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What Does South Africa's Pattern of Trade Say About Its Labor Market?

Trevor Alleyne and Arvind Subramanian

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Prepared by Trevor Alleyne and Arvind Subramanian[1]

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Abstract

This paper examines the factor intensity of South Africa's trade. The conclusion is that South Africa is revealed though its trade pattern to be capital abundant (relative to labor). Surprisingly, this result holds especially for South Africa's trade with its high income partners, which should presumably have been more capital-rich than South Africa. Moreover, this revealed capital intensity of South African production was not reversed during the 1990s after the dismantling of apartheid. This favoring of capital use, against the background of high and rising under-utilization of the country's labor resources, raises questions about the functioning of South Africa's labor market institutions.

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I. INTRODUCTION

During the 1990s, South Africa's international trade underwent substantial structural change, including the end of the trade embargo, the elimination of nontariff barriers, a large reduction in tariffs, and the end of the generalized export subsidies[2]. In addition, free trade agreements with the European Union and with its SADC partners have been negotiated which promise to strongly influence South African international trade in the coming years. This paper examines whether, associated with the structural changes occurring in the first half of the 1990s, there were also changes in the pattern of South Africa's trade, in terms of trading partners, commodity composition, and most importantly, factor content. With respect to the latter, one of the interesting phenomena in South Africa has been the high capital intensity of production in the context of very high unemployment rates. Is this capital intensity also reflected in South Africa's pattern of trade, that is, are South Africa's net exports relatively capital intensive?

We find that South Africa is revealed through trade to be relatively capital abundant and a net exporter of capital intensive goods. Surprisingly, this result is particularly strong in South Africa's trade with high income countries, which appears to contradict the Heckscher-Ohlin-Samuelson (HOS) theorem. That is, despite South Africa being more well endowed with labor in physical terms (relative to capital) when compared with its high-income-trading partners, this physical labor abundance has not translated into a lower price of labor (relative to capital) in South Africa and thus not resulted in a comparative advantage in the production and export of labor intensive goods. In fact, the opposite has occurred. Moreover, it appears as if this capital intensity has not been reversed and probably increased during the 1989–97 period.

This capital intensity may reflect, in part, the lingering effect of old apartheid policies that encouraged the under-utilization of labor resources via subsidies for capital intensive techni ques; low average labor productivity (indicative of a low skill base) and relatively sticky wages; and significant nonwage labor costs, including administrative and financial costs of compliance with aspects of the labor market legislation.

Section II describes some of the stylized facts concerning South Africa's trade: with whom South Africa carries out the majority of trade; what goods make up South Africa's trade; and what the relative factor intensities are of the goods that South Africa trades with its various partners. Section III outlines the theoretical considerations and the empirical approaches relevant to testing the Heckscher-Ohlin-Samuelson (HOS) theorem: Section IV reviews other recent studies on South Africa's trade; and Section V presents the results of the two approaches to testing the validity of the HOS theorem in South Africa, the standard factor content approach, in the tradition of Leontief (1954) and modified by Leamer (1980); and the commodity composition approach. Section VI concludes.

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[2] See Jonsson and Subramanian (2001). The removal of these trade distortions contributed significantly to the growth of economic efficiency.

II. SOUTH AFRICA'S PATTERN OF TRADE: THE STYLIZED FACTS

Three main themes are apparent when looking at South Africa's pattern of trade: the high concentration of trade with relatively high-income countries; the very diverse net export patterns with respect to different commodity groups; and the positive correlation between capital intensity and net exports in the commodity pattern of trade.[3]

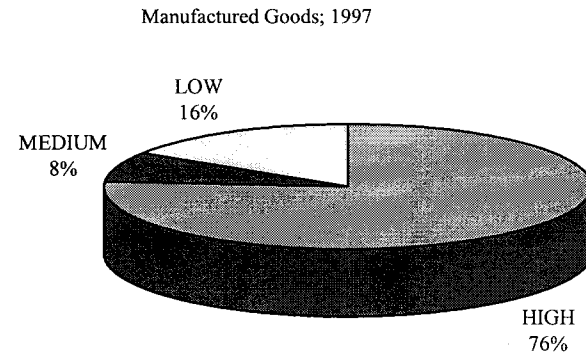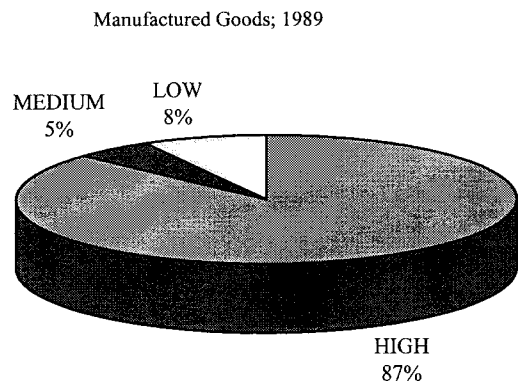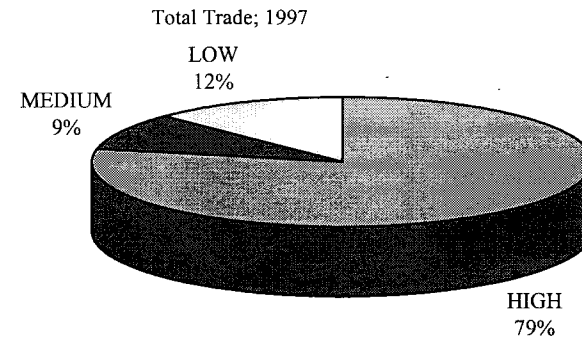### A. The Country and Commodity Composition of Trade

South Africa has a relatively open economy, with trade accounting for 32 percent of GDP in 1997. From a geographical standpoint, South Africa's trade is relatively concentrated with the European Community (EU), with which it conducts 39 percent of its trade (38 percent of exports and 41 percent of imports); East Asia and Pacific, with which it conducts 24 percent of its trade (27 percent of exports and 22 percent of imports); North America (15 percent of trade, 12 percent of exports, and 18 percent of imports); and sub-Saharan Africa (11 percent of trade, 14 percent of exports, and 7 percent of imports).

When trading partners are grouped according to their income level, South Africa's trade appears even more concentrated, with 79 percent of total trade conducted with high-income countries, compared with just 9 percent and 12 percent conducted with middle- and low-income countries, respectively (Figure 1). Moreover, this concentration is present even when South Africa's trade is disaggregated into natural resources, basic manufactured goods, and sophisticated manufac tured goods.[4] As Tables 1 and 2 show, for all categories of goods, the overwhelming majority of trade is carried out with the high-income countries. However, during the course of the 1990s, trade with the high-income countries declined in relative terms while it increased with the middle-income countries (in the case of natural resources) and the low-income countries (in the case of sophisticated manufactured goods).

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[3] All the analysis in this study is based on a detailed input-output table with 45 sectors (defined at ISIC 3-digit level) and five primary factors of production (capital plus four types of labor- highly skilled, skilled, unskilled and informal sector workers) provided by Quantec (formerly WEFA), South Africa. The study focuses on the 32 nonservice, or commodity sectors, of which 28 are manufacturing and four are natural resources. For the purposes of this study, the four labor categories were aggregated into two: **skilled labor** and **unskilled labor**. Bilateral trade data were available for 12 groups of partner countries, which were combined into three catego- ries: the high-income countries, made up of the EU (including the rest of western Europe), North America (including Mexico) and East Asia and Pacific; the low-income countries, made up of sub-Saharan Africa and South Asia; and the middle-income countries, comprising South Africa's remaining trading partners.

[4] See the footnote to Table 3 for a definition of the commodity groups. In 1997, trade in natural resources constituted 33 percent of total trade, while trade in basic manufactured goods and sophisticated manufactured goods constituted 38 percent and 29 percent, respectively.

Figure 1. South Africa: Distribution of Trade by Income Level of Partner Country, 1989 and 1997

Total Trade; 1989

MEDIUM
4%

LOW
7%

HIGH
89%

Total Trade; 1997

MEDIUM
9%

LOW
12%

HIGH
79%

Manufactured Goods; 1989

MEDIUM
5%

LOW
8%

HIGH
87%

Manufactured Goods; 1997

MEDIUM
8%

LOW
16%

HIGH
76%
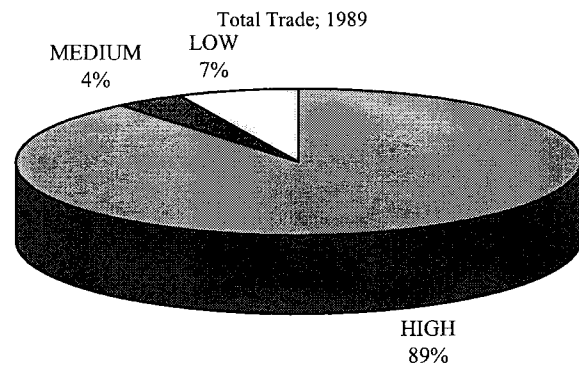
Source: Quantec South Africa; and IMF staff estimates.

Table 1. South Africa: Trade Patterns, by Commodity Group and Trading Partner Group, 1989

Trading Partner	Share of Trade in:				Net Exports as a Percent of Trade			
	Total Trade	Natural Resources	Manufactured goods		Total Trade	Natural Resources	Manufactured goods	
			Basic	Sophisticated			Basic	Sophisticated
High income	89.2	92.8	83.5	93.1	7.5	71.9	-3.9	-84.0
Middle Income	4.0	2.5	6.7	1.6	14.9	45.1	12.9	-53.9
Low income	6.8	4.7	9.7	5.3	38.6	-72.9	75.1	88.3
Total	100.0	100.0	100.0	100.0	9.9	64.4	4.9	-74.3

Sources: WEFA South Africa; and IMF staff estimates.

Table 2. South Africa: Trade Patterns, by Commodity Group and Trading Partner Group, 1997

Trading Partner	Share of Trade in:				Net Exports as a Percent of Trade			
	Total Trade	Natural Resources	Manufactured goods		Total Trade	Natural Resources	Manufactured goods	
			Basic	Sophisticated			Basic	Sophisticated
High income	78.3	82.3	73.6	80.2	-1.4	66.2	-4.2	-73.9
Middle Income	9.3	12.4	7.8	8.0	-7.9	6.3	12.3	-57.9
Low income	12.4	5.2	18.7	11.8	27.0	-22.0	35.5	33.0
Total	100.0	100.0	100.0	100.0	1.5	54.1	4.5	-60.0

Sources: Quantec South Africa; and IMF staff estimates.

On a net export basis, South Africa, in 1997, had close to a zero balance in its overall merchandise trade account, comprising small absolute deficits with the high- and middle-income countries and a moderately large surplus with the low-income countries. As a proportion of total bilateral trade, the imbalance with the high-income countries was negligible (a deficit of under 2 percent), while that with middle- and low-income countries (a deficit of 8 percent and a surplus of 27 percent, respectively) was much higher; in the latter case, the imbalance is a matter of some contention between South Africa and its African partners (see Table 2).

The near-zero balance on overall net exports masks the existence of large imbalances in trade across commodities (see Tables 1 and 2). South African trade is characterized by large surpluses in natural resources, similarly large deficits in sophisticated manufactured goods, and near balance in basic manufactured goods. This aggregate pattern essentially reflects the separate commodity trade patterns with its high- and middle-income partners.[5] In contrast, trade with the low-income countries is characterized by large South African surpluses in both basic and sophisticated manufactured goods, which are only partially offset by a deficit in natural resource commodities.[6]

B. Factor Intensity of South Africa's Production and Trade

On the basis of a cursory inspection of the input-output coefficients (Table 3 and Figure 2), one can make some general observations about the relative factor intensities of the three broad sectors. First, the production of basic manufactured goods tends to be more capital intensive than that of sophisticated manufactured goods; the production of the latter, which tend to be net imports for South Africa, are, on average, more skilled labor intensive. Second, the natural resource sector does not exhibit any homogeneity in terms of the factor intensities of its subsectors: agriculture is the most capital-intensive sector of all three-digit categories, the legacy of past policies designed to create a large, mechanized farming sector, while gold mining is the most unskilled labor intensive subsector of all the three-digit categories. Third, capital-labor ratios declined across-the-board during the 1989–97 period, while the ratio of skilled to unskilled labor generally increased.

In this context, it is useful to look at various rank correlations between net exports and relative factor intensities (Figure 3). For overall trade, there is a positive correlation between net exports and the capital-labor ratio. This result holds when examining trade with each of the high-, middle-, and low-income countries. At least with respect to the high-income countries, this result is somewhat counterintuitive and will be investigated more formally in the following sections. Another result, which is more intuitively appealing, is the correlation between net

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[5] In the case of natural resource trade with the middle-income countries, South Africa's surplus is relatively small because of offsetting petroleum imports.

[6] The significant reduction in the magnitudes of ratios since 1989 may simply reflect a large increase in the value of total trade with the low-income countries.

Table 3. South Africa: Factor Intensities, 1997

		High-skilled and skilled	Semi, unskilled, and informal	Total Labor	Capital	Capital-Labor ratio	Skilled-Unskilled ratio
AG	Agriculture, forestry, & fishing	0.15	0.18	0.33	0.67	2.02	0.80
CO	Coal mining	0.27	0.22	0.49	0.51	1.04	1.22
G	Gold & uranium ore mining	0.20	0.41	0.61	0.39	0.63	0.50
O	Other mining	0.22	0.25	0.47	0.53	1.13	0.88
F	Food	0.27	0.19	0.46	0.54	1.16	1.42
BV	Beverages	0.27	0.15	0.41	0.59	1.43	1.82
TO	Tobacco	0.27	0.15	0.42	0.58	1.39	1.80
TX	Textiles	0.26	0.31	0.57	0.43	0.75	0.82
AP	Wearing apparel	0.26	0.39	0.65	0.35	0.54	0.67
LE	Leather & leather products	0.24	0.23	0.47	0.53	1.13	1.08
FW	Footwear	0.25	0.29	0.54	0.46	0.86	0.88
W	Wood & wood products	0.29	0.24	0.53	0.47	0.90	1.19
P	Paper & paper products	0.28	0.16	0.44	0.56	1.25	1.77
PR	Printing, publishing, & recorded media	0.42	0.14	0.56	0.44	0.79	3.04
CK	Coke & refined petroleum products	0.27	0.19	0.46	0.55	1.20	1.44
C	Basic chemicals	0.31	0.15	0.46	0.54	1.18	2.05
OC	Other chemicals & manmade fibres	0.33	0.15	0.48	0.52	1.08	2.20
R	Rubber products	0.30	0.22	0.52	0.48	0.92	1.36
PL	Plastic products	0.30	0.21	0.52	0.49	0.94	1.44
GL	Glass & glass products	0.26	0.23	0.49	0.51	1.03	1.11
NM	Nonmetallic minerals	0.26	0.23	0.49	0.51	1.05	1.14
FE	Basic iron & steel	0.30	0.22	0.52	0.48	0.91	1.36
NF	Basic nonferrous metals	0.23	0.15	0.39	0.61	1.58	1.53
MP	Metal products, excluding machinery	0.32	0.25	0.57	0.43	0.76	1.29
MA	Machinery & equipment	0.38	0.21	0.59	0.41	0.70	1.76
EM	Electrical machinery	0.36	0.27	0.63	0.37	0.60	1.31
TV	Television, radio, & communication equipment	0.33	0.27	0.60	0.40	0.66	1.24
SC	Professional & scientific equipment	0.29	0.24	0.53	0.47	0.88	1.18
MV	Motor vehicles, parts, & accessories	0.34	0.19	0.53	0.47	0.88	1.80
OT	Other transport equipment	0.40	0.24	0.64	0.36	0.55	1.66
FU	Furniture	0.31	0.28	0.59	0.41	0.69	1.09
O	Other industries	0.27	0.20	0.47	0.53	1.12	1.38

Sources: Quantec South Africa; and IMF staff estimates.

Note: The upper shaded region represents the natural resource goods; the lower shaded region represents the sophisticated manufactured goods; and the unshaded region represents the basic manufactured goods.
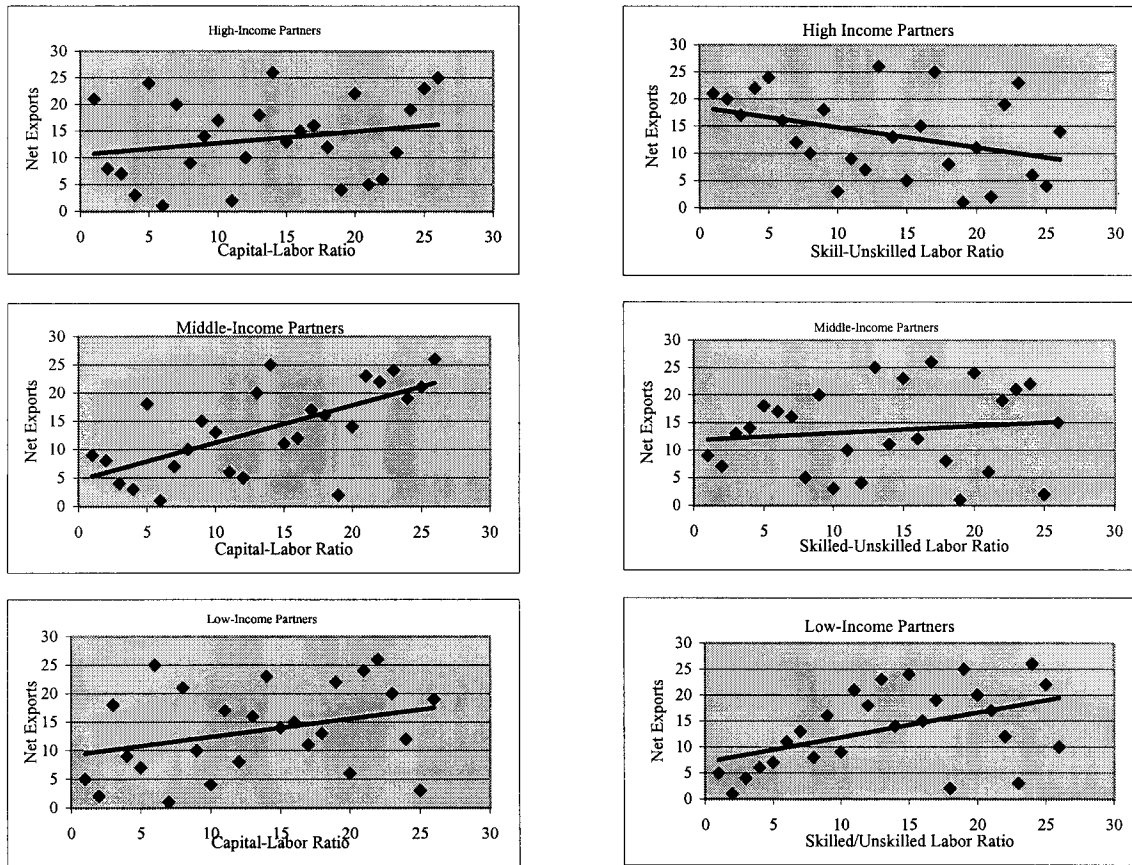
Figure 2. South Africa: Factor Input Ratios, 1989 and 1997
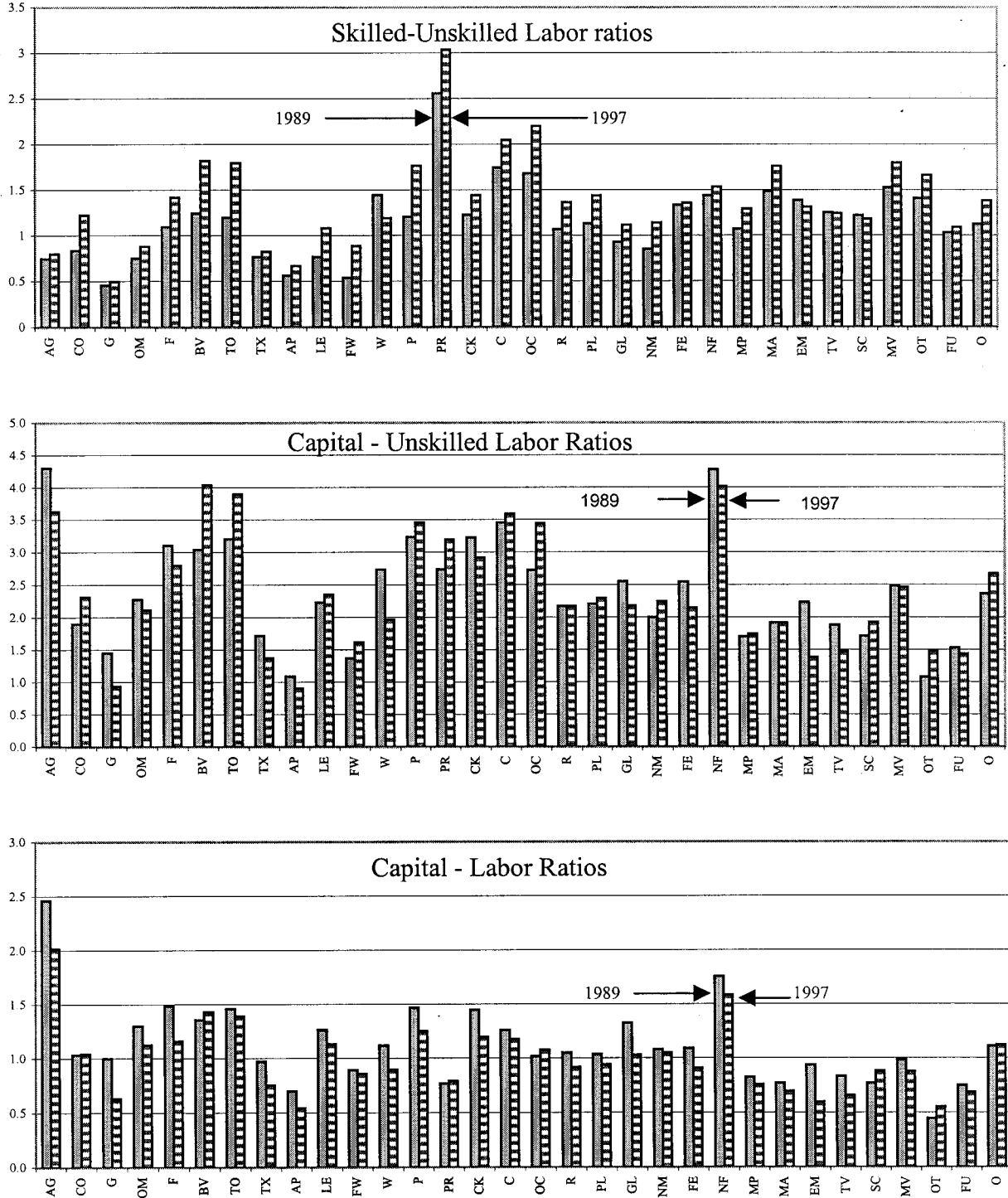
Sources: Quantec South Africa; and IMF staff estimates.
Note: See Table 3 for definition of items on the horizontal axes.

Figure 3. South Africa: Rank Correlations between Net Exports and Factor Ratios, 1997

Source: WEFA South Africa; and IMF staff estimates.

exports and the ratio of skilled to unskilled labor, which is negative for trade with high-income countries and positive for trade with low-income countries.

III. Explaining the Pattern of Trade: Theory and Empirical Approaches to Testing

In the basic two-sector, two-factor, two-good Hecksher-Ohlin-Samuelson (HOS) model, a country exports those goods whose production uses intensively the factor in which the country is relatively well endowed and imports those goods whose production uses intensively the factor that is relatively scarce in the country. Because this proposition does not generalize easily with many goods and factors (Deardorff, 1984),[7] empirical testing of this proposition takes two forms.

A. Factor Content Approach

The first approach is an extension of the "factor content" version of the HOS theorem. This says that countries will be net exporters of their abundant factors and net importers of their scarce factors.

Let A be the $m \times n$ matrix of technology coefficients whose typical element, a_{kj}, represents the total quantity (i.e. direct plus indirect) of the kth factor used per unit of production of good j; E_w is the world's endowment vector of factors, which is summed over all i's.

Country i's trade, T_i, is given by $T_i = Q_i - C_i$, where Q_i and C_i denote respectively output and consumption; thus, the factors embodied in trade are:

$$AT_i = A(Q_i - C_i). \tag{1}$$

If Q_i is the vector of outputs of country i, factor market equilibrium requires $AQ_i = E_i$ where E_i is the endowment of factors of country i. The left hand side represents the demand for factors and the right hand side their supply. Summing over all countries (and assuming identical production technologies) yields factor market equilibrium at the global level:

$$AQ_w = E_w \tag{2}$$

Identical and homothetic tastes imply that the consumption vectors C_i of each country are proportional to each other and to world output (Q_w): $C_i = Q_w B_i$ where B_i is a scalar.

Factor market equilibrium in country i and homotheticity of tastes yields:

$$AT_i = E_i - AQ_w B_i \tag{3}$$

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[7] For example, how can goods be ranked by factor intensities when there are more than two factors?

Global factor market equilibrium then yields:

$$AT_i = E_i - E_w B_i \qquad (4)$$

If there are two factors of production, capital (K) and labor (L), two equations, one for each factor, can be derived from (4) above:

$$K_T = K_i - B_i K_w; \text{ and} \qquad (5)$$

$$L_T = L_i - B_i L_w, \qquad (6)$$

where K_T and L_T are capital and labor embodied in net exports. It is then natural to define capital and labor abundance for a particular country relative to the world's endowments; that is, a country is relatively capital abundant if:

$$K_i/K_w > L_i/L_w. \qquad (7)$$

Equations (5) and (6) can be re-written as:

$$K_w = (K_i - K_T)/B_i \qquad (8)$$

$$L_w = (L_i - L_T)/B_i \qquad (9)$$

Then K_i/K_w and L_i/L_w can be denoted as:

$$K_i/K_w = B_i K_i (K_i - K_T) \qquad (10)$$

$$L_i/L_w = B_i L_i (L_i - L_T) \qquad (11)$$

Using the inequality in (7), relative capital abundance is then defined by the inequality:

$$K_i/(K_i - K_T) > L_i (L_i - L_T) \qquad \text{or} \quad - K_i L_T > - L_i K_T \qquad (12)$$

This is clearly satisfied when a country is a net exporter of capital $(K_T > 0)$ and a net importer of labor $(L_T < 0)$.

In one of the first tests of the HOS proposition, Leontief (1954) drew attention to the "paradox", whereby the United States appeared to be relatively labor abundant because of his empirical demonstration that the capital-labor ratio embodied in U.S. exports was smaller than that in U.S. imports. While many subsequent studies have tried to reconcile the observed U.S. pattern of trade with the theory, Leamer (1980) has shown that Leontief's test was not the appropriate one, especially in the case of unbalanced trade. For example, if a country has a large trade surplus, it is possible for it to be a net exporter of factor services with which it is relatively poorly

endowed. Indeed, in the U.S. data studies of Leontief, the United States was a net exporter of both capital and labor services, in part because it had a large trade surplus.

Leamer (1980) shows that a valid test of the factor content proposition in the presence of unbalanced trade is to compare factor ratios in trade versus those in consumption. Specifically, if a country is a net **exporter** of both capital and labor services, it is relatively **capital abundant** if the capital intensity of net exports **exceeds** the capital intensity in consumption (i.e., $K_T/L_T >$ K_c/L_c); conversely, if it is a net **importer** of both services, it is relatively capital abundant if the capital intensity of net exports is less than the capital intensity of consumption (i.e., $K_T/L_T <$ K_c/L_c).[8]

B. Modified Factor Content Approach

Hakura (1999) presents a modified version of the HOS theorem that permits differences in production techniques and technologies between countries, as well as differences in endowments. She points out that if countries have different technologies, the way in which factor content of trade is measured becomes very important. Specifically, the standard measures of factor content of trade under the Leontief definition, i.e., from total (direct plus indirect) factor requirements, are likely to be biased, because the domestic country's technology is attributed to the imported intermediate good. For example, if country A uses a labor-intensive technique to produce a good, but is a net importer of that good from country B, which uses a capital-intensive technique, the standard calculations would (erroneously) show country A to be a net importer of labor services. To avoid this problem, Hakura recommends that the factor content calculation be based on the direct plus indirect factor inputs, where the latter refers to the factor-requirements for producing the domestically-produced intermediate goods.

$$T_i = (I - D_i)\, Q_i - C_i \tag{13}$$

The vector of net exports can be rewritten to reflect that two kinds of imports exist: imports for immediate consumption, M_c, and imports for use as intermediate goods, M_I. D is the (n x n) matrix reflecting the distribution of intermediate goods across sectors; Q_i is gross output and C_i is final consumption. Since intermediate goods can either be produced domestically or imported, the definition of D encompasses both types of intermediate inputs. Decomposing D into its two components, D_d (the (n x n) matrix representing the distribution of domestically-produced intermediate goods across sectors), and D_f (the (n x n) matrix representing the distribution of imported intermediate goods across sectors), equation (13) can be rewritten as:

$$X_i - M_{Ii} - M_{Ci} = Q_i - D_{di}Q_i - D_{fi}Q_i - C_i \tag{14}$$

Recognizing that $D_{fi}Q_i = M_I$ yields an expression for net trade in final goods only:

$$T_i{}' = (I - D_{di})\, Q_i - C_i, \tag{15}$$

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[8] These results can be obtained by manipulating the inequality in (12).

Where $T_i{}^/$ represents total exports minus imports of goods that are used in final consumption only. Premultiplying equation (15) by F_i $(I - B_{di})^{-1}$, where F_i is the (mxn) matrix of factor coefficients whose $f_{kj}{}^{th}$ element represents the amount of factor k directly used to produce one unit of good j, yields

$$F_i(I - B_{di})^{-1}T_i^/ = Q_i - F_i (I - B_{di})^{-1} C_i \tag{16}$$

Noting that $F_iQ_i = E_i$ (factor market equilibrium) and assuming identical homothetic tastes yields

$$A^/ T_i^/ = E_i - E_w B_i \tag{17}$$

where $A^/ = F_i (I - B_{di})^{-1}$

Equation (17) is a modified version of equation (4) in which the imported intermediate inputs have been separated from domestically produced inputs which allows for the calculation of the domestic factor content in net exports and its relation to the factor endowments in a given country, along the lines described in equations (5)–(12).

C. Commodity Composition Approach

An alternative route to testing the HOS theorem is to conduct a regression analysis of the commodity composition of trade, with the regression equation taking the form

$$T_j = \beta_1\theta_{1j} + \beta_2\theta_{2j} + \beta_m\theta_{mj} + \mu_j \quad j = 1, ..., n \tag{18}$$

where T_j represents net trade of commodity j, the θ's are the gross factor input requirements (factor intensities), and β's the associated coefficients.[9] Equation (18) can be theoretically justified based on an underlying trade model that relates a country's autarky price to factor intensities and factor abundance defined relative to the world. The justification is less than perfect because although the HOS theorem is a relationship among three variables—factor abundance, factor intensity, and trade—the empirical testing using the commodity composition approach involves only intensity and trade. However, Bowen and Sveikauskas (1992) show, on the basis of extensive multicountry and multicommodity analyses, that this deficiency is not severe. Thus, the commodity composition approach remains a useful way to test the HOS theory.

Deardorff (1984) highlights some important considerations for estimating equation (18). First, according to the theory, the independent variables must be factor shares and not relative physical ratios, although many studies have resorted to the latter. Second, the factor shares must

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[9] Because the factor shares sum to unity, the regression equation has no constant term.

be the total factor shares, that is, those derived from the gross input-output coefficients (direct plus indirect) and not those from the direct input-output coefficients, because gross factor intensities determine autarky prices.[10] Third, the dependent variable should be net exports; gross exports may behave very differently from net exports, reflecting the phenomenon of intra-industry trade, about which the standard HOS theory has little to say. Fourth, the dependent variable must be scaled, preferably by a measure of the size of the world market. However, this has rarely been done in practice: many studies have not scaled at all or have scaled by final output or by gross trade (exports plus imports). Fifth, because of the likely relation between the variance of the error term and the industry size, heteroscedasticity could significantly affect the estimation of equation (18) and thus should be corrected for. Finally, it would be preferable to test the HOS theorem by applying it to bilateral trade and not to aggregate trade. This is especially important for countries, like South Africa, that have less extreme relative endowments of labor and capital.

Two versions of the theory set out in equation (18) are usually tested with correspondingly different estimation techniques. One version, using regression analysis, tests for the sign on the coefficient of the various factor shares on the right-hand side; in the other version, the dependent variable is binary rather than continuous, because the theory of comparative advantage can explain only the direction, not the quantity, of trade flows. Thus, a number of studies have used probit and logit analysis to test the probability that the sign of the dependent variable is related to the explanatory variables.

IV. COMPARISON WITH OTHER WORK

Two recent papers, Tsikata (1998) and ILO (1999), have also examined South Africa's pattern of trade. However, their analyses suffer from the following shortcomings. Tsikata (1998) examines the pattern of total exports rather than that of net exports, raising questions as to how her results should be interpreted. Second, Tsikata classifies products as skilled labor, unskilled labor, resource, or capital intensive on the basis of a priori criteria drawn from experience around the world. This classification could fail to capture an important feature of South Africa's production structure, namely, that certain sectors could actually be capital intensive (because of various distortions) even though they might be classified as labor intensive in other countries. Third, Tsikata only looks at aggregate exports, that is, exports with all partners, rather than trade with different trading partners, which, theory suggests, is a more appropriate approach, especially if there are significant variations in the pattern of trade across trading partners (as appears to be the case for South Africa). Fourth, Tsikata uses physical factor intensities rather than those in terms of factor shares, which Deardorff (1984) suggests is the more appropriate one. Tsikata does not undertake any formal econometric analysis of the pattern of trade.

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[10] It is clear—at least for nontraded inputs—that the factors used in producing them should be accounted for in assessing the potential for trade in a good that uses these inputs. This is so because the costs of these factors will be passed through to the goods.

The examination of the patterns of South African trade in the recent paper by the ILO (1999) consists essentially of a categorization of product categories according to (physical) capital-labor ratios and natural resource intensity[11] and the correlation of these to the trade performance of the sector. The determination of whether a sector is export oriented or import substituting is based on an index of revealed comparative advantage. In addition to the arbitrary nature of the definitions and classifications, the ILO paper suffers from the shortcomings noted above in relation to Tsikata (1998). The ILO paper does, however, extend the analysis in one important direction by incorporating South Africa's endowment of natural resources and raising the possibility that South Africa's apparent abundance of capital might be related to an assumed inherent capital intensity of resource-based sectors. In the following subsection, we control explicitly for South Africa's endowments of natural resources in order to test the hypothesis of capital intensity of trade and production.

V. RESULTS

A. Factor Content Approach

Tables 4-6 contain the results of the analysis based on measuring the factor content of South Africa's trade in manufactured goods for 1989 and 1997. Although exports are overwhelmingly more capital intensive than imports (with a capital-labor ratio of 0.18 for exports versus a ratio of 0.11 for imports in 1997), South Africa is a net **importer** of both capital and labor services (note the negative entries in the "Net trade" columns under "Total Trade" in Tables 4 and 5). In such a situation, the more appropriate comparison, as shown by Leamer, is between the factor intensity of net trade (0.03) and that of consumption (0.11), which suggests that, South Africa is relatively capital abundant.

South Africa is also a net importer of skilled and unskilled labor services, and thus the correct test condition for skilled labor versus unskilled labor intensity requires a comparison between net trade and consumption in those services (i.e., 0.90 and 0.80, respectively, in 1997). Following Leamer, these results suggest that South Africa is more endowed with unskilled labor because the skilled-unskilled labor ratio is greater for net trade than for consumption.

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[11] Product categories are classified as capital intensive, intermediate, or labor intensive depending on whether the capital-labor ratio (rand/employment) is greater than 15, between 5 and 15, or less than 5, respectively. Similarly, a sector is classified as resource intensive if it uses a minimum of 20 percent of inputs from natural resource sectors.

Table 4. South Africa: Factor Services Embodied in Actual Trade and Consumption, 1989

Factor	Units	Total Trade				High-Income		Medium-Income		Low-Income	
		Exports	Imports	Net trade	Consumption	Net trade	Consumption	Net trade	Consumption	Net trade	Consumption
Capital	Billions of rand	38	46	-8	481	-13.2	486.1	-0.67	473.6	6.2	466.7
Labor	Thousands of man-years	560	923	-363	9442	-303	9383	-129	9209	94	8986
Capital-labor ratio		0.07	0.05	0.02	0.05	0.04	0.05	0.01	0.05	0.07	0.05
Skilled labor	Thousands of man-years	238	418	-180	4,070	-151	4,041	-59	3,949	40.5	3,849
Unskilled labor	Thousands of man-years	322	505	-183	5,373	-152	5,341	-69	5,259	54	5,136
Skilled-unskilled labor ratio		0.74	0.83	0.98	0.76	0.99	0.76	0.86	0.75	0.75	0.75
Capital/labor abundance				Capital		Capital		Capital		Capital	
Skilled/unskilled abundance				Unskilled		Unskilled		Unskilled		...	

Table 5. South Africa: Factor Services Embodied in Actual Trade and Consumption, 1997

Factor	Units	Total Trade				High-Income		Medium-Income		Low-Income	
		Exports	Imports	Net trade	Consumption	Net trade	Consumption	Net trade	Consumption	Net trade	Consumption
Capital	Billions of rand	113	110	-19	419	-49	549	5	494	13	487
Labor	Thousands of man-years	613	1,043	-558	3,879	-589	4,761	-210	4,382	59	4,114
Capital-labor ratio		0.18	0.11	0.03	0.11	0.08	0.12	-0.02	0.11	0.22	0.12
Skilled labor	Thousands of man-years	276	480	-264	1,723	-283	2,135	-95	1,948	29	1,824
Unskilled labor	Thousands of man-years	337	563	-294	2,156	-306	2,625	-115	2,434	30	2,289
Skilled-unskilled labor ratio		0.82	0.85	0.90	0.80	0.92	0.81	0.83	0.80	0.97	0.80
Capital/labor abundance				Capital		Capital		Capital		Capital	
Skilled/unskilled abundance				Unskilled		Unskilled		Unskilled		Skilled	

Note:
Given factors a and b, where a_t, b_t, a_c, and b_c are the amounts of a and b embodied in net trade and consumption,
Leamer (1980) shows that the country is relatively more endowed in a if and only if one of the following three conditions hold:
(i) $a_t > 0, b_t < 0$,
(ii) $a_t > 0, b_t > 0, a_t/b_t > a_c/b_c$, or
(iii) $a_t < 0, b_t < 0, a_t/b_t < a_c/b_c$

With respect to the disaggregated trade data, South Africa is revealed through trade to be capital rich in comparison with each of its trading partners.[12] It is not surprising that South Africa would be capital abundant relative to its low-income trading partners, given its level of income and the development of the manufacturing sector. However, it is surprising that South Africa's trade with richer countries suggests that it is relatively more capital abundant. The disaggregated data also indicate that South Africa has relatively more unskilled labor than its high- and medium-income trading partners and relatively more skilled labor than its low-income partners both of which are intuitively appealing results.

It is interesting to note that the difference between the capital-labor ratios in trade versus those in consumption increased over time. This suggests, although not in any rigorous way, that South Africa's use of capital increased during the 1990s.

As indicated in Section III.B, the standard empirical test of the HOS theorem could be biased to the extent that imported intermediate inputs are assumed to have the same factor services embodied in them as domestically produced counterparts. To avoid this potential problem, a modified factor content test was carried out, comparing the domestic factor services embodied in "final" net exports (i.e., exports minus imports of final goods) and the corresponding factor services embodied in consumption.

Table 6 presents the results of the factor content analysis under the modified approach proposed by Hakura (1999). This exercise produced even stronger results than those obtained with the standard factor content approach. South Africa was a net exporter of capital services (37) and a net importer of labor services (-112.3), suggesting that South Africa is overwhelmingly capital abundant.[13]

B. Cross-Commodity Regression Approach

This analysis also focuses on net exports of the various manufacturing goods sectors. Tables 7-8 present the regression results that use a simple ordinary least squares (OLS) estimation procedure, while Tables 9 and 10 contain the results of the logit analysis. For the OLS regressions, the dependent variable is net exports scaled by total trade, the scaling being necessary to keep the explanatory variables from picking up the effect of size. As the theory is agnostic about the quantitative magnitude of the parameters, only their sign (along with the statistical significance) is reported. All t-statistics are computed based on White's heteroscedasticity-consistent standard errors.

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[12] South Africa is a net exporter of factor services to low-income countries but a net importer from high-income countries. The appropriate test condition to determine relative factor abundance is therefore different, but in both cases the conclusion is similar.

[13] This test was carried out at the aggregate level only because data on intermediate and final good imports from individual trading partners were not available.

Table 6. South Africa: Factor Services Embodied in Actual Trade and Consumption--Extended Hecksher-Ohlin Version, 1997

Factor	Units	Total Trade			Consumption
		Exports	Imports	Net trade	
Capital	Billions of rand	91	54	37	359
Labor	Thousands of man-years	493	605	-112.3	3,482
Capital-labor ratio		0.184	0.089	0.117	0.103
Skilled labor	Thousands of man-years	220	279	-60	1,540
Unskilled labor	Thousands of man-years	273	326	-53	1,943
Skilled-unskilled labor ratio		0.81	0.86	1.13	0.79
Capital/labor abundance		**Capital**			
Skilled/unskilled abundance		**Unskilled**			

Note:

Given factors a and b, where a_t, b_t, a_c, and b_c are the amounts of a and b embodied in net trade and consumption,

Leamer (1980) shows that the country is relatively more endowed in a if and only if one of the following three conditions hold:

(i) $a_t > 0$, $b_t < 0$,

(ii) $a_t > 0$, $b_t > 0$, $a_t/b_t > a_c/b_c$, or

(iii) $a_t < 0$, $b_t < 0$, $a_t/b_t < a_c/b_c$

Table 7. South Africa: Results of OLS Regression Analysis, 1997

	Total	Total	High Income	High Income	Middle Income	Middle Income	Low Income	Low Income
	Dependent Variable: Net Exports/Total Trade
Constant	-2.75 ***	-1.27	-3.18 ***	-1.42	-0.35	0.36	-2.71 ***	-0.77
Capital-labor ratio	4.74 ***	3.53 ***	2.70 ***	1.23	0.42	-0.32	3.99 ***	3.11 ***
Skilled-unskilled labor ratio	-2.28 **	-2.21 **	0.14	0.37	1.21	1.20	-1.55	-1.87 *
Intermediate imported inputs		-0.51		-0.55		-0.55		-2.08 **
Resource inputs 1/		0.19		1.40		0.91		-0.41
Adjusted R-squared	0.28	0.23	0.14	0.22	-0.02	-0.01	0.25	0.30
R squared	0.33	0.35	0.21	0.34	0.06	0.15	0.30	0.41

Notes: Numbers denote t-statisics. ***represents significance at 1 percent, ** at 5 percent, and * at 10 percent.
1/ Direct intermediate inputs of the agriculture and mining sectors.

Table 8. South Africa: Results of OLS Regression Analysis with Pooled (1989 and 1997) Data

	Total	Total	High Income	High Income	Middle Income	Middle Income	Low Income	Low Income
	Dependent Variable: Net Exports/Total Trade
Constant	-1.31	-2.64 ***	-1.33	-2.94 ***	0.55	-1.80 *	-0.79	0.03
Dummy 1/	0.74		0.37		-1.40		2.07 **	
Capital-labor ratio	3.99 ***	5.56 ***	2.29 **	3.59 ***	0.15	0.93	3.37 ***	2.04
Dum_kl 2/	-1.06		-0.07		0.90		-3.13 ***	
Skilled-unskilled labor ratio	-2.40 **	-3.66 ***	-0.11	-0.72	0.90	1.48	-1.82 *	-1.74
dum_su 3/	-0.99		-1.84 *		-0.88		0.72	
Intermediate imported inputs	-0.68		-1.34		-1.24		-1.69 *	
dum_imp 4/	0.50		1.14		1.16		1.77 *	
Adjusted R-squared	0.33	0.32	0.25	0.17	0.24	0.01	0.46	0.37
R squared	0.42	0.34	0.35	0.20	0.34	0.05	0.53	0.01

Notes: Numbers denote t-statisics. ***represents significance at 1 percent, ** at 5 percent, and * at 10 percent.
Dependent variable : Net Exports/Total Trade.
1/ Dummy = 1 in 1989; 0 in 1997.
2/ Dum_kl = Dummy * capital labor ratio.
3/ Dum_su = Dummy * skilled-unskilled labor ratio.
4/ Dum_imp = Dummy * intermediate imported inputs.

Table 9. South Africa: Results of Logit Regression Analysis, 1997

	Total	Total	High Income	High Income	Middle Income	Middle Income	Low Income	Low Income
Dependent variable is a binary variable: If net exports > 0, dependent variable = 1; 0 otherwise.								
Constant	-1.91 *	-0.63	-1.98 **	-1.18	-1.83 *	-0.89	-1.91 **	-0.63
Capital-labor ratio	2.62 ***	2.88 ***	2.73 ***	2.70 ***	1.87 *	1.15	2.62 ***	2.88 ***
Skilled-unskilled labor ratio	-1.58	-1.68 *	-1.72 *	-1.76 *	-0.57	-0.35	-1.58	-1.68 *
Intermediate imported inputs		-2.31 **		-0.86		-0.46		-2.31 **
Resource inputs 1/		-1.54		-0.50		1.30		-1.54
L-R statistic	8.58 ***	12.33 ***	10.31 ***	11.02 **	5.89 **	8.80 *	8.58 ***	12.33 ***
R squared	0.26	0.37	0.30	0.32	0.16	0.25	0.26	0.37

Notes: Numbers denote t-statisics. ***represents significance at 1 percent, ** at 5 percent, and * at 10 percent.
1/ Direct intermediate inputs of the agriculture and mining sectors.

Table 10. South Africa: Results of Logit Regression Analysis with Pooled (1989 and 1997) Data

	Total	Total	High Income	High Income	Middle Income	Middle Income	Low Income	Low Income
Dependent variable is a binary variable: If net exports > 0, dependent variable = 1; 0 otherwise.								
Constant	-0.87	-1.81 *	-1.26	-1.97 **	-0.84	-2.13 **	-0.40	0.43
Dummy 1/	0.76		1.00		0.04		1.42	
Capital-labor ratio	2.37 ***	3.45 ***	2.45 ***	2.89 ***	1.77 *	2.26 **	-0.38	0.01
Dum_kl 2/	-0.36		-1.18		-0.69		0.07	
Skilled-unskilled labor ratio	-1.55	-2.21 **	-1.72 *	-1.21	-0.71	0.17	1.25	0.45
dum_su 3/	-1.39		-0.60		0.39		-1.54	
Intermediate imported inputs	-1.63 *		-0.82		-1.06		-0.60	
dum_imp 4/	1.37		-0.50		0.06		1.14	
L-R statistic	25.17 ***	18.73	20.43 ***	10.36 ***	13.26	6.66 **	8.21	0.37
R squared	0.36	0.27	0.03	0.16	0.20	0.10	0.15	0.01

Notes: Numbers denote t-statisics. ***represents significance at 1 percent, ** at 5 percent, and * at 10 percent.
1/ *Dummy* = 1 in 1989; 0 in 1997.
2/ *Dum_kl* = *Dummy* * capital labor ratio.
3/ *Dum_su* = *Dummy* * skilled-unskilled labor ratio.
4/ *Dum_imp* = *Dummy* * intermediate imported inputs.

The regressions were done using 1997 data only (Tables 7 and 9), and also pooling the 1989 and 1997 data (Tables 8 and 10). Two specifications were used to study the determinants of overall trade in manufactured goods, as well as of trade with the high-, middle-, and low-income countries separately. The first specification used the capital-labor ratio and the skilled-unskilled labor ratio as the two explanatory variables, while the second specification used the capital-labor ratio, the skilled-unskilled labor ratio, but also controlled for the economy's intermediate import and resource intensities.

The OLS and logit regressions using the 1997 data produced similar results. First, consistent with the calculation of the rank correlation coefficients in Section II, the coefficient on the capital-labor ratio is positive and significant in relation to net exports to high-income partners. This outcome indicates that, the higher the capital-labor ratio in the production of a commodity, the greater the probability that South Africa will be a net exporter of that commodity. This result holds generally, even after controlling for resource intensity.[14] In other words, South Africa's trade is not capital intensive because it is also concurrently resource intensive, as the ILO study tended to suggest. Second, the coefficient on the skilled-unskilled labor ratio is negative and significant for trade with high-income partners, indicating that, the higher the skilled-unskilled labor ratio in the production of a given commodity, the lower the probability that South Africa will be a net exporter of that product. That coefficient, however, is insignificant for trade with medium-income partners.

The results from the pooled sample reinforce those obtained for 1997, in that South Africa's trade is shown to be overwhelmingly capital-intensive, especially with its high-income trading partners. In addition, the negative value of the variable formed by interacting a time dummy with the capital-labor ratio coefficient (*dum_kl*), indicates that the capital intensity of net exports to high-and medium-income countries increased over the 1989-97 period.[15] This dummy is not always significant, however. Nevertheless one can infer that the trend toward capital-intensive methods of production has not been reversed during the 1990s.

VI. CONCLUSION

Intuition suggests that, relative to its trading partners, South Africa should be labor abundant and thus be a net exporter of relatively labor intensive goods. But the preceding analysis, whose results are unambiguous and robust across various testing approaches, indicates that South

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[14] For trade with middle-income countries, the results are more ambiguous. The logit analysis suggests that, when resource intensity is accounted for, the capital-labor ratio loses its significance as an explanatory variable. However, the OLS regression indicates that the capital-labor ratio is significant even after controlling for resource intensity.

[15] The dummy variable was set equal to 1 in 1989 and 0 in 1997.

Africa is revealed through trade to be relatively capital abundant and a net exporter of capital intensive goods. Surprisingly, this result is particularly strong in South Africa's trade with high income countries.

The fundamental proposition of the HOS theorem is the notion that, with identical production technologies and preferences across countries, different factor endowments will result in different autarchy factor prices, i.e., country A, with relatively more capital than labor compared with country B, will have a lower price of capital and will consequently have a comparative advantage in producing and exporting the good that uses capital intensively.

However, despite South Africa being more well endowed with labor in physical terms (relative to capital) when compared with its high income trading partners, this physical labor abundance has not translated into a lower price of labor (relative to capital) in South Africa and thus not resulted in a comparative advantage in the production and export of labor intensive goods. In fact, the opposite has occurred.

What does this say about South Africa's labor market, especially in the context of the country's large unemployment rate and implied under-utilization of its labor resources? Clearly, a comprehensive understanding of this problem would require analysis of the labor market itself. However, the evidence from an analysis of South Africa's pattern of trade suggests that the cost of labor relative to capital is too high. This may reflect, in part, the lingering effect of old apartheid policies that encouraged the under-utilization of labor resources via subsidies for capital intensive techniques; low average labor productivity (indicative of a low skill base) and relatively sticky wages; and significant nonwage labor costs, including administrative and financial costs of compliance with aspects of the labor market legislation.

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