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by

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Technical Progress and the Pattern of Specialization in World Trade in Manufactures, 1965 to 1987

by

Matthias Lücke

October 1992

Abstract:

It has been hypothesized that technical progress will erode the competitiveness of the manufactured exports of developing countries. The paper tests two assumptions underlying this hypothesis. First, limited technological competence might prevent developing countries from competing effectively in industries with rapid technological change. Secondly, increases in labour productivity might reduce the importance of low labour costs as a determinant of competitiveness. This paper presents a cross-country, cross-industry econometric analysis of the determinants of specialization in trade in manufactures, covering 37 industrialized and developing countries. Neither hypothesized relationship is supported by the data.

Zusammenfassung:

Es wurde vermutet, daß der technische Fortschritt die Wettbewerbsfähigkeit von Industriegüterexporten aus Entwicklungsländern beeinträchtigt. In diesem Arbeitspapier werden zwei Annahmen empirisch überprüft, die dieser Hypothese zugrundeliegen. Zum einen könnte begrenzte technologische Kompetenz es Produzenten in Entwicklungsländern erschweren, sich in Industrien mit raschem technischen Fortschritt zu behaupten. Zum anderen könnte die Steigerung der Arbeitsproduktivität durch technischen Fortschritt die Bedeutung niedriger Lohnkosten als Standortvorteil schmälern. Eine ökonometrische Analyse der Spezialisierungsmuster im Industriegüterhandel, die sich auf 37 Industrie- und Entwicklungsländer erstreckt, findet keine Bestätigung für den vermuteten Zusammenhang zwischen dem technischen Fortschritt und der Wettbewerbsfähigkeit der Entwicklungsländer.

Keywords (JEL Classification):

033 Technical Change - F14 Country and Industry Studies of Trade

1. Introduction

The purpose of this paper is to test the hypothesis that technical progress will lead to the relocation of manufacturing industries from developing to industrialized countries (cf., among many others, Kaplinsky, 1984; UNCTAD, 1986; Henke, 1990, pp. 8ff.). At least two arguments have been put forward to support this view: First, increasingly rapid technological advance in areas like microelectronics may result in a widening productivity gap between industrialized and developing countries. This could be due either to limited technological competence on the part of developing country firms, preventing them from adopting innovations timely, or to "technological protectionism" on the part of the industrialized countries (Ernst, O'Connor, 1989).[1]

Secondly, there is some evidence that the introduction of microelectronics in industrialized countries has made many industrial processes less labour-intensive (e.g. Vickery and Campbell, 1991, p. 66). It has been argued, furthermore, that the new techniques of production provide only limited opportunities for the substitution of labour for capital (i.e. they represent "localized" technical progress according to Lapan, 1975).[2] At the same time, the competitive edge of firms based in developing countries continues to hinge upon low unit labour costs, because the per-unit costs of other inputs are fairly similar across countries.[3] If this argument is valid, developing country producers face a choice between Scylla and Charybdis: Either they stick to their traditional, labour-intensive, but relatively inefficient technique. In that case their competitiveness is bound to deteriorate in the face of the improved efficiency of their industrialized country competitors. Alternatively, they may adopt the new, more efficient, but also more capital-intensive technique. Then their competitive edge, based on low unit labour costs, will be eroded by reduced labour intensity.[4]

Empirical tests of the relocation hypothesis have been based mainly on case studies of particular industries or countries.[5] These studies have remained inconclusive because, on the one hand, isolated instances of relocation do not constitute evidence of a general trend. On the other hand, the absence so far of a trend towards relocation does not in itself preclude this possibility for the future. Areas such as microelectronics, biotechnology, and new materials hold a vast potential for innovations that could conceivably exert a profound influence on the division of labour between industrialized and developing countries.

The present paper therefore tests the empirical foundation of the assumptions on which the relocation hypothesis is based. The focus is on how technical progress in individual manufacturing industries has affected the specialization patterns of industrialized vs. developing countries in trade in manufactures. If the productivity gap between industrialized and developing countries has indeed become larger, the competitive position of developing countries should have deteriorated most (<u>ceteris paribus</u>) in industries with relatively fast technical progress. A similar consideration applies regarding the possible effects of "localized", labour-saving technical progress: Developing countries should have become less specialized (<u>ceteris paribus</u>) in those industries where a relatively large share of the technology-induced cost decrease has been due to a reduction in the use of (unskilled) labour.

Evidence of either relationship would imply that certain necessary conditions for a more general trend towards relocation are satisfied. Whether such a development actually occurs would of course depend on the nature of future technical progress as well as other determinants of the international division of labour. On the other hand, if no well-defined relationship between technical progress and the pattern of specialization has existed in the past, a significant trend towards relocation in the future could be considered rather unlikely.

An empirical test of the above hypotheses has to be based on a model of the determinants of the pattern of specialization in international trade. Recent studies have demonstrated that models along Heckscher-Ohlin lines ("capital-rich countries specialize in exporting capital-intensive goods") are capable of explaining a large proportion of the inter-country, inter-industry variation in net exports of manufactures (Balassa, Bauwens, 1988; Clague, 1991). The present analysis is based on the approach developed by Balassa and Bauwens (1988, esp. pp. 27ff.) for mainly three reasons. First, their procedure allows for a sample of countries at different levels of economic development, which is essential for the proposed test of the relocation hypothesis.[6] Secondly, industry categories should not be too highly aggregated for the measurement of technical progress at the industry level to be meaningful. Otherwise the calculated rates of technical progress might reflect predominantly economic rather than technological change. This requirement precludes the use of models such as Leamer's (1984) and Sautter's (1984) where the number of goods must equal the number of factors of production. Lastly, Balassa and Bauwens (1988) restrict their analysis to the pattern of specialization in manufacturing industry. This limitation avoids serious measurement problems related to the factors of production used extensively in agriculture and mining (cf. Bowen, Leamer, Sveikauskas, 1987). Besides, the distortions which may result from this restriction in the case of resource-rich countries are probably quite small, given the high explanatory power of Balassa's and Bauwens's estimates.

In the present paper the model developed by Balassa and Bauwens (1988) is modified and extended in several respects. Various specifications of human and physical capital intensities are tested and a version different from Balassa's and Bauwens's is adopted. It is also found that the explanatory power of the model increases substantially when a higher level of aggregation is chosen for the industry categories. Finally, testing for the impact of technical progress on the pattern of specialization requires not only the inclusion of technology-related variables, but also the transformation of the original static model into a comparative-static framework.

The remainder of this paper is structured as follows: Section 2 introduces the econometric model, Section 3 presents the estimates, and Section 4 contains a brief summary. Abbreviations of variables, data sources, etc. are listed in the Appendix.

2. Econometric Specification

Balassa and Bauwens (1988) use a two-stage estimating procedure that can be looked upon as a variable coefficient model. In the first stage the pattern of specialization of each country in the sample is described by a regression of normalized net exports on the capital intensity of each product:[7]

[1] $NNX_{jk} = a_k + b_k \ln KI_j$

where

NNX_{jk} normalized net exports as an indicator of the degree of specialization of country k in industry j (k = 1,..., K)

KI_j capital intensity of industry j (may be disaggregated into human and physical capital intensity - cf. Section 3)

Capital intensity data are drawn from only one country (the USA) and are assumed to be representative of the sample as a whole. This procedure is necessitated by the scarcity of data, and justified by the high inter-country correlation of capital intensities (cf. Footnote 2).

b_k in equation [1] increases with the degree to which country k specializes in exporting capital-intensive products. Hence Heckscher-Ohlin theory suggests that b_k should be a positive function of the capital endowment of each country. This hypothesis is tested in the second stage of Balassa's and Bauwens's model:

[2] $b_k = \alpha + \beta \, KE_k$

where

KE_k capital endowment (per capita) of country k

[1] and [2] may be combined into one equation:

[3] $NNX_{jk} = a_k + \alpha \, \ln KI_j + \beta \, KE_k \, \ln KI_j$

In the present paper this static model is used primarily for specification tests relating to the definition of human and physical capital intensities and to the degree of sectoral aggregation. In addition, the technology-related explanatory variables that are later used to test the relocation hypothesis are included in the static model as a point of reference for the comparative-static framework developed below. For that purpose the estimated model becomes (neglecting the residual):

[4] $NNX_{jk} = a_1 + D_2 + \ldots D_K + \alpha \, \ln KI_j + \beta \, KE_k \, \ln KI_j + \gamma \, T_j + \delta \, T_j \, RGDP_k$

where

D_k country dummies

T_j several alternative indicators of the rate of technical progress or technology intensity (cf. below)

The country dummies are included in [4] to account for the fact that a_k in equation [3] is country-specific. A positive and significant estimate of δ would constitute evidence that countries at a higher level of economic development tend to specialize (ceteris paribus) in "technology-intensive" exports. The indicators of the rate of technical progress and technology intensity relate to the USA on the assumption that during most of the period of observation the U.S. could be considered the world technological leader.

The present analysis focusses on the changes in the pattern of specialization due to technical progress, rather than on the pattern of specialization at a given point in time. Therefore a comparative-static model corresponding to equations [1], [2], and [3] is derived by taking differences of [1] and [2]:

$$[5] \quad \Delta NNX_{jk} = \Delta a_k + b_k^{(1)} \Delta lnKI_j + \Delta b_k \, lnKI_j^{(0)}$$

(first stage)

$$[6] \quad b_k^{(1)} = \alpha^{(1)} + \beta^{(1)} KE_k^{(1)}$$

$$[7] \quad \Delta b_k = \Delta\alpha + \beta^{(1)} \Delta KE_k + \Delta\beta \, KE_k^{(0)}$$

(second stage)

$$[8] \quad \Delta NNX_{jk} = \Delta a_k + \alpha^{(1)} \Delta lnKI_j + \beta^{(1)}(KE_k^{(1)} \Delta lnKI_j + \Delta KE_k \, lnKI_j^{(0)}) + \Delta\alpha \, lnKI_j^{(0)} + \Delta\beta \, KE_k^{(0)} \, lnKI_j^{(0)}$$

(first and second stage combined)

where

(0), (1) first and last year of the period of observation

When indicators of the rate of technical progress or of technology intensity (T_j) are included to test the assumptions underlying the relocation hypothesis, the estimated model becomes (still neglecting the residuals):

$$[9] \quad \Delta NNX_{jk} = \Delta a_1 + D_2 + \ldots D_k + \Delta\alpha \ln KI_j^{(0)} + \alpha^{(1)} \Delta \ln KI_j + \Delta\beta \, KE_j^{(0)} \ln KI_j^{(0)}$$

$$+ \beta^{(1)}(KE_k^{(1)} \Delta \ln KI_j + \Delta KE_k \ln KI_j^{(0)}) + \gamma' \, T_j + \delta' \, T_j \, \varnothing RGDP_k$$

where

ΦRGDP geometric average of RGDP between first and last year of period of observation

Econometric estimation of [4] and [9] has to deal with the problem of heteroskedastic residuals, because the second-stage dependent variables are themselves random coefficients from the first-stage regressions (Amemiya, 1978). Balassa and Bauwens (1988) estimate their model alternatively by Weighted Least Squares (pp. 30ff.), by an error components approach (pp. 55ff.), and by OLS with standard errors corrected for heteroskedasticity of unknown form. Their results, however, are not materially affected by the choice of the estimation technique. The present analysis therefore uses only OLS corrected for heteroskedasticity.

The indicators of the inter-branch dispersion of technical progress (T_j in equations [4] and [9]) are based on annual average growth rates of various factor productivities. Data on total factor productivity growth (TFP) are alternatively drawn from Jorgenson and Kuroda (1990; TFPJK), and calculated as Törnqvist indices with the value of production in the numerator and a fairly disaggregated set of inputs in the denominator (cf. the appendix).[8] Following Nelson (1989), the growth rate of total factor productivity is interpreted as the percentage decrease in unit costs under the (hypothetical) assumption of constant factor prices. The first part of the relocation hypothesis implies that developing countries should have lost competitive strength (ceteris paribus) in those industries where unit costs have decreased particularly fast due to technical progress. In equation [9] this would be reflected in a significantly positive coefficient for the interaction variable TFP • ΦRGDP.

The second part of the relocation hypothesis relates to the reduction in unit costs that is due to an increase in labour productivity. This is measured by the growth rate of labour productivity multiplied by the share of labour in total costs (LS). As before, the (hypothetical) assumption of unchanged factor prices is maintained in accordance with Nelson (1989). Alternatively, an explanatory variable LSK is defined as the difference between LS and the reduction in unit costs due to greater productivity of all other inputs. LSK is included in the regressions along with TFP, and may be thought of as an indicator of the relative contributions of labour and other factor productivities to the unit cost decrease (which, in turn, is measured by TFP). If technical progress has indeed eroded the comparative advantage of developing countries based on low unit labour costs, positive and significant coefficients should show up for LS • ϕRGDP and LSK • ϕRGDP, respectively.

In addition to TFP, LS, and LSK, the (unweighted) growth rate of labour productivity in production is used as an indicator of the rate of technical progress. In spite of its well-known shortcomings this measure is still found frequently in the literature. Also included is the share of scientists and engineers engaged in research and development in the total workforce (SERD). An obvious drawback of this measure lies in the fact that the technology intensity of an industry may differ across countries if research and production activities can be located separately. As a rather simple indicator, however, SERD circumvents many of the conceptual and measurement problems associated with factor productivity growth rates.[9]

All indicators based on factor productivity growth rates are calculated as Törnqvist indices from data for the first and last year of the period of observation. This raises the question of whether production function estimates would provide more reliable estimates of the rate and bias of technical progress. Recent studies have demonstrated, however, that production function estimates are extremely sensitive to the specification of the input and output variables, even when the methodology and data sources are essentially the same (Bergström, Panas, 1985; 1987). When the present model was estimated with West German data for the industry-specific variables, no substantial differences have surfaced in the regression results depending on whether rates of technical progress based on production function estimates (Unger, 1986) or conventionally estimated factor productivity growth rates were used. The present study relies exclusively on Törnqvist indices because no production function estimates are available for individual manufacturing industries in the US for the period of observation. It seems highly unlikely, however, that this limitation materially affects the results.

3. Estimation Results[10]

The estimates are based on a data set containing the normalized net exports of resource-free manufactures of 37 industrialized and developing countries, the capital endowments and per capita GDP of these countries, and industry-specific variables relating to the USA. The data cover the years 1965, 1978, and 1987. Thus they reflect the expansion of manufactured exports in a number of developing countries since the mid-1960s. The period of observation is sub-divided in 1978 (the year before the second oil price shock) in order to account for possible differences in the pattern of specialization in the 1980s. The country sample is the same as in Balassa and Bauwens (1988, p. 6), except for the exclusion of Taiwan due to problems of data availability. Sample countries have been selected on the basis of the value and relative importance of their manufactured exports (cf. Balassa and Bauwens, 1988, p. 5).

Table 1 presents regression results used to test alternative specifications of the capital intensity variables and the level of sectoral aggregation. A distinction is made between human capital per head of production workers (HKIP) and other staff (HKINP), as well as between physical capital per head in the form of own machinery (PKIMO), own buildings (PKIBO) and rented

Table 1: Regression Results for the Static Model: Specification Tests

<table>
<tr><th rowspan="2">Dependent Variable/
Data</th><th colspan="5">Explanatory Variables (β-coefficients)[a]</th><th rowspan="2">$\bar{R}^2$</th></tr>
<tr><th>lnHKIP·HKE</th><th>lnHKINP·HKE</th><th>lnPKIMO·PKE</th><th>lnPKIBO·PKE</th><th>lnPKIBR·PKE</th></tr>
<tr><td>(1) NNX-ISIC 1965</td><td colspan="5">(constant and country dummies only)</td><td>.352</td></tr>
<tr><td>(2) (N=814)</td><td colspan="2">1.26***</td><td colspan="2">.54***</td><td></td><td>.539</td></tr>
<tr><td>(3)</td><td>.90***</td><td>-.06</td><td>-.23</td><td>.67***</td><td></td><td>.533</td></tr>
<tr><td>(4)</td><td>.91***</td><td></td><td></td><td>.47***</td><td>.22***</td><td>.536</td></tr>
<tr><td>(5) NNX-ISIC 1978</td><td colspan="5">(constant and country dummies only)</td><td>.221</td></tr>
<tr><td>(6) (N=814)</td><td colspan="2">1.35***</td><td colspan="2">1.01***</td><td></td><td>.534</td></tr>
<tr><td>(7)</td><td>1.11***</td><td>-.72</td><td>-.04</td><td>.93***</td><td></td><td>.527</td></tr>
<tr><td>(8)</td><td>.97***</td><td></td><td></td><td>.88***</td><td>.18***</td><td>.534</td></tr>
<tr><td>(9) NNX-ISIC 1987</td><td colspan="5">(constant and country dummies only)</td><td>.191</td></tr>
<tr><td>(10) (N=814)</td><td colspan="2">1.47***</td><td colspan="2">1.51***</td><td></td><td>.512</td></tr>
<tr><td>(11)</td><td>.87***</td><td>.39</td><td>.42</td><td>.97***</td><td></td><td>.502</td></tr>
<tr><td>(12)</td><td>1.02***</td><td></td><td></td><td>1.14***</td><td>.60***</td><td>.536</td></tr>
<tr><td>(13) NNX-Sectors[b] 1965</td><td colspan="5">(constant and country dummies only)</td><td>.333</td></tr>
<tr><td>(14) (N=5252)</td><td colspan="2">.97***</td><td colspan="2">.20***</td><td></td><td>.417</td></tr>
<tr><td>(15)</td><td>.76***</td><td>-.23</td><td>-.01</td><td>.15***</td><td></td><td>.414</td></tr>
<tr><td>(16)</td><td>.72***</td><td></td><td></td><td>.16***</td><td>.05**</td><td>.413</td></tr>
<tr><td>(17) NNX-Sectors[b] 1978</td><td colspan="5">(constant and country dummies only)</td><td>.218</td></tr>
<tr><td>(18) (N=5332)</td><td colspan="2">1.15***</td><td colspan="2">.51***</td><td></td><td>.361</td></tr>
<tr><td>(19)</td><td>.74***</td><td>.30**</td><td>-.20**</td><td>.62***</td><td></td><td>.356</td></tr>
<tr><td>(20)</td><td>.82***</td><td></td><td></td><td>.51***</td><td>.14***</td><td>.360</td></tr>
<tr><td>(21) NNX-Sectors[b] 1987</td><td colspan="5">(constant and country dummies only)</td><td>.176</td></tr>
<tr><td>(22) (N=5363)</td><td colspan="2">1.32***</td><td colspan="2">.72***</td><td></td><td>.320</td></tr>
<tr><td>(23)</td><td>.90***</td><td>.14***</td><td>.26***</td><td>.38***</td><td></td><td>.309</td></tr>
<tr><td>(24)</td><td>.94***</td><td></td><td></td><td>.62***</td><td>.26***</td><td>.323</td></tr>
</table>

***(**,*) Significantly different from 0 at the .01 (.05, .10) confidence level (2-tailed test). - OLS estimates with standard errors corrected for heteroskedasticity of unknown form.
[a] All regressions contain, in addition, a constant, 36 country dummies, and all industry-specific variables separately. - [b] Estimates not corrected for heteroskedasticity.

Source: Data cf. the Appendix; own calculations with TSP Version 4.2A software.

building (PKIBR). Capital endowments distinguish only between human capital (HKE), which is proxied by the Harbison Myers Index, and physical capital (PKE), which is defined as per capita gross domestic investment accumulated over 15 years. Net exports of resource-free manufactures and capital intensities are calculated alternatively for 147 "sectors" (adopted from Balassa and Bauwens, 1988, pp. 10 ff.), and for 22 ISIC 3-digit industries (cf. Table A1).

The explanatory power of the econometric model may be gauged from the increase in $\bar{R}^2$ when the genuinely economic variables are included in the regressions in addition to the constant and country dummies (cf. regression (1), (5), (9), (13), (17), (21) vs. the rest). Overall $\bar{R}^2$ rises substantially, independent of the specification of the explanatory variables. This result confirms the findings of many previous studies which also attributed significant explanatory power to Heckscher-Ohlin-type variables (recent contributions include Clague, 1991; Balassa, Bauwens, 1988). The increase, however, is much larger at the higher level of aggregation (i.e. ISIC 3-digit industries). This finding suggests the presence of close linkages between subsectors within the more broadly defined ISIC 3-digit industries. The competitive position of each subsector is apparently determined largely by the competitiveness of the industry as a whole. Therefore, the following analysis concentrates on the estimates for ISIC 3-digit industries.

The differences in the explanatory power of the regressions for different definitions of capital intensity are comparatively small. The specification finally adopted focusses on human capital in production and physical capital in the form of own and rented buildings.[11] Other specification tests which are not reported here demonstrate that omitting physical capital intensity decreases $\bar{R}^2$ considerably. This may appear surprising since physical capital is frequently considered a mobile factor of production, and the physical capital stock at a given point in time should therefore not determine the pattern of specialization. One interpretation of the result is that the value of immobile, depreciable assets per head (PKIB) is an indicator of the extent to which industries rely on the physical infrastructure of a country. The availability and quality of infrastructure service, in turn, can be expected to be highly correlated with accumulated gross domestic investment (PKE).[12]

The inclusion of technology-related explanatory variables in the static model increases $\bar{R}^2$ marginally in some cases (Table 2). Frequently, however, the coefficients for the interaction variables (TFP • RGDP, etc.) are insignificant or show unexpected (i.e. negative) signs. There is limited evidence of the hypothesized relationship between technology intensity and the pattern of specialization only in the case of SERD. Overall, however, the β coefficients pertaining to the technology-related variables remain rather small compared with those for the "Heckscher-Ohlin" variables. Hence the impact of technical progress on the pattern of specialization is at least extremely limited.

The same conclusion applies, a forteriori, to the regressions based on the comparative-static model (Table 3). Overall, the explanatory power of these regressions with the changes in normalized net exports as the dependent variable is considerably smaller than in the static model. The interaction between changes in factor intensities and factor endowments, which is reflected by the variables VA4 through VA6 (cf. the appendix), has only a modest impact on the changes in the patterns of specialization. Nevertheless the coefficients for VA5, as well as those for VA3 from 1965 to 1978 and for VA6 from 1965 to 1987, are all positive as expected and significant.

A similarly clear pattern does not emerge for the technology-related variables. The coefficients for the interaction variables are mostly insignificant, and of the few significant coefficients more than half are negative. Neither technology-related decreases in unit costs as such, nor cost reductions due to greater labour

Table 2: Regression Results for the Static Model: Technology-Related Variables (ISIC 3-digit industries)

Dependent Variable/ Data	lnHKIP·HKE	lnPKIBO·PKE	lnPKIBR·PKE	TFP	LSK	LS · RGDP	LPDP	SERD	$\bar{R}^2$
	Explanatory Variables (β coefficients)[a]								
(1) NNX 1965	.91***	.47***	.22***						.536
(2) (TFPJK 1960-70)	.94***	.44***	.22***	.09					.541
(3)	.77***	.42***	.19**					.20***	.551
(4) NNX 1978	.97***	.88***	.18***						.534
(5) (TFPJK 1970-80)	.90***	1.01***	.18***	.18***					.540
(6)	.96***	.88***	.19***	.04					.533
(7)	.82***	.62***	.13**	.06	-.27**				.536
(8)	.97***	.88***	.18***			.00			.533
(9)	.91***	.81***	.19***				.12		.535
(10)	.86***	.77***	.15***					.26***	.552
(11) NNX 1987	1.02***	1.14***	.60***						.536
(12) (TFPJK 1970-85)	1.00***	1.15***	.59***	.07					.536
(13)	1.00***	1.15***	.58***	-.06					.536
(14)	1.00***	1.16***	.64***	-.06	.06				.536
(15)	.93***	.93***	.66***			-.27***			.545
(16)	1.01***	1.11***	.70***				-.17**		.541
(17)	1.01***	1.10***	.57***					.06	.538

***(**,*) Significantly different from 0 at the .01 (.05, .10) confidence level (2-tailed test). - OLS estimates with standard errors corrected for heteroskedasticity of unknown form.
[a] All regressions contain, in addition, a constant, 36 country dummies, and all industry-specific variables separately.

Source: Data cf. the Appendix; own calculations with TSP Version 4.2A software.

Table 3: Regression Results for the Comparative-Static Model (ISIC 3-digit industries)

Dependent Variable/ Data		VA4	VA5	VA6	Explanatory Variables (β coefficients)[a] TFP	LSK	LS · øRGDP	LPDP	SERD	$\bar{R}^2$
(1)	ΔNNX 1965-78	(constant and country dummies only)								.327
(2)		.25*	.52***	.02						.364
(3)	(TFPJK 1960-80)	.25*	.56***	.03	-.11*					.368
(4)		.25*	.54***	.02	.02					.363
(5)		.31**	.59***	.07	.01	.16				.368
(6)		.26**	.52***	.02			-.03			.363
(7)		.24*	.53***	.01				.03		.363
(8)		.25*	.52***	.02					.00	.363
(9)	ΔNNX 1978-87	(constant and country dummies only)								.395
(10)		.09	.22**	.04						.420
(11)	(TFPJK 1970-85)	.13	.26***	.09	-.15					.424
(12)		.10	.23**	.13	.14**					.422
(13)		.11	.24***	.17	.14**	.07				.423
(14)		.08	.21**	.03			.06			.418
(15)		.08	.21**	.03				.04		.418
(16)		.10	.27***	.16					-.18***	.422
(17)	ΔNNX 1965-87	(constant and country dummies only)								.384
(18)		.22	.61***	.14**						.423
(19)	(TFPJK 1960-85)	.26	.74***	.12*	-.22***					.432
(20)		.22	.61***	.16**	.06					.424
(21)		.34*	.68***	.28***	.04	.28***				.436
(22)		.23	.62***	.15**			-.06			.424
(23)		.26	.66***	.18**				-.12		.427
(24)		.22	.75***	.24***					-.24***	.428

***(**,*) Significantly different from 0 at the .01 (.05, .10) confidence level (2-tailed test). - OLS estimates with standard errors corrected for heteroskedasticity of unknown form.
[a] All regressions contain, in addition, a constant, 36 country dummies, VA1, VA2, VA3, and all industry-specific variables separately.

Source: Data cf. the Appendix; own calculations with TSP Version 4.2A software.

productivity have undermined the competitive position of relatively poor countries. Thus no empirical support is found for the assumptions underlying the relocation hypothesis.

4. Summary

This paper has tested the hypothesis that technical progress had a differential impact on the trade specialization of industrialized vs. developing countries. A cross-country, cross-industry econometric analysis has been undertaken of the determinants of normalized net exports of resource-free manufactures, relating to 37 industrialized and developing countries in 1965, 1978 and 1987. No evidence has been found of a link between technical progress and the patterns of specialization. This applies both to the rate of technical progress in individual branches of manufacturing as such, and to the unit cost reductions due to improved labour productivity.

This finding implies, first, that the productivity gap between industrialized and developing countries has not widened; otherwise developing countries should have become less competitive, ceteris paribus, in industries with fast technical progress. Secondly, the competitive edge of developing countries, which continues to hinge up on low unit labour costs, has not been eroded by improved labour productivity. Either the capital-intensive innovations introduced in industrialized countries have predominantly substituted capital for ever-more-expensive labour, with less important improvements in efficiency. Or else, developing country firms have been able to adapt the new techniques to local conditions, i.e. increase labour intensity in peripheral activities without losing efficiency in core processes.

For the relocation hypothesis to be plausible, either a widening productivity gap or an erosion of the competitive edge of developing countries on the basis of low unit labour costs should have been observed. It may be concluded, therefore, that the two assumptions underlying the relocation hypothesis are lacking empirical support. A future large-scale relocation of manufacturing industries from developing to industrialized countries thus appears rather unlikely.

Two further findings of this study bear mentioning. The results of previous studies are confirmed that the interaction of capital endowments and capital intensities explains a substantial proportion of the inter-country variation in trade specialization in a static framework. The same does not apply, however, when the focus is on changes in the pattern of specialization over time. Although the modified "Heckscher-Ohlin" variables remain significant, the limited explanatory power of the comparative-static model points to an important role played by country and industry-specific factors.

Secondly, studies similar to the present one frequently use a fairly low level of sectoral aggregation of industry categories. This approach probably underestimates the extent to which the competitiveness of a particular sub-sector depends on the competitiveness of the pertinent industry as a whole. In the present paper, at least, the estimation results for the three-digit level of the International Standard Industrial Classification with 22 individual industries were much more satisfactory than those for a total of 147 sectors.

Footnotes

1 Grossman and Helpman (1991, pp. 310ff.) have recently demonstrated how production of a particular good may even shift back and forth between industrialized and developing countries, depending on the patterns of innovation in the "North" (leading to higher quality goods) and of imitation in the "South". In this particular case of vertical product differentiation, product innovations are equivalent to process innovations (Grossman, Helpman, 1991, p. 87).

2 This assertion is supported by the fact that the capital intensities of ISIC 3-digit industries are highly correlated across countries at different levels of economic development (Lücke, 1992; Ballance, Forstner, 1990, pp. 98ff.). Recently, however, the technology blending literature has emphasized the wide scope for substitution in peripheral activities, as opposed to relatively fixed factor proportions in the core processes of each industry (Rosenberg, 1988, pp. 29 ff.; Bhalla, James, 1991).

3 Cf., for example, Fischer, Nunnenkamp et al. (1988, Figure 2) for an international comparison of steel production costs, and Lücke (1990, Figures 1, 2 and 3) for similar data relating to the textile and clothing industries.

4 The competitiveness of developing country firms will deteriorate less sharply if local wages decline in response to reduced world demand for the countries' exports and, therefore, reduced domestic demand for labour.

5 Hoffman and Rush (1988) on the world clothing industry is a prominent example. The most comprehensive study to date is Jungnickel (1990), covering 11 "sensitive" branches of manufacturing industry in West Germany. Based on a careful evaluation of official statistics as well as numerous interviews he concludes that there is no sign of a general tendency

towards relocation. Even in those industries where relocation did occur in some instances, these have been more than compensated for by a continuing shift of production activities to developing countries.

6 This is in contrast to Clague (1991) who considers only a small group of Asian developing countries.

7 Net exports are used in preference to alternative indicators of specialization (cf. Ballance, Forstner, Murray, 1987) because they exclude intra-industry trade between countries of similar capital endowments (Deardorff, 1984). Normalized net exports are calculated for each country and industry as the value of net exports divided by the sum of export and import values. Further adjustment for inter-country differences in the balance of trade in manufactures is not required because the first-stage regressions are country-specific.

8 Factor productivity growth rates have also been calculated with value added in the numerator and only the factors of production (labour and capital) in the denominator. The estimated regression coefficients, however, are fairly similar.

9 Other quantitative indicators (patent output, research and development expenditures) have been used in additional regressions with rather similar results.

10 A list of the abbreviations of variables, definitions and data sources is found in the appendix.

11 The values of own and rented buildings could not be added because the underlying data (book values in historical prices, current rents) are not comparable.

12 On the determinants of "efficiency differences" between industrialized and developing countries cf. Clague (1991).

Appendix: Variable Definitions and Data Sources

Trade Data

NNX normalized net exports for each country and industry: value of net exports divided by sum of export and import values (UN, COMTRADE database; based on SITC Rev. 1)

Country-specific variables

HKE human capital endowment: Harbison Myers Index, defined as secondary school enrolment ratio plus five times the tertiary education enrolment ratio, lagged six years (UNESCO, Statistical Yearbook, various issues)

PKE physical capital endowment per capita: gross domestic investment measured in constant prices, aggregated over 15 years (UN, National Accounts Statistics, various issues)

RGDP real per capita GDP measured in 1988 international prices (RGDP1 in Heston, Summers, 1988)

Industry-specific variables

All industry-specific variables except those for which a data source is indicated below, are calculated from US Dept. of Commerce, Bureau of the Census, Annual Survey of Manufactures, various issues; -, -, 1987 Census of Manufactures.

HKI human capital per employee: total compensation per employee minus hypothetical compensation for unskilled labour, deflated by US Wholesale Price Index (WPI); hypothetical compensation is defined as 80 per cent of the average wage in retail trade (wage data from US Dept. of Labor, Bureau of Labor Statistics, Monthly Labor Review, various issues)

HKIP (HKINP)	human capital per production worker (per non-production employee)
PKIBO/ PKIMO	physical capital per employee: book value of depreciable assets per employee deflated by WPI (own builidings; own machinery)
PKIBR	hypothetical value of rented buildings per employee, calculated as rental payments divided by hypothetical capital costs (treasury bill rate plus 2 per cent annual depreciation), deflated by WPI (interest rates from IMF, International Financial Statistics)
TFP	Törnqvist index of total factor productivity growth minus 1, with the value of production in the numerator and the following inputs in the denominator: production labour, non-production labour, human capital in production, human capital outside production, electricity consumption, fuel consumption, consumption of other materials, inventories, own and rented buildings, own and rented machinery
TFPJK	growth rates of total factor productivity for the USA from Jorgensen, Kuroda (1990)
LS	hypothetical reduction in unit costs due to improved labour productivity during the period of observation: index of labour productivity (1.00 for first year of period of observation) weighted by (i.e. to the power of) the share of labour costs in the value of production (average of first and last year of period of observation) minus 1
LSK	LS divided by the weighted indices of productivity growth of the remaining inputs (cf. the list of inputs under TFP)
LPDP	growth rate of labour productivity in production

SERD share of scientists and engineers in all employees in 1978 (NSF, 1990)

Industry-Country Interaction Variables (cf. Table 3)

VA1 $HKE^{(0)} \cdot \ln HKIP^{(0)}$

VA2 $PKE^{(0)} \cdot \ln PKIBO^{(0)}$

VA3 $PKE^{(0)} \cdot \ln PKIBR^{(0)}$

VA4 $HKE^{(1)} \cdot \Delta\ln HKIP + \Delta HKE \cdot \ln HKIP^{(0)}$

VA5 $PKE^{(1)} \cdot \Delta\ln PKIBO + \Delta PKE \cdot \ln PKIBO^{(0)}$

VA6 $PKE^{(1)} \cdot \Delta\ln PKIBR + \Delta PKE \cdot \ln PKIBR^{(0)}$

References

AMEMIYA, Takeshi, "A Note on a Random Coefficient Model". International Economic Review, Vol. 19, 1978, pp. 793-796.

BALASSA, Bela, Luc BAUWENS, Changing Trade Patterns in Manufactured Goods: An Econometric Investigation. Contributions to Economic Analysis, 176, Amsterdam, etc. 1988.

BALLANCE, Robert H., Helmut FORSTNER, Competing in a Global Economy. An Empirical Study on Specialization and Trade in Manufactures. London, etc. 1990.

--, Tracy MURRAY, "Consistency Tests of Alternative Measures of Comparative Advantage". Review of Economics and Statistics, Vol. 69, 1987, pp. 157-161.

BERGSTRÖM, Villy, Epaminondas E. PANAS, How Robust is the Capital-Skill Complementarity Hypothesis? Fackföreningsrörelsens Institut för Ekonomisk Forskning, Working Paper No. 32, Stockholm, March 1987.

BHALLA, Ajit S., Dilmus D. JAMES, "Integrating New Technologies with Traditional Economic Activities: An Evaluative Look at 'Technology Blending'". Journal of Developing Areas, Vol. 25, 1991, pp. 477-496.

BOWEN, Harry P, Edward F. LEAMER, Leo SVEIKAUSKAS, "Multicountry, Multifactor Tests of the Factor Abundance Theory". American Economic Review, Vol. 77, 1987, pp. 791-809.

CLAGUE, Christopher K., "Factor Proportions, Relative Efficiency, and Developing Countries' Trade". Journal of Development Economics, Vol. 35, 1991, pp. 357-380.

DEARDORFF, Alan V., Testing Trade Theories and Predicting Trade Flows. In: Ronald W. JONES, Peter B. KENEN (Hrsg.), Handbook of International Economics, Vol. 1; Amsterdam usw. 1984, pp. 465-517.

ERNST, Dieter, David O'CONNOR, Technology and Global Competition. The Challenge for Newly Industrializing Economies. OECD, Paris 1989.

FISCHER, Bernhard, Juan-Carlos HERKEN-KRAUER, Matthias LÜCKE, Peter NUNNENKAMP, Capital-Intensive Industries in Newly Industrializing Countries - The Case of the Brazilian Automobile and Steel Industries. Kieler Studien, 221, Tübingen 1988.

GROSSMAN, Gene M., Elhanan HELPMAN, Innovation and Growth in the Global Economy. Cambridge, Mass. and London 1991.

HENKE, Jürgen, Moderne Hochtechnologie und nationale Selbständigkeit. Berlin 1990.

HESTON, Alan, Robert SUMMERS, "A New Set of International Comparisons of Real Product and Price Levels - Estimates for 130 Countries, 1950-1985". The Review of Income and Wealth, Vol. 34, No. 1, March 1988.

HOFFMAN, Kurt, Howard RUSH, Micro-Electronics and Clothing - The Impact of Technical Change on a Global Industry. A Study prepared for the International Labour Office within the Framework of the World Employment Programme. New York 1988.

JORGENSON, Dale W., Masahiro KURODA, Productivity and International Competitiveness in Japan and the United States, 1960-1985. Discussion Paper No. 1510, Harvard Institute of Economic Research, Cambridge, Mass., August 1990.

JUNGNICKEL, Rolf, Neue Technologien und Produktionsverlagerung. Hamburg 1990.

KAPLINSKY, Raphael, Automation. The Technology and Society. Harlow/Essex 1984.

LEAMER, Edward E., Sources of International Comparative Advantage - Theory and Evidence. Cambridge, Mass. und London 1984.

LÜCKE, Matthias, Traditional Labour-Intensive Industries in Newly Industrializing Countries. The Case of Brazil. Kieler Studien No. 231, Tübingen 1990.

--, Empirical Evidence on Factor Intensity Reversals in Manufacturing Industry - A Note. Institut für Weltwirtschaft, Kiel, February 1992 (mimeo).

NATIONAL SCIENCE FOUNDATION (NSF), National Patterns of R&D Resources: 1990, Final Report (John E. Jankowskki, Jr., Principal Author). Surveys of Science Resources Series, Washington, D.C. 1990.

NELSON, Richard R., "Industry Growth Accounts and Production Functions when Techniques are Idiosyncratic". Journal of Economic Behaviour and Organization, Vol. 11, 1989, pp. 323-341.

ROSENBERG, Nathan, "On Technology Blending". Gestion 2000, Vol. 4, 1988, pp. 17-44.

SAUTTER, Herrmann, Die Aussagefähigkeit von Hypothesen zur Spezialisierungsstruktur des Außenhandels. Paper presented at the Annual Meeting of the Verein für Socialpolitik, Travemünde, September 1984 (mimeo).

UNGER, Ralph, Messung und Analyse der Totalen Faktorproduktivität für 28 Sektoren der Bundesrepublik Deutschland, 1960 bis 1981. Frankfurt/Main, Bern, New York 1986.

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT (UNCTAD), Impact of New and Emerging Technologies on Trade and Development. A Review of the UNCTAD Secretariat's Research Findings. New York 1986.

VICKERY, Graham, Duncan CAMPBELL, "Advanced Manufacturing Technology and the Organization of Work". STI Review (OECD), 6, December 1989.

Synoptical Table A1: Sectoral Disaggregation of the Database

Sector (Balassa, Bauwens, 1988)		USSIC 1967	USSIC 1972	USSIC 1987	SITC Rev. 1 (Balassa, Bauwens, 1988)	ISIC-3
		(Balassa, Bauwens, 1988 - 1972, 1987 Census of Manufactures)				
001	Cotton Fabrics (Grey)	2211	2111	2111	652.1	321
002	Synthetic Fabrics	2221, 2262	2221, 2262	2221, 2262	653 (less 653.2,.3,.4,.9)	321
003	Woolen Fabrics	2231	2231	2231	653.2	321
004	Narrow Fabrics	2241	2241	2241	655.5, 655.9	321
005	Hosiery & Knit Fabrics	2251, 2252, 2256, 2259	2251, 2252, 2257, 2258, 2259	2251, 2252, 2257, 2258, 2259	841.4 (less 841.43,.44)	321
006	Knit Outwear	2253	2253	2253	841.44	321
007	Knit Underwear	2254	2254	2254	841.43	321
008	Cotton Fabrics (Finished)	2261	2261	2261	652.2	321
009/010	Carpets & Rugs	2271, 2272	2271, 2272	2273	657.5, 657.6, 657.8	321
011/012/014	Yarn & Thread, Lace & Embroidery	2281, 2282, 2284, 2283, 2292, 2395, 2396, 2397	2281, 2282, 2284, 2283, 2292, 2395, 2396, 2397	2281, 2282, 2284, 2395, 2396, 2397	651 (less 651.5,.8,.9), 654	321
016	Nonrubberized Coated Fabrics	2295	2295	2295	611.2, 655.4	321
017	Cordage & Twine	2298	2298	2298	655.6	321
013/015/018	Textile Goods nes	2291, 2293, 2299	2291, 2293, 2297, 2299	2297, 2299	651.5, 651.9, 653.3, 653.4, 653.9, 655.1, 655.8	321
019	Men's and Boys' Outer Apparel	2311, 2321, 2327, 2328, 2329	2311, 2321, 2327, 2328, 2329	2311, 2321, 2326, 2329	841.11	322
020	Nonknit Underwear	2322, 2341	2322, 2341	2322, 2341	841.1 (less 841.11, .12)	322
021	Ties, Corsets & Gloves	2323, 2342, 2381, 2389	2323, 2342, 2381, 2389	2323, 2342, 2381, 2389	841.2	322
022	Womens and Childrens Clothing	2331, 2335, 2337, 2339, 2361, 2369	2331, 2335, 2337, 2339, 2361, 2369	2331, 2335, 2337, 2339, 2361, 2369	841.12	322
023	Hats & Caps	2352	2352	2353	655.7, 841.5	322
024	Fur Goods	2371	2371	2371	842	322
025	Leather Clothing	2386, 3151	2386, 3151	2386, 3151	841.3	322
026	Curtains & Draperies	2391, 2392	2391, 2392	2391, 2392	656.6, 656.9, 657.7	322
027	Textile Bags & Sacks	2393	2393	2393	656.1	322
028	Canvas Products	2394	2394	2394	656.2	322
029/030	Wooden Boxes & Crates, Cooperage Products	2441, 2442, 2443, 2445	2441, 2449	2441, 2449	632.1, 632.2	331
031	Wood Products nes	2499	2448, 2492, 2499	2448, 2493, 2499	631.42, 632.7, 632.8, 633	331
032	Furniture & Fixtures	25	25	25	821, 895.1	332
033	Paper, including Building Paper and Products	2621, 2661	2621, 2661	2621	641 (less 641.5)	341

Synoptical Table A1 (continued)

Sector (Balassa, Bauwens, 1988)		USSIC 1967 (Balassa, Bauwens, 1988 - 1972, 1987 Census of Manufactures)	USSIC 1972	USSIC 1987	SITC Rev. 1 (Balassa, Bauwens, 1988)	ISIC-3
034	Paperboard	2631, 2641	2631, 2641		641.5	341
035/037	Stationery, Paper Products nes	2642, 2645, 2649, 2761, 2646, 2647, 2655, 2782	2642, 2645, 2648, 2649, 2646, 2647, 2655, 2761, 2782	2675, 2676, 2677, 2678, 2679, 2761, 2782	642.2, 642.3, 642.9	341
036	Paper Bags & Containers	2643, 2651, 2652, 2653, 2654	2643, 2651, 2652, 2653, 2654	2657, 2652, 2653, 2656, 2673, 2674	642.1	341
039	Newspapers & Periodicals	2711, 2721	2711, 2721	2711, 2721	892.2	342
040	Books	2731, 2732	2731, 2732	2731, 2732	892.1, 892.3	342
041	Miscellaneous Publishing	2741, 2751, 2752, 2771	2741, 2751, 2754, 2752, 2795, 2771, 2753	2741, 2759, 2754, 2752, 2796, 2771	892.4, 892.9	342
042	Engineering & Printing	3555	3555	3555	718.2	382
043	Inorganic Chemicals	2812, 2813, 2816, 2819,	2812, 2813, 2816, 2819, 2873	2812, 2813, 2816, 2819, 2873	513 (less 513.27), 514, 515, 533.1, 561.1	351
044	Organic Chemicals	2815, 2818	2865, 2869	2865, 2869	512, 521, 531, 532.3, 551.2	351
045	Plastic Materials & Products	2821, 3079	2821, 3079	2821, 3081, 3082, 3083, 3084, 3085, 3086, 3087, 3088, 3089	581, 893	351[a]
046	Synthetic Rubber	2822	2822	2822	231.2	351
047	Cellulosic Manmade Fibers	2823	2823	2823	266.3	351
048	Synthetic Fibers	2824	2824	2824	266.21, 266.22	351
049	Biological & Medicinal Products	2831, 2833, 2834	2831, 2833, 2834	2835, 2836, 2834	541 (less 541.9)	352
050	Soap & Cleansers	2841, 2842, 2843	2841, 2842, 2843	2841, 2842, 2843	554	352
051	Toilet Preparations	2844	2844	2844	553	352
052	Paints	2851	2851	2851	533.3	352
053	Misc. Agricultural Chemicals	2879	2879	2879	599.2	352
054	Explosives	2892	2892	2892	571.1, 571.2, 571.4	352
055	Printing Ink	2893	2893	2893	533.2	352
056	Misc. Chemical Preparations	2899	2899	2899	551.1, 571.3, 599.7, 599.9	352
057	Tires & Tubes	3011	3011	3011	629.1	355

Synoptical Table A1 (continued)

Sector (Balassa, Bauwens, 1988)		USSIC 1967 (Balassa, Bauwens, 1988 - 1972, 1987 Census of Manufactures)	USSIC 1972	USSIC 1987	SITC Rev. 1 (Balassa, Bauwens, 1988)	ISIC-3
058	Footwear	3021,	3021,		851	324
		3141,	3143,	3143,		
		3142	3144,	3144,		
			3149,	3149,		
			3142	3142		
059/060	Reclaimed Rubber,	3031,	3031,	3052,	231.3, 231.4	355
	Misc. Rubber Products	3069	3041,	3053,	621, 629 (less	355
			3069	3061	629.1), 841.6	
				3069		
061	Leather	3111	3111	3111	611 (less 611.2)	323
062/65	Industrial Leather Belting,	3121	3199	3199	612.1	
	Misc. Leather Goods	3199			612.2, 612.9	
063	Leather Uppers	3131	3131	3131	612.3	323
064	Leather Bags & Purses	3161,	3161,	3161,	831	323
		3171,	3171,	3171,		
		3172	3172	3172		
066	Flat Glass	3211	3211	3211	664.2, 664.4,	362
					664.5	
067	Glass Containers	3211,	3221,	3221,	651.8, 664 (less	362
		3229,	3229,	3229,	664.2,.4,.5), 665	
		3231	3231	3231		
068	Brick & Structural Clay	3251,	3251,	3251,	662.4	369
	Tiles	3253,	3253,	3253,		
		3259	3259	3259		
069	Refractories	3255,	3255,	3255,	662.3, 663.7	369
		3297	3297	3297		
070	Vitreous Plumbing Fixtures	3261	3261	3261	812.2	361
071	Vitreous China Food Utensils	3262	3262	3262	666.4	361
072	Earthenware Food Utensils	3263	3263	3263	666.5	361
073	Porcelain Products	3264,	3264,	3264,	663.9, 666.6,	361
		3269	3269	3269	723.2	
074	Concrete & Brick Products	3271,	3271,	3271,	663.6	369
		3272	3272	3272		
075	Abrasive Products	3291	3291	3291	663.1, 663.2,	369
					697.9	
076	Asbestos Products	3292	3292	3292	663.8	369
077	Mineral Wool	3296	3296	3296	663.5	369
078	Misc. Nonmetallic Mineral	3299	3299	3299	663.4	369
	Products					
079/080	Steel & Steel Products,	3312,	3312,	3312,	67 (less 671.3,	371
	Iron Foundries	3313,	3313,	3313,	679.2, 679.3),	
		3315,	3315,	3315,	693.2, 693.3,	
		3316,	3316,	3316,	694.1, 698.3,	
		3317,	3317,	3317,	698.6, 719.93	
		3481,	3495,	3495,		
		3493,	3496,	3496,		
		3566,	3493,	3491,		
			3566,	3566,		
			3568,	3568,		
		3321,	3321,	3321,	679.1, 719.92	371
		3322,	3322,	3322,		
		3494,	3494,	3394,		
		3497	3497	3497		
081	Steel Foundries	3323	3324,	3324,	679.2	371
			3325	3325		
082	Wrought Copper	3351	3351	3351	682.2	372
083	Wrought Aluminum	3352	3353,	3353,	684.2	372
			3354,	3354,		
			3355	3355		
084	Nonferrous Metals nes	3356,	3356,	3356,	681, 683.2, 685.2,	372
		3357	3357	3357	686.2, 687.2, 688,	
					689 (less 689.31),	
					693.1, 723.1	

Synoptical Table A1 (continued)

Sector (Balassa, Bauwens, 1988)		USSIC 1967	USSIC 1972	USSIC 1987	SITC Rev. 1 (Balassa, Bauwens, 1988)	ISIC-3
		(Balassa, Bauwens, 1988 - 1972, 1987 Census of Manufactures)				
085	Aluminum Castings & Stampings	3361, 3461	3361, 3465, 3466, 3469	3363, 3365, 3465, 3466, 3469	697.2	372
086	Brass, Bronze & Copper Castings	3362, 3369, 3392	3362, 3369, 3463	3364, 3366, 3369, 3463	698.8, 698.9	372
087	Iron & Steel Forgings	3391	3462	3462	679.3, 698.4	371
088	Primary Metall Products nes	3399	3398, 3399	3398, 3399	671.3	371
089	Metal Containers	3411, 3491,	3411, 3412	3411, 3412	692.2	381
090	Cutlery	3421	3421	3421	696	381
091	Hand & Edge Tools	3423	3423	3423	695.1, 695.22, 695.23	381
092	Handsaws & Sawblades	3425	3425	3425	695.21	381
093	Hardware nes	3429	3429	3429	698.1	381
094	Sanitary & Plumbing Fixtures	3431, 3432	3431, 3432	3431, 3432	812.3	381
095	Nonelectric Heating Equipment	3433	3433	3433	719.13, 812.1	381
096	Structural Metal Products	3441, 3442, 3444, 3446, 3449	3441, 3442, 3444, 3446, 3448, 3449	3441, 3442, 3444, 3446, 3448, 3449	691, 693.4	381
097	Platework & Boilers	3443	3443	3443	692.1, 692.3, 711.1, 711.2, 711.7	381
098	Bolts & Nuts	3452	3452	3452	694.2	381
099/100	Safes & Vaults, Fabricated Metal Products nes	3492, 3499	3499	3499	698.2, 719.66, 729.91	381
101	Steam Engines & Turbines	3511	3511	3511	711.3, 711.6, 711.8	382
102	International Combustion Engines	3519, 3714	3519, 3714	3519, 3714	711.5	384
103	Farm Machinery	3522	3523, 3524	3523, 3524	712, 719.64	382
104	Construction & Drilling Machinery	3531, 3532, 3533, 3544, 3545	3531, 3532, 3533, 3544, 3545	3531, 3532, 3533, 3544, 3545	695.24, 695.25 695.26, 718.4, 718.51, 719.91, 719.54	382 382
105	Conveying & Carrying Equipment	3534, 3535, 3536	3534, 3535, 3536	3534, 3535, 3536	719.31	382
106	Industrial Trucks & Tractors	3537	3537	3537	719.32	382
107	Machine Tools	3541, 3542	3541, 3542	3541, 3542	715.1	382
108/115	Metal and Woodworking, Machinery, Industrial Furnaces & Ovens	3548, 3553, 3567, 3623	3546, 3547, 3549, 3553, 3567, 3623	3546, 3547, 3549, 3548	715.22, 715,23 719.14, 719.52, 719.53, 729.6, 729.92	382
109/116	Food Products Machinery, General Industrial Machinery nes	3551, 3569	3551, 3569	3556, 3565, 3569	718.3, 719.11, 719.23, 719.62	382
110	Textile & Laundry Machinery	3552, 3582, 3633	3552, 3582, 3633	3552, 3582, 3633	717.1 (less 717.14), 725.02 719.61, 719.8	382

Synoptical Table A1 (continued)

Sector (Balassa, Bauwens, 1988)		USSIC 1967 (Balassa, Bauwens, 1988 - 1972, 1987 Census of Manufactures)	USSIC 1972	USSIC 1987	SITC Rev. 1 (Balassa, Bauwens, 1988)	ISIC-3
111	Paper Making Machinery	3554	3554	3554	718.1	382
112/131	Special Industry Machines nes, Sewing Machines	3559, 3636	3559, 3636	3559	715.21, 717.14, 717.2, 717.3, 718.52, 719.19, 719.51, 719.61, 719.8	382
113	Air Compressors & Pumps	3561, 3564, 3586	3561, 3563, 3564, 3586	3561, 3563, 3564, 3586, 3594	719.21, 719.22	382
114	Ball & Roller Bearings	3562	3562	3562	719.7	382
117/121	Typewriters, Office Machinery nes	3572, 3579	3579	3579	714.1 714.9	382
118/119	Computers, Calculating & Accounting Machines	3573, 3574	3573, 3574	3571, 3572, 3575, 3577, 3578	714.3 714.2	382
120	Scales & Balances	3576	3576	3596	719.63	385
122	Automatic Merchandising Machines	3581	3581	3581	719.65	382
123	Refrigeration Machinery	3585	3585	3585	719.12, 719.15	382
124	Nonelectrical Machinery nes	3599	3592, 3599	3592 3599, 3593	719.94, 719.99	382
125	Electric Measuring Instruments	3611	3825	3825	729.5, 729.99	383
126	Transformers, Motors & Generators	3612, 3621	3612, 3621	3612, 3621	722.1	383
127	Carbon & Graphite Products	3624	3624	3624	729.96	383
128	Household Cooking Equipment	3631	3631	3631	697.1	383
129	Household Refrigerators & Freezers	3632, 3639	3632, 3639	3632, 3639	719.4, 725.01	383
130	Electrical Housewares & Fans	3634, 3635	3634, 3635	3634, 3635	725 (less 725.01, .02)	383
132	Electric Lamps	3641	3641	3641	729.2, 729.42	383
133	Lighting Fixtures	3642	3645, 3646, 3647, 3648	3645, 3646, 3647, 3648	729.94, 812.4	383
134	Radio & TV Equipment	3651, 3662	3651, 3662	3651, 3663, 3669, 3699	724 (less 724.91), 729.7, 729.93, 891.1	383
135	Phonographic Records	3652	3652	3652	891.2	383
136	Telephone & Telegraph Apparatus	3661	3661	3661	724.91	383
137	Electronic Components & Accessories	3671, 3672, 3673, 3674, 3679	3671, 3672, 3673, 3674, 3675, 3676, 3677, 3678, 3679	3671, 3672, 3695, 3674, 3675, 3676, 3677, 3678, 3679	722.2, 729.3, 729.95, 729.98	383
138	Storage Batteries	3691	3691	3691	729.12	383
139	Primary Batteries	3692	3692	3692	729.11	383
140	X-Ray Apparatus & Tubes	3693	3693	3844 3845	726	383
141	Automotive Electrical Equipment	3694	3694	3694	729.41	383
142	Motor Vehicles & Bodies	3711, 3712, 3713	3711, 3713	3711, 3713	732 (less 732.9)	384

Synoptical Table A1 (continued)

Sector (Balassa, Bauwens, 1988)		USSIC 1967	USSIC 1972	USSIC 1987	SITC Rev. 1 (Balassa, Bauwens, 1988)	ISIC-3
		(Balassa, Bauwens, 1988 - 1972, 1987 Census of Manufactures)				
143	Trailers	3715, 3791, 3799	3715, 2451, 3792, 3799	3715, 2451, 3799, 3721	733.3	384
144	Aircraft	3721	3721		734 (less 734.92)	384
145	Aircraft Engines & Equipment	3722, 3723, 3729	3724, 3764, 3728, 3769	3724, 3764, 3728, 3769,	711.4, 734.92	384
146	Ships & Boats	3731, 3732	3731, 3732	3731, 3732	735	384
147/148	Locomotives and Parts, Railroad Cars	3741, 3742	3743	3743	731	384
149	Motocycles, Bicycles & Parts	3751	3751,	3751	732.9, 733.1	384
150	Scientific Instruments & Control Equipment	3811, 3821, 3822	3811, 3823, 3824, 3829, 3822	3812, 3821, 3823, 3824, 3829, 3822	861.8, 861.9 (less 861.92, .94)	385
151	Optical Instruments	3831	3832	3826, 3827	861.1, 861.3	385
152	Medical Appliances & Equipment	3841, 3842, 3843	3841, 3842, 3843	3841, 3842, 3843	541.9, 733.4, 861.7, 899.6	385
153	Ophtalmic Goods	3851	3851	3851	861.2	385
154	Photographic Equipment & Supplies	3861	3861	3861	861.4, 861.5, 861.6, 862	385
155	Watches & Clocks	3871	3873	3873	864	390
156	Jewelry & Silverware	3911, 3912, 3914,	3911, 3915, 3914	3911, 3915, 3914	897.1	390
157	Musical Instruments & Parts	3931	3931	3931	891 (less 891.1, .2)	390
158/159	Games & Toys, Childrens Vehicles	3941, 3942, 3943	3944, 3942	3944 3942	894.2, 894.1	390
160	Misc. Sporting Goods	3949	3949	3949	894.3, 894.4	390
161	Writing Instruments & Materials	3951, 3952, 3953, 3955	3951, 3952, 3953, 3955	3951, 3952, 3953, 3955	895 (less 895.1)	390
162	Costume Jewelry	3961	3961	3961	897.2	390
163/164/	Buttons, Needles,	3963	3963	3965	899.5	390
165/167	Pins & Fasteners,	3964	3964		698.5	390
	Brooms & Brushes,	3991	3991	3991	899.2	390
	Misc. Manufactures nes	3999	3999	3999	613, 861.92, 861.94, 894.5, 899 (less 899.2, .5, .6)	390

nes = not elsewhere specified.
[a] Sector 045 contains parts of ISIC 351 and 356, which could not be separated congruously according to USSIC and SITC. Therefore ISIC 356 is included with ISIC 351.

Quelle: Balassa, Bauwens (1988, Tab. 1.2); United States, Department of Commerce, Bureau of the Census, 1972/1987 Census of Manufactures; United Nations, International Standard Industrial Classification of All Economic Activities. Statistical Papers, Series M, No. 4, Rev. 2, New York, 1968; own compilation.