operations other than aggregation had also to be undertaken. The commodity groups 109 (Basic chemical products) and 116 (Condensed gases, charcoal, lubricants, glue, linoleum, other chemical products) of the original 1957 table were disaggregated to constitute seven commodity groups in the 72-order table of 1957. All the output of commodity groups 109 and 116 could not be given a pattern of intermediate flows by use of statistical information in the Industrial Statistics for Sweden, which were used also by Höglund and

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[2]For a further description of the data used in the computations, see appendix and Östblom (1986).

[3]This classification is based on the industry code recommended by the U.N., ISIC 1968.

Imported [illegible] goods [illegible] which [illegible] goods [illegible] which are adopted for the commodity sector of the [illegible] in exports the [illegible] [illegible] possible influence on [illegible] technological level [illegible] in the tables [illegible] employed quantities of imported and domestic [illegible] changes in [illegible] observed variations [illegible] changes in [illegible] of domestic quantities.

Finally, it should be pointed out that some of the differences in [illegible] reflect random factors such as differences in the various tables in the data sources and statistical methods for making the technical [illegible] of the Swedish economy [illegible] suggested [illegible] the year 1950.

[2] Input-output tables [illegible] information exist for the years 1957, 1964 and 1968. For the latter period, compiled by the Central Bureau of Statistics, [illegible] information about producing activities was organized according to the Swedish Standard of Classification of Economic Activities (SNI)[3]. Without this alternative for [illegible] Höglund and Werin (1964), [illegible] the 1957 [illegible] commodities differently and there is no [illegible] ability of establishing a direct correspondence between [illegible] that of SNI [illegible] grouping of goods [illegible] table of 1957 and the tables of 1964 and 1968 into [illegible] commodity groups [illegible] made mainly by [illegible] making the original [illegible]. The 1968 table [illegible] not included in the present study.

In order to obtain comparable input-output tables, aggregations [illegible] than expected [illegible] had also to be undertaken. The commodity groups 108 (Basic chemical products) and 115 (Bleached paper, chemicals, lubricants, glue, linoleum, other chemical products) of the original 1957 table were disaggregated [illegible] seven commodity groups in the [illegible] table of 1964. All the output of commodity groups 107 and 116 could not be [illegible] a pattern of intermediate flows by use of statistical information in the Industrial Statistics for Sweden, which was also used by Höglund and

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[2] [illegible] classification [illegible] based on the [illegible] code recommended by the U.N., ISIC 1968.

Werin (1964) in the construction of the original 1957 input-output table, and in this case information about the pattern of intermediate flows in the 1975 table was used. When no other information was available, proportionality between total production and flows of intermediates was assumed. These operations should have the effect of smoothing out differences between the 1957 and 1975 input coefficients.

In view of all this, although comparisons of individual coefficients are undertaken, no great emphasis is laid on identified differences in specific individual coefficients. Rather, the study seeks to identify differences between the technical structures of different years which are general, since such differences reflect more pervasive change in technical structure.

3 Distribution of actual coefficient differences

The aim is here to examine whether coefficient differences over time have a systematic bias compared to random errors of measurement. If such a bias exists, one matrix could be characterized as having, in general, coefficients of smaller magnitude compared to another matrix. This matrix thus represents the technical structure which uses less intermediates for production of final output. Differences in individual coefficients are examined in more detail by row and by column in the following section. In the present section, various summary measures and distributions of coefficient differences are presented, but only coefficient differences with an absolute value greater than 0.0001 are registered as a coefficient change. This procedure excludes all coefficients which were zero for both the compared years.

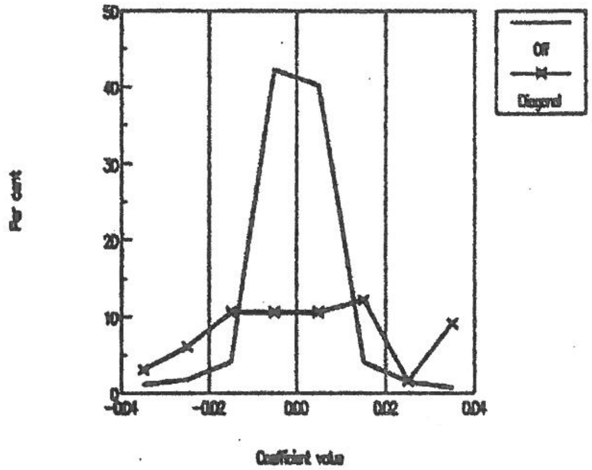
Difference matrices D^1 and D^2 are constructed.

$$D^1 = A^{75} - A^{57} \qquad d^1_{ij} \in D^1 \tag{1}$$

$$D^2 = A^{80} - A^{75} \qquad d^2_{ij} \in D^2 \tag{2}$$

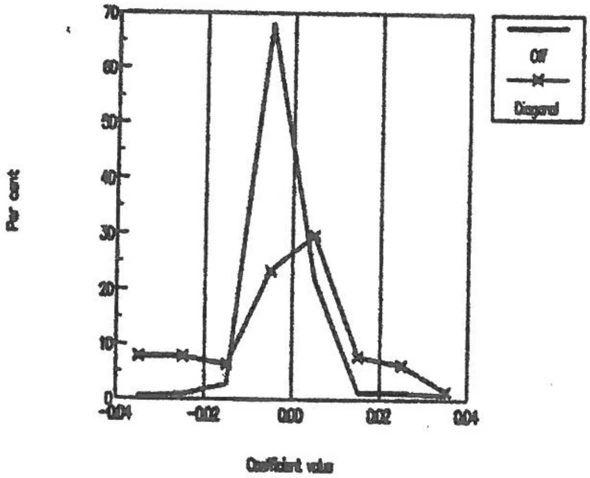
The elements of D^1 and D^2 have been classified into off-diagonal elements and diagonal elements. Diagonal elements represent the organization of intrasectoral deliveries whereas off-diagonal elements represent technical coefficients.

Figure 1 Distribution of coefficient differences for the technical matrices of 1957 and 1975. Off=Differences in off-diagonal elements;Diagonal=Differences in diagonal elements



Figures 1 and 2 show that coefficient differences for off-diagonal elements are more or less symmetrically distributed around a value less than zero. From the figures it can be seen that more than 90 per cent of the coefficient differences are in the range -0.04 to +0.04. Such differences are small in absolute value but many of the compared coefficients are of even smaller magnitude.

Figure 2 Distribution of coefficient differences for the technical matrices of 1975 and 1980.Off=Differences in off-diagonal elements;Diagonal=Differences in diagonal elements



When computing the various statistics shown i Table 1, we also ditinguish between negative elements and positive elements. A negative element indicates that the coefficient difference goes in the direction expected from technical change.

Table 1 Measures of differences in the technical matrices of 1957, 1975 and 1980

Elements		Number of objects	Mean	Standard deviation	Variation coefficient
Off-diagonal; $i \neq j$:					
d^1_{ij}	≥ 0.0001	1165	0.006763	0.015961	2.36
$-d^1_{ij}$	≥ 0.0001	1268	0.008592	0.022139	2.58
d^2_{ij}	≥ 0.0001	510	0.010381	0.022277	2.15
$-d^2_{ij}$	≥ 0.0001	1344	0.003350	0.008579	2.56
Diagonal; $i=j$:					
d^1_{ij}	≥ 0.0001	31	0.0336	0.0342	1.02
$-d^1_{ij}$	≥ 0.0001	35	0.0342	0.1347	1.49
d^2_{ij}	≥ 0.0001	32	0.01879	0.03717	1.98
$-d^2_{ij}$	≥ 0.0001	32	0.01921	0.02006	1.04

Comparison of the number of negative elements with the number of positive elements supports the hypothesis that matrices of later years have coefficients which in general are of smaller magnitude than those in matrices of preceding years. This statement holds also for the matrix D^1 but not for the matrix D^2 when mean values for off-diagonal elements are compared.

Fabrication and substitution effects

Adopting the approach attributed to Leontief (1941) and Stone (1962), which assumes that coefficient matrices change over time in a biproportional manner, changes in input-output coefficients are due to an effect that works by rows and another effect that works by columns. The former is called substitution effect and the latter fabrication effect. If technical change is the only or the major factor affecting coefficients, the

substitution effect gauges the importance of saving on certain materials in production rather than on other materials (biased technical change). The fabrication effect will then measure the saving of intermediates in relation to the use of primary factors in production.

For a difference matrix with elements d_{ij}, we may compute the following means for off-diagonal elements with absolute value greater than 0.0001:

$$e=\Sigma_i \Sigma_j d_{ij}/(n(n-1)-k) \quad i \neq j; \quad k=\text{number of } |d_{ij}| \leq 0.0001 \qquad (3)$$

$$e_i=\Sigma_j d_{ij}/((n-1)-k_i) \quad i \neq j; \quad k_i=\text{number of } |d_{ij}| \leq 0.0001 \text{ in row } i \qquad (4)$$

$$e_j=\Sigma_j d_{ij}/((n-1)-k_j) \quad i \neq j; \quad k_j=\text{number of } |d_{ij}| \leq 0.0001 \text{ in column } j \qquad (5)$$

e is the mean of all coefficient differences being off-diagonal elements in matrix D. e_i is the mean of all coefficient differences being off-diagonal elements in row i of matrix D. e_j is the mean of all coefficient differences being off-diagonal elements in column j of matrix D. The direction of change in technical structure between two periods of time is indicated by the mean e. If this mean is negative, the technical coefficients of a later year are on average smaller than for a preceding year. The mean e_i and the mean e_j correspondingly indicate the contribution to this change from the technical coefficients of a certain row i and of a certain column j. By inspection of all e_i and all e_j we are able to conclude wether the change in technical structure in general has worked as a substitution effect by rows or as a fabrication effect by columns.

The distributions of e_i and e_j for D^1 and D^2 respectively are given in table 2, separated into positive and negative values. In the lower part of the table are given some summary measures. We notice that the column means for D^1 and the row means for D^2 are dominated by negative values. Sectors for which the mean $-e_j$ indicates substantial saving of materials between 1957 and 1975 include: Plastic products, Fibreboards, Wearing apparel, Knitting mills, Basic industrial chemicals, Petroleum & coal and Synthetic plastics. Commodities for which the mean $-e_i$ indicates a substantial negative substitution effect between 1975 and 1980 include:

Soaps, cosmetics & other toilet preparations, Other mining & quarrying, Basic industrial chemicals, Motor vehicles, Cement, lime & plaster, and Constructions.

Table 2 Coefficient differences by columns and rows

Class interval	Number of observations for matrix D^1				Number of observations for matrix D^2			
	Rows:		Columns:		Rows:		Columns:	
	e_i	$-e_i$	e_j	$-e_j$	e_i	$-e_i$	e_j	$-e_j$
> .01000	2	3	1	0	3	0	1	1
.00901 - .01000	0	0	0	0	0	0	1	0
.00801 - .00900	0	3	0	2	0	0	0	0
.00701 - .00800	1	3	0	1	0	0	1	1
.00601 - .00700	2	1	1	3	0	1	3	0
.00501 - .00600	1	2	2	1	0	0	0	1
.00401 - .00500	0	1	2	1	2	2	2	1
.00301 - .00400	5	4	1	10	2	8	1	0
.00201 - .00300	4	3	1	7	3	8	5	10
.00101 - .00200	10	8	3	17	1	22	11	3
.00001 - .00100	10	9	6	13	9	9	12	18
Total:	35	37	17	55	20	50	37	35

Matrix D^1	Matrix D^2
e = -0.001232	e = 0.000423
Mean for e_i: -0.001050	Mean for e_i: -0.000044
Mean for e_j: -0.001270	Mean for e_j: 0.000363

The average decrease in coefficients between 1957 and 1975 worked mostly by columns but also by rows. The change in average row coefficients also tended to a decrease in coefficients from 1975 to 1980, but the effect of increasing average column coefficients overcame this tendency. For both periods then the saving of certain rather than other materials worked in the direction of decreasing coefficients. The saving of intermediates in relation to primary factors also worked in this direction for the first period but not for the second period, when the use of intermediates increased relative to the use of primary factors.

Produced and imported quantities - correspondences between coefficient differences

The different conventions for dealing with imports in input-output tables also imply assumptions about the production technology. In the input-output tables exploited for the present study, produced quantities are separated from imported quantities. The technology matrix will consist of coefficients a_{ij} for produced quantities and coefficients b_{ij} for imported quantities of commodity i used for production of commodity j. The production technology will use produced and imported quantities in a fixed relation in this case and substitution cannot take place between these quantities. The assumption behind this procedure is that one unit of produced commodity i is not identical to one unit of imported commodity i even in the case of competitive imports. The coefficients b_{ij} as well as the coefficients a_{ij} may of course change over time due to technical change.

Taking also differences for import coefficients b_{ij} into account, the difference matrices D^3 and D4 are constructed.

$$D^3 = B^{75} - B^{57} \qquad d^3_{ij} \in D^3 \qquad (6)$$

$$D^4 = B^{80} - B^{75} \qquad d^4_{ij} \in D^4 \qquad (7)$$

Elements in D^3 such that $|d^3{}_{ij}| \leq 0.0001$ and elements in D^4 such that $|d^4{}_{ij}| \leq 0.0001$ are not considered.

Positive, negative and zero differences for coefficients of imported quantities are tabulated against the corresponding differences for coefficients of produced quantities in tables 3 and 4. Table 3 shows the figures for matrices D^1 and D^3 whereas the figures for matrices D^2 and D^4 are given in table 4. Apparently, coefficients of imported quantities changed in the same direction as coefficients of produced quantities as indicated by high numbers in the diagonals of the tables compared to the off-diagonal numbers. This indicates that imported and produced quantities are complements rather than substitutes.

Table 3 Elements in D^3 and corresponding elements in D^1

Elements in matrix D^1	Elements in matrix D^3: Positive	Negative	Zero	Total
Positive	658	187	325	1165
Negative	282	594	392	1268
Zero	51	82	2618	2751
Total	991	858	3335	5184

Technical change could very well explain the coefficient differences noted for produced quantities in matrix D^1. The coefficient differences for imported quantities in matrix D^3 disturb the picture. The fact that the number of increasing coefficients is greater than the number of decreasing coefficients for imported quantities gives a more mixed picture of the causes for change in technical structure between 1957 and 1975. The technical structure changed in the same direction between 1975 and 1980, whether elements in matrix D^2, produced quantities, or elements in matrix D^4, imported quantities, are compared. The number of decreasing coefficients was much higher than the number of increasing coefficients for both produced and imported quantities. This is also a result which fits in well with the assumption of technical change as a dominating factor behind coefficient changes from 1975 to 1980.

The mean for off-diagonal elements was calculated as defined in equation (3) for matrices D^3 and D^4. The coefficient differences averaged to 0.0009352 for matrix D^3 and to -0.0005199 for matrix D^4. This indicates increases from 1957 to 1975 but decreases from 1975 to 1980 for coefficients of imported quantities. Only the direction of change noted for the later period should be expected to follow from technical change. The mean for matrix D^3 is opposite in sign to the mean of matrix D^1 (-0.001232) and also the mean for matrix D^4 is opposite in sign to the mean for matrix D^2 (0.000423).

With reference to the number of decreasing coefficients compared to the number of increasing coefficients for produced and imported quantities, technical structure did not change in the direction expected from technical change for the period 1957-1975 but did for the period 1975-1980. The number of decreasing coefficients was 2126 for the period 1957-1975 and 2190 for the period 1975-1980 to be compared with the corresponding figures 2156 and 899 for the numbers of increasing

coefficients. Taking the values of coefficient differences for produced and imported quantities as indication of change in technical structure, technical coefficients on average declined from 1957 to 1975 but increased somewhat from 1975 to 1980. The weighted average of the means for matrices D^1 and D^3 is -0.0002962. For matrices D^2 and D^4 it is 0.000046.

Table 4 Elements in D^4 and corresponding elements in D^2

Elements in matrix D^2	Elements in matrix D^4: Positive	Negative	Zero	Total
Positive	175	168	167	510
Negative	196	585	563	1344
Zero	18	93	3219	3330
Total	389	846	3949	5184

4 Tests for change in technical structure

We observe the coefficients $a_{11},\ldots,a_{nn}$ at two periods of time, t1 and t2. The differences between coefficients observed at t1 and t2 are denoted d_{ij}. The effect of technical change alone would imply that coefficients decrease from t1 to t2. All other causes of change in coefficients, taken together, could increase as well as decrease coefficients from t1 to t2. If we reject the hypothesis of no change in favour of the alternative hypothesis of negative change in coefficients, we conclude that the coefficients have changed in a direction expected if technical change is the only cause of change in coefficients or if all other causes of change, taken together, act as a variable of random nature. This, of course, does not imply that the effect of other causes of coefficient change could not go in a negative direction, but a priori information gives no support for such a belief as discussed in section 2.

The "treatment" we want to test for here is thus the effect of technical change, which we expect to decrease input coefficients. The null hypothesis is that coefficient differences d_{ij} are zero, but the alternative hypothesis is that matrices of later years in general have coefficients of smaller magnitude than those of preceding years. We assume the following model:

$$d_{ij}=\theta+\epsilon_{ij} \qquad i,j=1,\ldots,n \tag{8}$$

coefficients. Table [illegible] values of coefficients [illegible] and [illegible] negative [illegible] indication of change [illegible]

[illegible] coefficients [illegible] between [illegible]

[illegible] from 1971 to 19[illegible]. The [illegible]

[illegible] and [illegible] is [illegible] percentages [illegible]

Table [illegible]

Coefficients in table [illegible]	Significance [illegible]			
	Positive	Negative	[illegible]	Total
Positive	[illegible]	[illegible]	[illegible]	[illegible]
Negative	[illegible]	[illegible]	[illegible]	[illegible]
Zero	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]

Tests for change [illegible]

We observe the coefficients [illegible]

The differences between [illegible]

[illegible]; the effect of [illegible]

decrease [illegible]

[illegible] could [illegible]

If we reject the [illegible] change [illegible]

hypothesis [illegible]

coefficients [illegible]

the only cause of change [illegible]

taken together, [illegible]

not imply that the effects of other causes [illegible]

go in a negative direction, [illegible]

such a belief as discussed in [illegible]

The "treatment" [illegible] for [illegible]

[illegible] change [illegible]

hypothesis is [illegible] difference [illegible]

[illegible]

[illegible]

[illegible] belief.

The parameter of interest θ is the unknown "treatment effect". A test for the direction of change in coefficients is set up by having technical change as the alternative, i e $H_1:\theta<0$, to the hypothesis of no change in coefficients, i.e. $H_0:\theta=0$.

The assumptions in a parametric test is that the ϵ's are mutually independent random variables, which have normal distribution with mean zero and constant variance. A simple test of this kind is a test for paired samples, which we call test of type A here, using the t-value for the mean μ_d of the variable d as test statistic. We test for $-t_{\alpha,n-1}$ of Student's distribution but use normal theory approximation for large samples, i.e. use $z_{(\alpha)}$ which is the upper α upper percentile of the N(0,1) distribution.

Accept H_0 if $t>-z_{(\alpha)}$
Reject H_0 if $t\leq-z_{(\alpha)}$

It might be too restrictive to assume that the total effect of causes of coefficient change other than technical change could be described as a random variable which has normal distribution with mean zero and constant variance might be too restrictive. A test for "treatment" effect can also be performed with less restrictive assumptions on the random variable. Therefore, we also use nonparametric methods here in testing for shift in the location of a population; the Fisher sign test and the Wilcoxon signed rank test as presented by Hollander and Wolfe (1973). The assumptions of the random variable are, as we shall see, less restrictive in these tests than in parametric tests but with some loss of efficiency.

For the distribution-free sign test of Fisher, which we call test of type B here, we assume the ϵ's to be mutually independent and each ϵ comes from a continuous population (not necessarily the same) that has median 0, so that

$$P(\epsilon_{ij} < 0) = P(\epsilon_{ij} > 0) = (\tfrac{1}{2}), \qquad i,j = 1,\ldots,n \qquad (9)$$

The test statistic B here is the number of positive d's and the large sample approximation is:

$$B^* = \frac{B - (n/2)}{(n/4)^{\frac{1}{2}}} \qquad (10)$$

The normal theory approximation to procedure (10) is

Accept H_0 if $B^* > -z_{(\alpha)}$
Reject H_0 if $B^* \leq -z_{(\alpha)}$.

For the distribution-free signed rank test of Wilcoxon, which we call test of type C here, we assume the ϵ's to be mutually independent and each ϵ comes from a continuous population (not necessarily the same) that is symmetric about zero.

The test statistic T^+ here is the sum of ranks for positive d's in the joint ranking of absolute difference $|d_{ij}|$ from least to greatest of $|d_{11}|,\ldots,|d_{nn}|$. The large sample approximation is:

$$T^* = \frac{T^+ - \left[(n+1)/4\right]}{\left[\ n(n+1)(2n+1)/24\ \right]^{\frac{1}{2}}} \qquad (11)$$

The normal theory approximation to procedure (11) is:

Accept H_0 if $T^* > -z_{(\alpha)}$
Reject H_0 if $T^* \leq -z_{(\alpha)}$

The results of these tests for the matrices D^1, D^2, D^3 and D^4 are shown in table 5. The null hypothesis is rejected for matrix D^4 in all tests and thus we conclude that import coefficients have changed in a direction expected to follow from technical change. Changes in import coefficients from 1957 to 1975 in matrix D^3 are not coherent with the direction of change expected to follow from technical change. The technical coefficients of domestic quantities in matrices D^1 and D^2 have changed in the direction expected from technical change according to the Fisher

sign test. The null hypothesis must, however be accepted for matrix D^2 according to the test for paired samples and for matrix D^1 according to the Wilcoxon signed rank test.

The results concerning the changes in technical coefficients thus point in somewhat different directions. The reasons could be that causes of coefficient changes other than technical change have not acted as random disturbances but have influenced technical matrices more than technical change. It could also be that the "treatment effect" is wrongly specified.

Table 5 Tests for change in technical coefficients

Matrix	No of elements	Mean of d_{ij}	Test A			Test B			Test C		
			t-value	α%	$H_0:\theta=0$	B*	α%	$H_0:\theta=0$	T*	α%	$H_0:\theta=0$
D^1	2433	-0.001232	-2.91	0.2	Reject	-2.09	1.8	Reject	0.97	16.6	Accept
D^2	1854	0.000423	1.21	11.5	Accept	-19.37	<0.1	Reject	-15.09	<0.1	Reject
D^3	1849	0.000935	2.13	1.7	Accept	3.10	<0.1	Accept	8.95	<0.1	Accept
D^4	1235	-0.000520	-2.29	1.1	Reject	-12.90	<0.1	Reject	-9.95	<0.1	Reject

An alternative specification of the treatment model would be to let relative changes in technical coefficients indicate the direction of technical change. As many of the coefficients are very small, even a small difference could mean a great relative change in a coefficient. With this specification, technical change affects coefficients in proportion to their magnitudes. Accordingly, we assume new technical coefficients to be x per cent more effective than old technical coefficients rather than that new technical coefficients differ by a negative number x from old coefficients.

To measure relative change in technical coefficients, the differences d_{ij} of matrices D^1, D^2, D^3 and D^4 are related to the mean of the values at t1 and t2 for the coefficient a_{ij}. The same tests were performed for these matrices of relative change in technical coefficients, but for the Fisher sign test there can be no change in result.

Table 6 Tests for relative change in technical coefficients

Matrix	No of elements	Mean of d_{ij}	Test A			Test C		
			t-value	α%	$H_0:\theta=0$	T*	α%	$H_0:\theta=0$
D^1	2433	-0.078071	-2.51	0.6	Reject	-3.29	0.1	Reject
D^2	1854	-0.631723	-25.52	<0.1	Reject	-22.04	<0.1	Reject
D^3	1849	<0.116695	0.42	33.7	Accept	-2.25	1.2	Reject
D^4	1235	-0.688436	-20.37	<0.1	Reject	-17.17	<0.1	Reject

In this perspective, we see that the null hypothesis can be rejected in favour of the hypothesis that the treatment effect has worked in a negative direction. Only for matrix D^3 are we unable to adopt this conclusion fully as the null hypothesis here must be accepted for the Fisher sign test and the test for paired samples.

5 Conclusions

On the basis of a discussion of the direction of coefficient change in relation to its various causes, the hypothesis of random changes in technical structure is set up against the hypothesis that technical structures changed in the direction expected when technical change is the only or the dominating factor leading to coefficient change over time. The differences in the coefficient matrices of 1957, 1975 and 1980 for Sweden are then analyzed with these hypotheses in mind. In the analysis of coefficient changes, we separate coefficients of domestically produced quantities from coefficients of imported quantities. The examination is carried out for input-output tables in 1968 prices and with 72 sectors.

Looking at mean values for changes in off-diagonal coefficients for domestically produced quantities, the hypothesis that coefficients of later years in general are smaller in magnitude than those of preceding years is supported. Also, when the number of decreasing coefficients is compared with the number of increasing coefficients, the hypothesis holds for changes between 1957 and 1975 but not for changes between 1975 and 1980. The decreases in coefficients between 1957 and 1975 worked mostly by columns but also by rows. The mean value of differences in row coefficients shows a tendency towards a decrease in off-diagonal coefficients also from 1975 to 1980, but changes in column coefficients overcame this tendency. For both periods then, the substitution effect (or the effect from biased technical change) decreased coefficients. The fabrication effect worked in the same direction for the first period but in the opposite direction for the second period.

For the period 1957-1975, technical change could very well explain the differences in coefficients for produced quantities, but not for imported quantities. The fact that the number of increasing coefficients is greater than the number of decreasing coefficients for imported quantities points in the direction of change not expected to follow from technical change. The change in technical structure between 1975 and 1980

goes in the same direction whether coefficients of produced quantities or coefficients of imported quantities are compared. The number of decreasing coefficients was much higher than the number of increasing coefficients for produced quantities as well as for imported quantities.

Results of statistical tests performed for technical change show that import coefficients have changed in a direction expected to follow from technical change for the period 1975 to 1980 but not for the period 1957 to 1975. The coefficients of domestic quantities have changed in the direction expected from technical change according to the Fisher sign test. The null hypothesis must, however, be accepted for the period 1957 to 1975 according to the test for paired samples, and for the period 1975 to 1980 according to the Wilcoxon signed rank test. The results concerning changes in technical coefficients thus point in somewhat different directions. The reason could be that causes other than technical change have not acted as random disturbances but influenced technical matrices more than technical change. It could also be that the "treatment effect" is wrongly specified in the model with absolute differences.

The "treatment effect" was specified also as relative change in technical coefficients. For the Fisher sign test, there can be no change in result but for the other tests, the null hypothesis can be rejected in favour of the hypothesis that the treatment effect has influenced coefficients in the direction expected to follow from technical change. For differences in coefficients of imported quantities, however, we cannot adopt this conclusion fully for the period 1957 to 1975, since the null hypothesis here must be accepted for the Fisher sign test as well as for the test of paired samples.

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ment in the same direction, whether coefficients of product-[illegible] coefficients of [illegible] are compared. [illegible] coefficients and such [illegible] the number of [illegible] for [illegible] commodities as well as [illegible] commodities.

Results of [illegible] tests [illegible] import coefficients have changed in a direction as expected [illegible] technical change for the period [illegible] for the period [illegible] to 1975. The coefficients [illegible] direction expected [illegible] change [illegible] cent. The [illegible] for the period [illegible] to 1975 according to the [illegible] or 1980 according to the [illegible] changes in technical coefficients [illegible] tions, the reason [illegible] not acted as [illegible] and technical [illegible] technical change [illegible] wrongly specified [illegible] differences.

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APPENDIX

Input-output data

In order to obtain comparable input-output tables, operations other than aggregation had to be undertaken. The commodity groups 109 (Basic chemical products) and 116 (Condensed gases, charcoal, lubricants, glue, linoleum, other chemical products) of the original 1957 table were disaggregated to constitute seven commodity groups in the 72-order table of 1957. In carrying out this disaggregation, statistical information about the production values of various commodities classified in commodity groups 109 and 116 was exploited to the utmost extent to give the pattern of intermediate flows for the seven commodity groups 21, 33, 34, 35, 40, 42, and 66. Commodities classified in commodity group 109 were reclassified in commodity groups 33, 34 and 35. Commodities classified in commodity group 116 were reclassified in commodity groups 21, 33, 34, 40, 42 and 66. The source of this statistical information is the Industrial Statistics for Sweden, which were used also by Höglund and Werin (1964) in the construction of the original 1957 input-output table. All the output of commodity groups 109 and 116 could not be given a pattern of intermediate flows in this manner and in this case information about the pattern of intermediate flows in the 1975 table was used. When no other information was available, proportionality between total production and flows of intermediates was assumed. This procedure was followed mainly for the flows of intermediates between commodity groups 21, 33, 34, 35, 40, 42, and 66.

In the original 1957 table, scrap not originating from steel plants (commodity group 198) was considered as a primary input but in the 1975 and 1980 tables, it was regarded as delivered from the trading sector. Similar differences between the tables may also be noted for the classification of energy carriers, i.e. they are regarded as primary inputs in the original 1957 table but as produced goods in the 1975 and 1980 tables. For the commodity groups Tobacco, Beverages and Confectioneries (commodity groups 96, 95 and 87 in the original 1957 table), consumption taxes paid are included in the production value at producer's prices for the original 1957 table but not for the 1975 and 1980 tables. In connection with all these points, the 72-order input-output table for 1957 could be transformed, with the help of additional information given in the Industrial Statistics of Sweden, to correspond to the principles of the 1975 and 1980 input-output tables. On the other hand, the classification of the original 1957 table must be used for the business services sector (commodity group 199 in this classification) in order to obtain comparable input-output tables. This commodity group was considered as final demand in the original 1957 table due to the lack of information about its sales to other commodity groups of the economy.

Price index data

The 1968-1975 and the 1975-1980 price indices were compiled at the Central Bureau of Statistics. The calculations were carried out at the seven-digit level of the Swedish Customs Tariffs with a Statistical Commodity List (Tulltaxan) based on the Brussels nomenclature. Price indices for 300 commodity groups were used to transform the 1975 and 1980 input-output tables at current prices to 1968 prices and 1975 prices respectively at the Central Bureau of Statistics. The resulting 88-order input-output table for 1975 in 1968 prices and the corresponding table in current prices gave implicit price indices for 88 commodity groups, and these were used to transform the resulting 88-order input-output table for 1980 in 1975 prices to 1968 prices. These procedures were followed for produced commodities as well as for imported commodities but with different price indices.

For the year 1957, only an antiquated classification of the commodities used by the Swedish Board of Trade existed. In calculating the 1957-1968 price indices for transforming the 72-order table of 1957 at current

prices to 1968 prices, one of the main aims was to achieve as close a correspondence as possible between this classification system and the classification system mentioned above. This was achieved by transforming the detailed commodity lists used by Höglund and Werin (1964) for classifying produced and imported commodities in their 127-order input-output table for 1957, into the classification of the Swedish Customs Tariffs with a Statistical Commodity List (Tulltaxan). Statistical data on quantities and values for produced commodities could then be taken from the Industrial Statistics of Sweden. Corresponding data for imported commodities were taken from the Trade Statistics of Sweden. By following the commodity lists, quantity data and value data for commodities could be used at a detailed level when compiling price indices for all but six commodity groups: (67), (68), (69), (70), (71) and (72)) of the 72 commodity groups. For these six commodity groups, which are not imported, implicit price indices were compiled by using the 1957 production values in current and in 1968 prices for the corresponding sectors in the Swedish national accounts.

Labor and capital stock data

All the labor data, and all the capital stock data were compiled for the 26-order input-output tables of 1957, 1968, 1975 and 1980. Statistical data on hours worked are given in the Swedish national accounts for sectors corresponding to the commodity groups in the 26-order tables. This is also the case for statistical data on capital stock in 1968 SEK divided into stock of machines and stock of buildings and constructions. In order to be consistent in the estimation of labor coefficients and capital coefficients, labor data as well as capital stock data were related to the production values in 1968 SEK given in the Swedish national accounts for sectors corresponding to the commodity groups in the 26-order input-output tables.

Sector plans of the 34-, 88- and 127-order input-output tables and aggregation scheme for the 26- and 72-order tables*

72 Order	88 Order	127 Order
(1) Agriculture & hunting	(1) Agriculture & hunting	(1) Animal agriculture (2) Vegetable agriculture (3) Market gardening
(2) Forestry & logging (3) Fishing (4) Iron ore mining (5) Non-ferrous ore mining (6) Other mining & quarrying (7) Slaughtering, preparing & preserving meat	(2) Forestry & logging (3) Fishing (4) Iron ore mining (5) Non-ferrous ore mining (6) Other mining & quarrying (7) Slaughtering, preparing & preserving	(4) Timber & wood (5) Fishing (6) Iron ore (7) Other ores (64) Clay, gravel, stones & lime (89) Meat including cooked meat
(8) Dairy products (12) Grain mill products (13) Bakery products (14) Sugar (9) Canning & preserving of fruits & vegetables	(8) Dairy products (12) Grain mill products (13) Bakery products (14) Sugar (9) Canning & preserving of fruits & vegetables	(88) Milk, butter & cheese (84) Flour (85) Bread (86) Sugar (91) Vegetable preserves, soups, jams & juices
(10) Canning & preserving & processing of fish	(10) Canning & preserving & processing of fish	(90) Prepared & preserved fish
(11) Oils & fats	(11) Oils & fats	(92) Margarine (112) Animal & vegetable oils & fats
(15) Chocolates & sugar confectionery	(15) Chocolates & sugar confectionery	(87) Chocolate, confectionery & ice cream
(16) Other food & prepared animal feeds (17) Beverages	(16) Other food (17) Prepared animal feeds (18) Beverages	(93) Roasted coffee, starch, other food products & fodder mixtures (94) Alcoholic liquors (95) Malt beverage & mineral water
(18) Tobaccos (19) Spinning, weaving & manufacture of textiles & textile goods exc. wearing apparel	(19) Tobaccos (20) Spinning & weaving (21) Textiles other than clothing	(96) Tobaccos (97) Wool yarn, woollen textiles (98) Cotton yarn, cotton textiles (99) Linen & jute yarn; linen & jute textiles (100) Silk & silk textiles
(20) Knitting mills (21) Other textiles	(22) Hosiery & knitted goods (23) Carpets, rugs etc	(101) Knitted goods (103) Other textiles, needle work & rope prods; dyeing, bleaching & laundering (pt116)
(22) Wearing apparel exc. footwear	(24) Clothing	(102) Ready-made clothing (105) Furs, gloves, leather clothing
(23) Leather, leather products & footwear	(25) Leather shoes	(104) Leather (106) Shoes (107) Leather products & skin; brooms & brushes
(24) Sawing, planing & preserving of wood	(26) Sawing, planing & preserving of wood	(71) Sawn & planed timber
(25) Prefabricated wooden houses & other manufactures of wood	(27) Wooden building materials	(73) Prefabricated wooden houses (74) Joinery
(26) Other wood & cork products	(28) Other wooden mats. (29) Wooden packaging products	(75) Other wood working industry products
(27) Furniture & fixtures (28) Pulp	(30) Furniture & bedding (31) Pulp	(72) Furniture (76) Mechanical pulp
(29) Paper & board	(32) Paper & board	(77) Cellulose (78) Newsprint (79) Other paper & cardboard
(30) Fibreboards	(33) Fibreboards	(80) Wallboard

*The commodity groups 27, 30, 31, 32, 33 and 34 in the 34-order tables and the commodity groups 37, 77, 80, 83, 84, 85, 86 and 88 in the 88-order tables are service sectors which must be classified as final demand due to the reasons discussed above

72 Order	88 Order	127 Order
(31) Products of pulp, paper & paperboard	(34) Packaging products of paper, board etc (35) Other paper & board products	(81) Cardboard of paper products
(32) Printing	(36) Printing	(82) Printing & bookbinding (83) Newspaper advertising
(33) Basic industrial chemicals	(38) General chemicals	(pt109) Basic chemical prods. (pt116) Condensed gases, charcoal, lubricants, glue, linoleum & other chemical products
(34) Fertilizers & pesticides (35) Synthetics & plastics (36) Plastic products	(39) Fertilizers & pesticides (40) Synthetics & plastics (41) Semi-finished plastic products (49) Plastic products	(pt109), (pt116) (pt109) (115) Plastic goods
(37) Paints,varnishes&lacquers (38) Drugs & medicines	(42) Paints (43) Pharmaceutical chemicals & preparations	(113) Paints & enamels (110) Medicines
(39) Soaps, cosmetics & other toilet preparations	(44) Soaps, detergents & toilet preparations	(114) Soaps, detergents, cosmetics & candles
(40) Other chemical products	(45) Other chemical products	(pt116)
(44) Pottery, china & earthenware	(50) Pottery	(68) China, porcelain, glazed tiles & earthenware
(45) Glass & glass products (46) Structural clay products (47) Cement, lime & plaster (48) Non-metallic mineral products n.e.c.	(51) Glass & glass products (52) Structural clay products (53) Cement, lime & plaster (54) Other non-metallic products	(69) Glass (67) Bricks & tiles (65) Cement (66) Cement & concrete work (70) Mortar, abrasives, other earth & stone products (111) Explosives, ammunition, watches
(41) Petroleum refineries (42) Petroleum & coal products	(46) Petroleum refineries (47) Lubrication oils, greases etc.	(203) Petrol, paraffin, motor fuels & heating oils (pt116)
(43) Rubber products	(48) Rubber products	(108) Rubber goods
(49) Iron & steel	(55) Iron & steel	(8) Pig-iron, casting, hotrolled iron & steel (13) Drawn & cold-rolled iron & steel
(50) Ferrous alloys (51) Iron & steel foundring (52) Non-ferrous basic metals	(56) Ferrous alloys (57) Iron & steel casting (58) Non-ferrous metals (59) Semi-finished non-ferrous metal prods.	(9) Ferro-alloys (29) Cast-iron & articles of cast-iron (10) Unprocessed metals (11) Sheet metal: tubes, rods & wire of metal
(53) Non-ferrous metal found. (54) Fabricated metal products	(60) Non-ferrous metal casting (61) Other metal goods	(19) Metal castings (12) Products of thin sheet-metal (14) Implements & tools (15) Bolts, nuts, screws & nails (16) Fittings for gas, water, heating & steam (17) Iron & steel furniture, safes (18) Other manufactures of iron & steel (20) Lighting fittings (22) Other metal manufactures (24) Galvanizing, nickel plating & tinning (38) Heavy sheet-metal work, iron & steel structures (46) Central-heating boilers, metal radiators (59) Plumbing & sanitary instalations
(55) Machinery exc electrical	(62) Mechanical engineering	(21) Gas lamps, cooking apparatus for liquid fuel (31) Water & steam turbines (32) Machines for metal processing (33) Machines for wood, pulp & paper (34) Other machines for industry & handicrafts (35) Agriculture machines (36) Dairy machines (37) Bearings, couplings & transmissions (39) Office machines (40) Refrigerating apparatus (41) Fans, ventilors & pneumatic apparatus (42) Pumps (43) Lifts & lifting apparatus
(61) Railroad & other transport equipment	(68) Railroad equipment (72) Other vehicles	(28) Locomotives, railway wagons & other vehicles
(62) Motor vehicles	(69) Motor vehicles & parts	(25) Motor cars (27) Tractors (30) Internal combustion engines
(63) Motorcycles & bicycles (64) Aircraft (65) Professional & scientific equipment n.e.c.	(70) Motorcycles & bicycles (71) Aircraft (73) Instruments & photo equipment	(26) Cycles (44) Aircraft, armaments & weapons (58) Instruments
(56) Electrical industrial machinery & apparatus	(63) Electrical machinery	(51) Electric motors

72 Order	88 Order	127 Order
(57) Radio, television, & communication equipment	(64) Electronics & telecommunications	(50) Telephone & telegraph apparatus (52) Radio materials
(58) Electrical appliances & housewares	(65) Domestic electrical appliances	(45) Washing machines, sewing machines (53) Vacuum cleaners floor polishers (54) Electric cookers, ovens & cooking apparatus
(59) Electrical apparatus & supplies n.e.c.	(66) Other electrical goods	(49) Accumulators (55) Other electrical apparatus (56) Electrical lamps (57) Electrical conduction material (47) Other mechanical engineering products
(60) Shipbuilding & repairing	(67) Shipbuilding & repairing	(48) Ships & boats
(66) Manufactures n.e.c.	(74) Other manufactures	(23) Gold, silver & electroplate articles (pt116)
(67) Electricity, steam & hot water	(75) Electricity & steam water	(201) Electric power
(68) Gas	(76) Gas	(202) Coke & lighting gas
(69) Construction	(78) Construction	(117) Painting & decorating (118) Electrical installations (119) Buildings, structures & grounds
(70) Trade & transport services	(79) Trade services	(127) Trade services (158) Scrap & waste
	(81) Transport services	(122) Shipping (123) Railway transport (124) Road transport (125) Tramway & omnibus transport (126) Air transport
(71) Communications	(82) Communications	(120) Postal services (121) Telephone & telegraphic services
(72) Repair services	(87) Repair services	(60) Repairs to motor cars (61) Repairs to other vehicles (62) Repairs to machines & apparatus (63) Repairs to electrical machines & apparatus