

## **Determinants of Trade, inter- and intra-industry trade in South Africa**

by

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### **1. INTRODUCTION**

The performance of South African manufactured exports has for the last decade occupied a pivotal role in ensuring economic stability and growth. The debt crisis in the mid-1980s provoked a switch from import substituting to export promoting policy. Manufacturing exports had to shoulder the burden of earning foreign exchange.

From 1985 to 1990, the percentage contribution of manufactured exports to total exports rose, achieving the highest positive average annual growth rate (10.78 percent) of any of the main economic sectors. Bell (1995) attributes this accelerated growth of manufactured exports to the depreciation of the Rand in 1983-85. In the early 1990s, a decline in export growth was experienced, despite the introduction of the General Export Incentive Scheme (GEIS) in 1990.

Having had the task of stabilising a debt crisis in the mid eighties, a decade later a new urgency for the growth of manufactured exports was defined. In 1996 an integrated economic strategy for South Africa was released. The GEAR strategy as the acronym represents, targeted growth, employment and redistribution as economic goals. The GEAR strategy placed a significant emphasis on the role of exports in generating the growth and employment prospects desperately needed in the South African economy. The integrated scenario presented in the GEAR strategy requires that real non-gold exports grow at an annual average rate of 8,4%. The GEAR strategy proposes to achieve the superior performance in exports as projected in the integrated scenario, through continued commitment to free trade. In particular it asserts that import liberalisation, as achieved by an accelerated reduction in

tariffs, will generate export growth and provide the impetus for economic growth. In addition, a significant element of the GEAR plan was devoted to an industrial policy and export incentive scheme which outlined numerous supply side policy measures aimed at stimulating exports.

More importantly the GEAR strategy emphasises the need for growth to be employment creating. Alan Hirsch, director of the Department of Trade and Industry states that " growth must create jobs. Schemes to promote growth under the old regime tended to lead, through incentives based on artificially low interest rates and on incentivising the volume of investment, to relatively jobless growth." (Hirsch, pp.3) Schemes under the old regime related mainly to GEIS subsidies which placed strain on fiscal resources and were argued to be ineffective. As such the GEIS incentives have ceased to operate as from July 1997 and are to be replaced by "market-led supply-side support measures". The supply side support measure (SSM) agenda has several elements which contain a range of strategies and programs. These include:

- Technology promotion or innovation support
- Investment support - in 1996 the government introduced a tax holiday programme designed to provide incentives to downstream and relatively labour abundant manufacturing industries. In addition the depreciation allowance has been accelerated. The fundamental question that arises is whether such policies although targeted towards labour intensive industry have promoted the substitution of capital for labour in order to apparently raise productivity and consequently competitiveness.
- Export support measures - this program assists firms undertake export marketing expenditures through matching grants.
- Provision of finance guarantees to small, medium enterprises.

There are two fundamental issues that this paper then addresses. The first concerns establishing the determinants of South Africa's manufactured exports and imports with the aim of identifying gaps in our ability to generate export growth, particularly in high value added sectors. The second issue is whether South African exports may be considered

employment enhancing. Increases in the growth of employment associated with export growth, depend on changes in the relative factor-intensity of export production.

The current study attempts at both a theoretical and empirical level to understand the relationship between factor intensities (requirements) and exports. It attempts to determine at industry level which factors explained export success in the period 1988 to 1993 and therefore, whether current supply side measures and related policies, are likely to succeed in fostering the dual objectives of export and employment growth .

## **2. REVIEW OF TRADE THEORY & MODEL SPECIFICATION**

### **2.1 TRADE THEORY**

The supply theories of international trade identify differences in relative factor endowments and methods of production as the key determinants of trade patterns. There are several variations in the general proposition. Ricardian theory focuses on labour as the relevant factor of production, and suggests that differences in labour productivity exist across commodities, where each commodity has a unique method of production (i.e. a given input of labour). The differences in techniques of production across countries would give rise to differences in the relative prices of commodities, thereby forming a basis for trade.

In contrast, the Heckscher-Ohlin model in its two factor version, considers both capital and labour and assumes that the same techniques of production for all commodities are available in all countries. It concludes that relative differences in factor endowments between countries create a basis for trade. Evidently, it is relative abundance or scarcity of a resource that will imply lower or higher factor costs and consequently lower or higher relative prices of commodities between countries. The Heckscher-Ohlin model reveals that a country should export the commodity that uses relatively intensively the relatively abundant factor of production, and import the commodity which uses relatively intensively the relatively scarce resource.

The Heckscher-Ohlin model is somewhat more sophisticated than the Ricardian theory in acknowledging that there exists at least some commodities that can be produced with various techniques (i.e. using a number of combinations of capital and labour). This then means that it is not only the relative abundance of a resource that will be important in determining the comparative advantage of a country but also the intensity of the use of resources in producing the commodities across different countries that will determine a pattern of trade.

Leontief's apparently paradoxical findings provoked the introduction of other factors additional to capital and labour, as determinants of trade patterns. In particular the neo-factor proportions model, retains the neo-classical framework but regards differences in the composition of the labour force as an important determinant of comparative advantage. In this instance, labour is not treated as a homogenous entity. Differences between countries in the supply of skilled, semi-skilled and unskilled labour may account for a source of comparative advantage.

Finally the neo-technology model identifies the inherent differences in intercountry and interindustry ability to innovate and consequently exploit new methods and technology, as a factor crucial to determining trade patterns. Unlike the aforementioned theories this model does not assume that all countries have the same wealth of knowledge available to them. As such not only will the techniques used to produce commodities differ between countries, but so will their capacity to develop new products. This theory is aligned to the Product Cycle theory of trade. In addition recent empirical applications have sought to explain the pattern of trade as dependent upon the differences in economies of scale across industries. Economies of scale and imperfect competition form the basis of explanations for intra industry trade, whereas the earlier Heckscher-Ohlin theories have explained inter-industry trade.

The current study has sought to encompass the various elements of these paradigms in order to assess the influence of a wider range of factors than the endowments of aggregate capital and labour on the South African pattern of trade in manufactures between 1988 and 1993.

## 2.2 MODEL SPECIFICATION

Cross-commodity regressions have been conducted on ISIC four digit level data. Along the lines of the neo-factor proportions model, labour requirements have been disaggregated on the basis of skill. Skill has been proxied by race in this study. In recognition of the neo-technology theory, the ability to innovate of an industry has been proxied by the level of Research and Development (R&D) expenditure undertaken. In keeping with recent empirical applications, the scale economies of industries have also been included. The model is varied in terms of the trade variable considered. The production function type explanatory variables are applied in separate regressions to industry export levels, import levels and finally to the trade balance of a particular industry.

### 2.2.1 Theoretical Model

The model estimated in this study can therefore be denoted:

$$X_i = a_1 K_i + a_2 LS_i + a_3 LSM_i + a_4 LU_i + a_5 RD_i + a_6 NR_i + a_6 SE_i + a_0 \quad (i)$$

$$M_i = a_1 K_i + a_2 LS_i + a_3 LSM_i + a_4 LU_i + a_5 RD_i + a_6 NR_i + a_6 SE_i + a_0 \quad (ii)$$

$$(X - M)_i = a_1 K_i + a_2 LS_i + a_3 LSM_i + a_4 LU_i + a_5 RD_i + a_6 NR_i + a_6 SE_i + a_0 \quad (iii)$$

Where:

$X_i$ ,  $M_i$  : represent the levels of exports and imports in industry  $i$ ,

$K_i$  represents the direct and indirect capital requirements of an industry,

$LS_i$ ,  $LSM_i$ , and  $LU_i$  represent the total requirements in a particular sector of skilled, semi-skilled and unskilled labour respectively,

$RD_i$  attempts to proxy the innovative capacity of industry  $i$ ,

$NR_i$  is a dummy variable indicating natural resource intensive activities; and finally

$SE_i$  represents the economies of scale operating within a certain sector.

This study differs from similar papers by treating the endowments of capital and labour not as physical stocks within an industry producing a certain product, but also by examining backward linkages. Both the direct and indirect capital and labour requirements of an industry are taken into account. In this way recognition is given to the general proposition of the Heckscher - Ohlin model that it is not only the level of capital and labour embodied in a country that determines a source of comparative advantage but also the production technique used (i.e. relative intensity of use of capital or labour). A more complete

## **2.3. DATA**

### **2.3.1. Dependent Variables**

#### ***Trade levels - Exports ( $X_i$ ), Imports ( $M_i$ ) and Trade balance ( $X_i - M_i$ )***

Data on the level of exports, imports and trade balance of each industry was obtained from the Industrial Development Corporation (IDC) sectoral data set. The trade levels were measured in hundred thousand rands.

### **2.3.2. Independent Variables**

#### ***(i) Total Factor Requirements ( $K_i$ , $Lu_i$ , $Lsm_i$ , $Ls_j$ )***

Direct capital requirements were calculated as the physical stock of capital in an industry at each point in time (1988 and 1993) divided by the total annual output of that sector. Likewise, direct labour requirements were expressed as the number of man hours embodied in a Rand of final output of any sector. However, since each sector is reliant upon many others in the economy for intermediate inputs to its own production process; it depends indirectly on the factor requirements of other industries. Leontief input-output analysis was therefore, conducted in order to arrive at the total labour and capital requirements of a sector.

In order to disaggregate labour requirements, skill levels were proxied on the basis of race. Black workers were considered unskilled, coloured and asians semi-skilled and white labour

was classified as skilled. Although this classification of skill appears crude, the period 1988 to 1993 is not associated with the upward mobility of black labour.

**(ii) Research and development ( $RD_i$ )**

This variable measures the propensity to innovate in industry  $i$  as the actual expenditure on research and development, normalised by the sales of this industry. As Scerri remarks "the use of an R & D variable is largely accepted though not unquestioned, in the case of first world industrialised economies." However, in the case of developing countries where a significant proportion of technology is in fact imported, R&D statistics may be argued to be a less reliable estimate of a country to innovate new processes and methods. As always in the case of South Africa where data on imported technology is in many instances unavailable, it is essential to follow the suggestion of Scerri that the inclusion of the R&D variable should be intended to indicate domestic R&D activity and only tentatively proxy locally generated technology and innovative capacity. A scale economies variable is often used together with an R&D variable, as the fundamental constructs of the neo technology model.

**(iii) Economies of Scale ( $SE_i$ )**

The scale economies in industry  $i$  are proxied by the ratio of the output in industrial sector  $i$  in rand million per annum and the total output of the manufacturing industry per annum. This may at the outset seem to be an imprecise measure of scale economies. The primary purpose of its inclusion in the regression equation is as a measure of scale effects. The dependent variables in all regression equations relate to absolute levels of either exports, imports or the trade balance and as such it is necessary to control for the difference between those commodity groups that form a large share of output and consumption and others that form small shares. "If no attempt is made to control for scale, any explanatory variable that is correlated with the size of the commodity group will pick up the scale effect. To put this another way, without some way to correct for the relative sizes of different commodity groups,

the estimates will be highly sensitive to the level of aggregation." (Leamer,1994) In a regression equation that includes a scale effect variable, one may interpret each variable with confidence that all other variables are held constant including industry size.

The primary purpose of this scale variable is therefore, not in the traditional sense attempting to establish a likely relationship between where an industry is located on it's long run average cost curve and its level of exports and imports. In making a heroic assumption, one may be tempted to argue that industries with a larger share of output and consumption are more likely to experience economies of scale in the conventional economic sense.

**(iv) *Natural Resource Intensity***

A categorical variable was created to account for those industries associated with a high intensity of natural resource use. These sectors included the Ricardian sectors, food, beverages, tobacco, paper and related products, wood and wood products, leather as well as the non-metallic mineral industry, and the basic iron and steel and non-ferrous mineral sectors.

### **3. METHODOLOGY**

Two approaches were taken in the empirical application of the supply side models of trade to South African trade and industry data for the period 1988 to 1993. Firstly, pooled cross section regressions were undertaken in order to determine key features of South Africa's pattern of trade. A probit regression was then conducted to analyse the probability of an industry being a net exporter.

#### **3.1 POOLED CROSS SECTIONAL ANALYSIS**

The pooling of cross sectional data introduces two concerns regarding violations of the OLS method. Cross sectional data needs to be carefully analysed for heteroscedasticity, whereas



the time series element of pooling introduces the possibility of autocorrelation. Under both autocorrelation and heteroscedasticity, the usual OLS estimators, although unbiased, no longer represent the minimum variance among all linear unbiased estimators.

The concern with autocorrelation arises from the fact that the current regression pools cross sectional annual data from two points in time, namely 1988 and 1993. However, since  $t$  is small, there is no way to detect the pattern of correlation and its consequent remedy. In addition the argument is put forward, that since there is a sufficiently large lag between the two time points at which observations are taken, autocorrelation is unlikely to have significant effects on the analysis.

Regarding heteroscedasticity however, the current study employs the Cook-Weisberg test for heteroscedasticity. This test looks for heteroscedasticity by modelling the variance as a function of the fitted values of the dependent variable,  $Var(e) = \sigma^2 \exp(Zt)$ . The results of the test are reported for each regression equation in section 4. The test uses a Chi square distribution and establishes a null hypothesis that heteroscedasticity prevails. The Chi Square statistic and corresponding probability that emerges from the test, will support either the acceptance or rejection of this hypothesis.

In instances where heteroscedasticity was detected and since the true variance ( $\sigma^2$ ) is unknown, Huber's robust regression has been used to obtain consistent estimates of the variances and covariances of OLS estimators. The estimate is performed so that asymptotically valid statistical inferences can be made about the true parameter values. Huber's heteroscedasticity-corrected standard errors are considerably larger than OLS standard errors. Therefore, the estimated  $t$  values are generally smaller than those obtained by OLS. Whilst this method does not eliminate heteroscedasticity, it alters standard errors so that  $t$  and  $F$  tests are more prudent thereby, conferring confidence in the inferences and predictions made.

### **3.2 MAXIMUM LIKELIHOOD MODEL: PROBIT ANALYSIS**

The second type of model to be applied to this data is a maximum likelihood model which attempts to examine the probability of industries being net exporters, given the general factor input explanatory variables outlined by the Heckscher Ohlin theoretical model. The motivation for such a model comes from a similar study on factor inputs in U.S trade by Branson and Monoyios undertaken in 1973. The authors make the point that "It could be that the probability of an industry being a net exporter rises with capital intensity of production, but demand conditions cause capital- intensive industries to be small or net importers. One way to test for this possibility is to convert the dependent variable to a binary form and use a probability model, probit or logit."

It is assumed that the probability of an industry being a net exporter follows a normal density function, and due to the non-linearity of a function with a categorical dependent variable, a maximum likelihood technique is applied. There is no significance in the choice of a probit model over a logit model . Both are evaluated by a maximum likelihood method that multiplies the probability of individual entries and finds parameters that will maximise the probability. The results are usually not very different except when data is heavily concentrated in the tails of the distributions. A linear probability model assesses the rate of change of the probability. In this case, it would explain how the probability of being a net exporter alters given the various factor content characteristics specified as exogenous variables.

## **4. RESULTS**

### **4.1 INITIAL STATISTICAL ANALYSIS**

The first stage of analysis consisted of examining the graphical relationships between the level of exports and imports and factor requirements. Some of the more interesting results are presented below.

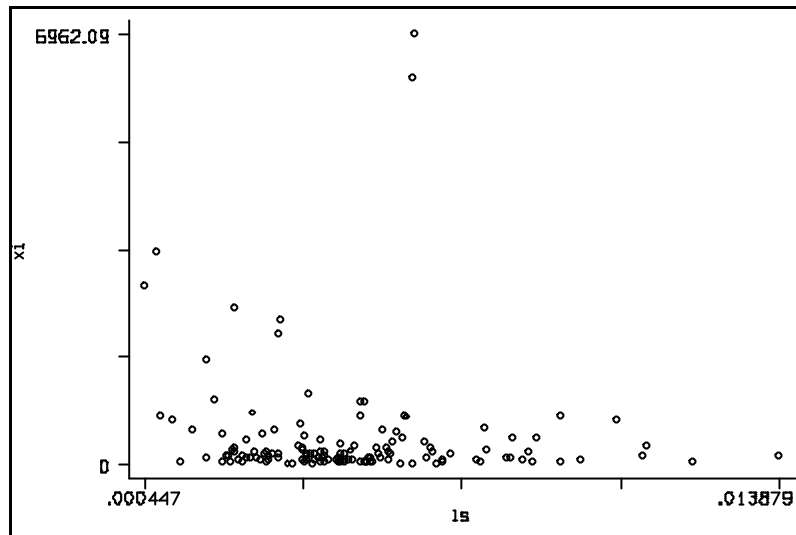


Figure 1 : Export Level Vs. Skilled Labour Requirements

Plotting industry export levels against direct and indirect skilled labour requirements of sectors, resulted in a graph which hinted at a negative relationship between the two variables. In other words, the graph suggests that as the requirements of skilled labour rises at sectoral level, so there is a decline in the level of exports of that particular industry. It is also evident that there are two distinct outliers which were identified as the basic iron and steel industry and the industrial chemicals sector, where clearly this negative relationship between skilled labour intensity and export performance does not hold.

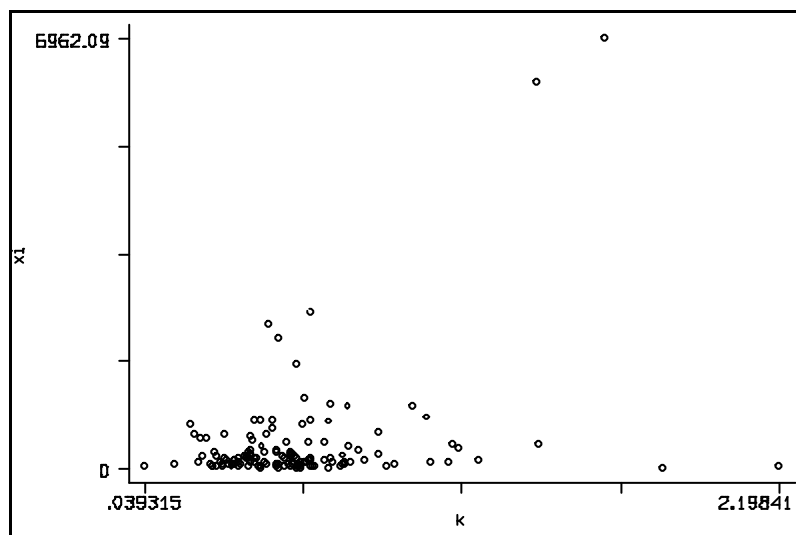


Figure 2 : Export levels Vs. Capital Requirements

Figure 2 examines the relationship between export performance and the capital intensity of an industry. This two way plot seems to suggest that there exists a positive relationship between

the two variables. At this initial stage of statistical exploration, a pattern seems to emerge that suggests that South African exports are capital intensive but involve relatively less skilled labour.

In addition a positive relationship between import levels and the skilled labour requirements of an industry is observed in figure 3.

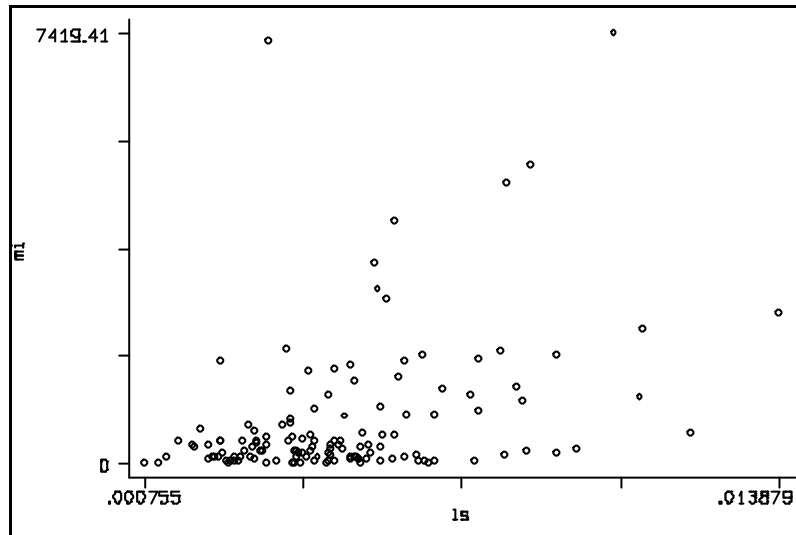


Figure 3: Import levels Vs. Skilled labour requirements

There appears to be a positive correlation between capital intensity and export levels, an observation that seems to have similar support in the findings of Bell and Cattaneo. Export levels share a negative relationship with skilled labour intensity. Finally, imports seem to be positively correlated with labour that is relatively more skilled. Although the analysis at this stage is very elementary, it draws attention to relationships which are ratified by multivariate regressions.

**4.2 CROSS COMMODITY REGRESSION RESULTS**

Cross commodity pooled regressions were undertaken at the four digit level ISIC classification. The independent variables comprised the Heckscher-Ohlin factor content variables, in this study indirect and direct capital and labour requirements were considered. The neo-factor proportions model contributed to the specification in that labour was not deemed homogenous but rather disaggregated on the basis of skill. Finally the inclusion of a variable relating to research and development expenditure was included in accordance with

the ideas embodied in the neo-technology theory. This model was initially estimated without considering industry specific features; thereby excluding industry dummy variables.

Table 1: Determinants of South African Imports & Exports

EXPLANATORY VARIABLES	DEPENDENT VARIABLE		
	Exports	Imports	Trade Balance
Economies of Scale (SE <sub>i</sub> )	32331.27 (10.12)*	412723.44 (9.331)*	-8972.03 (1.547)
Unskilled Labour (Total Requirements) (L <sub>u<sub>i</sub></sub> )	1487.94 (1.760)**	-21043.74 (1.718)**	22531.68 (1.384)
Semi skilled labour requirements (L <sub>sm<sub>i</sub></sub> )	-61.55 (0.005)	-5489.16 (0.286)	-3426.35 (0.139)
Skilled labour requirements (L <sub>s<sub>i</sub></sub> )	-58828.17 (2.090)*	189654 (4.924)*	-248479.2 (4.854)*
Capital requirements (K <sub>i</sub> )	967.44 (4.931)*	-299.99 (1.116)	1245.42 (3.287)*
R&D	-31219.57 (0.483)	201354 (2.274)*	-232573.6 (1.976)**
Natural Resource intensive	381.59 (1.470)	-489.93 (2.439)*	709.07 (2.723)**
1988 Year dummy variable	-12.46 (0.093)	-154.21 (0.837)	141.75 (0.579)
Constant	-145.86 (0.715)	-214.10 (0.766)	68.24 (0.184)
Number of Observations (N)	132	132	132
F- statistic ( 8, 123) Probability > F	19.13 0.0000	19.84 0.0000	5.92 0.0000
R <sup>2</sup> Adjusted R <sup>2</sup>	0.5484 0.5197	0.5575 0.5294	0.2731 0.2270
Cook-Weisberg test for heteroscedasticity $\chi^2$ Probability > $\chi^2$	357.49 0.0000	102.31 0.0000	2.70 0.1005

Note: Figures in parentheses denote t-statistics. A single asterisk signifies that the result is significant at all conventional levels, whereas a double asterisk indicates a result significant at the 10 % level.

#### **4.2.1 Export levels as the dependent variable**

##### Overall Significance of the model

The F-test establishes a null hypothesis that there is no explanatory power in the model. In the current regression equation, the F distribution is used to consider the possibility of obtaining the F statistic of 19.13, if there is in fact no explanatory power in the model. Since there is practically zero probability of this statistic being attained by chance, the null hypothesis is rejected and it can be accepted that this model provides a significant account of the level of industry exports. The R-square statistic considers the goodness of fit of the fitted regression line. In the case at hand, 54.45 percent of the total variation in exports is explained by the regression model.

##### Test for Heteroscedasticity

The Cook Weisberg test resulted in a  $\chi^2$  statistic of 357.49. Since there is virtually zero probability of this result being achieved if heteroscedasticity prevailed, the null hypothesis of the test is rejected. The model is shown to have constant variance and covariance and therefore, has not violated a fundamental assumption of the Least Square regression method. Confidence may then be placed on the conventional t-tests employed.

##### **Establishing the determinants of export levels**

The results of the OLS regression seem to suggest that export levels were positively linked to the size of an industry. The economies of scale variable ( $SE_i$ ) is associated with a positive coefficient which is statistically significant at all conventional levels, indicating that larger industries tended to export more. This is perhaps the purest interpretation of a simple variable that represents the size of an industry relative to the entire manufacturing sector. Extending the interpretation of this result any further, would mean advancing the argument that scale economies in production enhance competitiveness. This interpretation is only valid if one accepts the implicit assumption that larger industries are more likely to experience economies of scale in production.

Insofar, as factor intensities are concerned, an interesting pattern emerges. Those industries with relatively higher skilled labour intensity tend to export less, holding other factors constant. The skilled labour requirement variable has a negative coefficient which is significant at all conventional levels. Since it is an undisputed feature of the South African labour market that there exists a relative abundance of unskilled labour and relative scarcity of skilled labour, this result is orthodox in terms of the Heckscher-Ohlin model. It is difficult to become an exporter of skilled labour intensive commodities if the cost of this input is raised through domestic competition for this quality of labour. Furthermore, exports tend to embody a higher level of unskilled labour, this result being significant at the 10 percent level of significance.

The outcome on the capital requirements variable being positive and statistically significant at all conventional levels, is supported by a similar finding by Rouqe for the period 1970 to 1980 and by Bell and Cataneo in their factor intensity study. This prompted Rouqe to find alternative explanations for this result in the belief that South Africa suffered from a relative shortage of capital and therefore, conventional trade theory could not explain the empirical result that the manufacturing sector should enjoy a comparative advantage in capital intensive commodities. The counter argument is of course that South African manufacturing has through past policy and associated factor price distortions, in fact become relatively capital intensive. The structure of factor prices faced by producers in the past has encouraged capital intensive activities and the adoption of more capital-intensive production techniques. Past industrial incentive strategies instituted primarily through the tax regime, essentially subsidised investment in already capital intensive sectors. The tendency for the user cost of capital to have been lower in more capital intensive activities gave producers greater incentive to invest in these industries. Not only was the capital intensity of South African manufacturing raised by the policy measures that lead to the substitution of capital for labour, but as South Africa pursued a natural pattern of readily absorbing the abundance of unskilled labour into production, the economy experienced rising cost of unskilled labour before its surplus was exhausted. This again created an incentive for raising the capital intensity in production (Fallon and de Silva, 1994). In addition, the fact that comparative advantage relies on a *relative* abundance of a particular resource should not be overlooked. If South African

exports were directed toward sub-Saharan African economies, a relatively intensive use of capital in the production of these exports is highly plausible.

Turning attention to the propensity to innovate within the South African manufacturing sector, the proxy RDi, although negative appears as an insignificant determinant of export levels.

The positive and statistically significant outcome on the natural resource variable, indicates that natural resource intensity enhanced export levels, holding other variables constant. The South African economy has been argued to be a relatively natural resource abundant economy, and in keeping with the supply side models of trade, it should have a comparative advantage in products using natural resources relatively more intensively in production. This finding, in conjunction with a positive correlation between capital and unskilled labour intensity and export levels; suggests that South Africa tended to export beneficiated raw materials. The disturbing implication of this is that there are also capital hungry projects, sectors that have had to compete with natural resource intensive industries for capital and that have not been assisted by past policy. This becomes evident in interpreting the year dummy variable.

The dummy variable has a statistically insignificant result, implying that no structural shifts are evident in the sample. The inclusion of a categorical variable relating to the year 1988 allows one to determine whether export levels are significantly different from those in 1993, after having controlled for factor intensity in production. The finding that they are not has notable implications if interpreted in terms of policy. It indicates that trade policy implemented in this period was relatively ineffective in stimulating exports. The result supports the sentiment that the General Export Incentive Scheme (GEIS) implemented in 1990, midway in this data sample, was rather ineffectual. It is also notable that the sanctions effect is not being felt.

#### **4.2.2 Sources of comparative disadvantage - determinants of import levels**

##### Overall significance of the model



The F statistic on the import regression model rejects the hypothesis that the partial slope coefficients are simultaneously equal to zero at all conventional levels of significance, indicating that the estimated regression contains explanatory power. The residual square statistic ( $R^2$ ) indicates that 55.75 percent of the total variation in imports is in fact explained by the regression model.

#### Test for Heteroscedasticity

The Chi Square statistic of 102.31 indicates that there is virtually no probability that this result would have been achieved in the presence of heteroscedasticity. Therefore, since variance is constant, reliance may be placed on the conventional t-tests employed in OLS regression.

The estimated regression for imports indicates that relative industry size serves as a significant determinant of import levels. The coefficient on the economies of scale variable is positive and statistically significant. Interpreting this result as anything more consequential would be to suggest that the economies of scale variable as calculated in the current study assumes that relatively larger industries would tend to experience scale economies in production, and that this then causes the industry to import relatively more than smaller producers. This is a rather tenuous argument to be made for the relationship between the  $SE_i$  variable, as measured in this study, and import levels. As such it is preferable to perceive the function of the economies of scale variable in such a regression equation as controlling for industry size in a model that has not standardised import and export levels.

The results on factor intensity variables are consistent with the pattern of comparative advantage and disadvantage that began to emerge with the export regression estimates. Imported commodities tend to use relatively more intensively skilled labour which is relatively scarce in the South African context. The skilled labour requirements variable has a positive coefficient and is statistically significant at all conventional levels. This affirms the hypothesis that South Africa has a comparative disadvantage in the production of skill intensive goods. Furthermore, a negative coefficient is obtained on the unskilled labour variable. This result is significant at the 10 percent level of significance. This would mean that imports in general do

not seem to comprise unskilled labour intensive commodities. Again this result conforms with the outcomes in the export regression equation. South Africa seems to export commodities which are relatively unskilled labour intensive and imports goods which are relatively skilled labour intensive. This accords with the general idea that relative scarcity and abundance of resources creates the sources of comparative advantage and disadvantage within an economy.

The capital requirements variable has a negative coefficient complying with the results in the previous section which indicated a comparative advantage in capital intensive commodities. However, in the case of current estimation the result is not statistically significant. Perhaps of more interest then, is the positive and significant (at the 5 percent level) outcome on the research and development variable.

Viewed from a conventional trade theory standpoint, thinking in terms of relative endowments and correspondingly relative expenditures of R&D, it is expected that since South Africa does not invest in R&D to the same extent as its more innovative trading partners, its comparative advantage should lie away from product cycle or R&D intensive industries. This is a completely contradictory finding to that by Rouge in 1983. Rather than suggest that South Africa has seen a radical shift from comparative advantage to comparative disadvantage relating to research and development intensive commodities in the decade between the Moura Rouge study and this paper, the difference in results is attributed to the use of a more precise estimate of R&D variable in the current study. The Moura Rouge study proxies R&D as the ratio of skilled labour to the total labour force, whereas in the current regressions actual R&D expenditure standardised by the sales of an industry was used.

This result accords with the findings of a similar study undertaken by Scerri (1990) on data for the late seventies and early eighties. In finding R and D expenditures to be negatively correlated with net exports, Scerri concludes that comparative advantage in manufacturing is to be found in capital intensive industries, which employ a relatively low level of human capital and research and development.

This finding may be tentatively extended to argue that South African industries have suffered a comparative disadvantage in innovative capacity; suggesting that this corresponds with an economy that has in the past imported capital to be used in the production of relatively capital intensive commodities and yet lacked the ability to develop and exploit new technologies. Yet, it is with hesitation that this argument is advanced. Studies of innovation per se are only currently being explored after realising that R and D expenditures were not always a reliable proxy for innovation. In recent work in this area, some sectors have been found to be innovation intensive and yet engage in little research and development. Examples of such productivity-enhancing innovations include product design, trial production, training and tooling up and market analysis; all of which are not formally included in research and development expenditures.

The insignificant result on the year dummy again reveals no structural breaks in the data and suggests there was no significant change in the level of imports between 1988 and 1993 that could be attributed to policy.

#### **4.2.3 Trade Balance as the dependent variable**

##### Detection and correction of heteroscedasticity

The Chi Square statistic on the Cook Weisberg test gave rise to concern that heteroscedasticity was evident in the sample. Interpreting the statistic formally, there is a 0.01482 probability that this Chi Square statistic could have resulted in the presence of heteroscedasticity.

Heteroscedasticity may be dealt with in one of two ways. In some cases the cause or system of heteroscedasticity is known and theoretically substantiated. In this case it may be corrected by weighting variables and applying the generalised least square method (GLS). However, more often than not the systematic relationship between the variance and a variable in the model is not readily known or easily identified. Attempting to apply a generalised least square

regression often introduces spurious correlation. In this instance, as was the case at hand, rather than correcting the heteroscedasticity, a Huber robust standard errors regression was undertaken. The results of which are presented in Table 2.

Table 2: Results of Huber's robust standard error regression

EXPLANATORY VARIABLES	DEPENDENT VARIABLE
	Trade Balance
Economies of Scale (SE <sub>i</sub> )	-8972.03 (0.742)
Unskilled Labour (Total Requirements) (Lu <sub>i</sub> )	22531.68 (2.733)*
Semi-skilled labour requirements (Lsm <sub>i</sub> )	-3426.35 (0.251)
Skilled labour requirements (Ls <sub>i</sub> )	-248479.2 (4.353)*
Capital requirements (Ki)	1267.42 (1.753)**
Research and development (RD <sub>i</sub> )	-232573.6 (1.592)
Natural Resource intensive	709.06 (3.312)*
1988 Year dummy variable	141.75 (0.647)
Constant	68.24 (0.133)
Number of Observations (N)	132
R <sup>2</sup> Adjusted R <sup>2</sup>	0.3221 0.2780

Note: Figures in parentheses denote t-statistics. A single asterisk signifies that the result is significant at all conventional levels, whereas a double asterisk indicates a result significant at the 10 % level.

Comparing the results of the normal OLS and the Huber robust standard error regressions, it is obvious that while the coefficients have not altered, the t-statistics have changed. The Huber robust regression does not alleviate heteroscedasticity, but accounts for it in adjusting standard errors so that confidence intervals are widened and once again confidence may be placed on the conventional t-tests.

The results of the Huber regression, while confirming some of the prior results on comparative advantage and disadvantage, is somewhat disappointing in terms of its ability to explain

variation in the model. Whereas, the previous two regression equations were able to explain over 50 percent of the variation, the current model is only able to explain 32,21 percent of the variation in the trade balance. It appears that some of the explanatory power of the model is lost in combining the determinants of imports and exports.

The model is nevertheless, useful in that it yields results seemingly consistent with the ideas of South Africa's sources of comparative advantage and disadvantage that were proposed in interpreting the findings of the previous two regression estimates.

The coefficient on the unskilled labour requirement variable is positive and significant at the 1 percent level of significance. A positive and statistically significant outcome on the natural resource intensity variable once again confirms South Africa's comparative advantage in this area. There is a negative correlation between the skilled labour requirements and the trade balance, holding other variables constant. This relationship is statistically significant at all conventional levels. Finally, the negative coefficient on total capital requirements is positive and significant at the 10 percent level. Research and development expenditure appears to be insignificant in explaining the final effect on the trade balance.

Drawing together the results of all three regressions asserts the proposition that South Africa enjoys a comparative advantage in the production of capital intensive items which combine the intensive use of natural resources and unskilled labour. In addition, the South African manufacturing sector seems to experience a comparative disadvantage in skilled labour and R and D intensive production, tending to import these commodities. This finding does not seem fundamentally different to those obtained by Rouqe and Scerri, both of whom focused on seventies and early eighties data. It seems then that between 1988 and 1993, South Africa had still been unable to combine skilled labour and capital to produce a high value added exportable. The combination of unskilled labour and capital intensity of production, is indicative of South Africa's pattern of exporting beneficiated raw materials.

The next set of regressions retained the same supply side model, but included industry dummy variables in an attempt to observe whether industry specific characteristics were significant in explaining export performance and import intensity.

#### **4.3. CROSS COMMODITY REGRESSIONS INCLUDING INDUSTRY DUMMY VARIABLES**

The pattern of comparative advantage and disadvantage that emerged with the cross-commodity regression including industry dummy variables, accords in general with the findings of the previous set of estimations. The interpretation of the categorical dependent variables, however, yielded some interesting findings.

The F-statistic in all three regressions rejects the hypothesis that the partial slope coefficients are simultaneously equal to zero at all conventional levels. Of the 3 equations estimated, the R-square statistic exceeded 78 percent, with over 94 percent of the variation in exports being explained by the regression equation. The R-squared values are considerably greater than those resulting from the OLS regressions undertaken without the industry dummy variables, suggesting that industry specific factors account for a significant amount of the variation in exports and imports. The Cook Weisberg test for heteroscedasticity in all cases rejected the null hypothesis that variance was not constant.

Table 3: Pooled Cross Commodity Regression including industry categorical variables

EXPLANATORY VARIABLES	DEPENDENT VARIABLE		
	Exports	Imports	Trade Balance
Economies of Scale (SE <sub>i</sub> )	14946.21 (4.837)*	45751.14 (5.683)*	-30804.93 (3.832)*
Unskilled labour requirements (LU <sub>i</sub> )	7264.89 (1.335)	-11470.3 (0.809)	18735.19 (1.323)
Semi Skilled labour requirements (Lsm <sub>i</sub> )	12730.27 (1.313)	29934.36 (1.255)	-34755.45 (1.459)
Skilled labour requirements	-33930.61 (1.967)**	123480.8 (2.586)*	-157411.5 (3.302)*
Capital Requirements (K <sub>i</sub> )	256.27 (2.246)*	190.56 (0.641)	65.74 (0.221)
Research and Development (RD <sub>i</sub> )	-28264.56 (0.802)	-8223.42 (0.090)	-20041.15 (0.219)
Natural Resource Dummy (NR <sub>i</sub> )	771.43 (4.019)*	58.55 (0.156)	1655.41 (1.798)**
1988 Year Dummy	-52.89 (0.864)	85.26 (0.535)	-138.15 (0.867)
Food (312)	-854.96 (3.797)*	-353.05 (0.553)	-264.76 (0.683)
Beverages (313)	-977.80 (4.447)*	-132.74 (0.388)	-86.65 (0.253)
Tobacco (314)	-754.59 (2.914)*	-387.10 (0.726)	-403.50 (0.758)
Clothing (322)	-187.32 (0.706)	-1449.06 (1.926)**	-519.06 (0.503)
Leather and leather products (323)	-504.39 (2.553)*	-342.24 (0.750)	-263.56 (0.578)
Footwear (324)	-247.22 (1.157)	-218.01 (0.207)	156.14 (0.261)
Wood and wood products (331)	-760.33 (2.707)*	-362.78 (0.592)	-322.36 (0.527)
Furniture (332)	-144.53 (0.736)	-358.31 (0.641)	372.48 (0.668)
Paper and pulp (341)	-48.35 (0.335)	-81.96 (0.245)	119.05 (0.356)
Printing (342)	-181.03 (0.769)	251.34 (0.252)	-174.41 (0.264)
Chemicals (351)	271.39 (1.631)	1136.39 (1.129)	-256.50 (0.548)
352	41.62 (0.301)	581.80 (0.599)	-2071.05 (2.136)*
Rubber (355)	-26.22 (0.170)	684.63 (0.661)	-105.78 (0.245)
Plastic (356)	-273.25 (1.376)	-105.18 (0.106)	437.25 (0.785)
Pottery (361)	-92.93 (0.474)	-21.14 (0.221)	-94.30 (0.172)



EXPLANATORY VARIABLES	DEPENDENT VARIABLE		
	Exports	Imports	Trade Balance
Glass (362)	47.67 (0.235)	-27.57 (0.821)	-421.73 (0.799)
Other non-metallic mineral products (369)	-197.04 (1.177)	-175.59 (0.410)	-434.95 (1.018)
Basic Iron and Steel (371)	4816.33 (15.45)*	-2117.4 (2.591)*	5354.0 (6.020)*
Non ferrous (372)	1204.08 (4.737)*	-133.76 (0.134)	256.33 (0.258)
Fabricated metal (381)	3.97 (0.072)	-228.16 (0.237)	-1732.65 (1.803)**
Machinery (382)	207.22 (1.537)	1247.80 (3.262)*	-3162.88 (3.188)*
Electrical machinery (383)	119.75 (0.784)	624.58 (0.619)	-1986.57 (1.971)**
Motor vehicles (384)	487.83 (1.616)	3847.89 (4.990)*	-4967.49 (6.438)*
Other transport (385)	321.11 (1.850)*	1228.21 (1.161)	-2468.68 (2.337)*
Other manufacturing industries (386-390)	548.98 (2.855)*	2003.68 (1.897)**	-2954.66 (2.801)*
Constant	-46.76 (0.347)	1232.02 (1.198)	2756.78 (1.589)
Number of Observations (N)	132	132	132
F- statistic ( 35, 96) Probability > F	46.02 0.0000	10.87 0.0000	11.96 0.0000
R <sup>2</sup> Adjusted R <sup>2</sup>	0.9491 0.9306	0.7871 0.7147	0.8026 0.7355
Cook-Weisberg test for heteroscedasticity $\chi^2$ Probability > $\chi^2$	19.70 0.0000	60.23 0.0000	26.77 0.0000

Note: Figures in parentheses denote t-statistics. A single asterisk signifies that the result is significant at all conventional levels, whereas a double asterisk indicates a result significant at the 10 % level.

#### 4.3.1 Determining the sources of export success

There is a positive correlation between export levels and capital intensity significant at all conventional levels, whereas the negative coefficient on skilled labour intensity significant at the 95 percent confidence level, once again suggests a comparative disadvantage in the trade of these skilled labour intensive products. While these results support the findings in the previous set of regressions, there is an apparent lack of statistical significance with

respect to the positive relationship between export levels and unskilled labour intensity. Instead, many of the industry dummy variables are statistically significant. The benchmark category in this case is the textile sector so that the results on all other industry indicator variables are compared to the textile sector thereby avoiding the problem of perfect multicollinearity. The textile industry as a labour intensive sector, provides a relatively good benchmark in assessing the relative export performance of other sectors. It allows one to determine whether there are other industry inherent features besides factor intensity that enhance the export performance of sectors traditionally engaged in the beneficiation of raw materials.

Interpreting the results in Table 3, it is apparent that the basic iron and steel, non-ferrous sectors outperformed the textile industry in terms of export levels; these results are both significant at all conventional levels. In addition, the transport equipment and other manufacturing industries showed greater export success than textiles. This is an interesting result. It suggests that even after accounting for differences in factor intensity, there are still industry inherent features that account for export performance over and above the physical and human capital intensity of their operations.

It is also notable that many of the industries that have attained less export success than the textile sector, are those traditionally Ricardian sectors. These are the sectors that one would suspect of engaging in a greater amount of intraindustry trade.

#### **4.3.2 Explaining the level of imports**

The estimates attained in this regression substantiate the idea that South Africa tends to import commodities that are relatively skill intensive. A negative but statistically insignificant result on the unskilled labour requirement variable is somewhat disappointing. However, the results on the industry dummy variables propose that the machinery, motor vehicles and other manufacturing sectors all tend to import more than the textile industry. Again this result concludes that the higher value added sectors in South Africa have been a source of comparative disadvantage. It could be that market imperfections have stunted the potential of

higher value added sectors or that natural resource intensive activities have in the past captured a significant portion of capital in South Africa. Higher value added industries may still be capital hungry. The positive coefficient on other manufacturing industries is significant at the 10 percent level of significance whereas, the coefficient on the machinery motor vehicles and parts sector is significantly different from zero at all conventional levels. I

**4.3 MAXIMUM LIKELIHOOD METHOD: EXAMINING THE PROBABILITY OF AN INDUSTRY EXPORTING**

The final approach to the study involved the use of probability analysis in order to determine whether relative factor intensity impacted on the probability of an industry exporting. In this case, the trade balance was converted to a binary variable that was set at unity if net exports were greater than zero; and at zero if an industry was a net importer. The reasoning behind this analysis was that while skilled labour input is negatively correlated with net exports across commodities in South African trade, this may not necessarily imply that, *ceteris paribus* an increase in skilled labour intensity will lead to greater export levels. It could be that the probability of being a net exporter increases with intensity of production, but demand conditions cause these industries to be relatively small exporters or net importers.

**4.1 EXAMINING THE PROBABILITY OF AN INDUSTRY BEING A NET EXPORTER**

Table 4 : Probit Results: examining the probability of an industry being a net exporter

EXPLANATORY VARIABLES	DEPENDENT VARIABLE NET EXPORTS
Economies of Scale (SE <sub>i</sub> )	1.69 (0.257)
Unskilled labour requirements (LU <sub>i</sub> )	2.03 (0.110)
Semi Skilled labour requirements (Lsm <sub>i</sub> )	33.86 (1.199)
Skilled labour requirements (LS <sub>i</sub> )	-146.81 (2.304)

Capital Requirements ( $K_i$ )	0.288 (0.756)
Research and Development ( $RD_i$ )	-56.73 (0.413)
Natural Resource dummy ( $NR_i$ )	0.751 (2.519)
1988 Year dummy variable	-0.371 (1.408)
Constant	-0.204 (0.510)
Number of observations (N)	138
$\chi^2$ (7) Probability > $\chi^2$	15.83 (0.0449)
Pseudo $R^2$	0.0933

Note: Figures in parentheses signify z values.

The log likelihood test suggests that the model provides a significant explanation of the probability of an industry being a net exporter at the 95 percent confidence interval. The log likelihood ratio or pseudo R-square is quite disappointing, indicating that only 9.33 percent of the likelihood of being a net exporter is explained by the model. The relatively low explanatory of the model may be attributed to the fact that in combining exports and imports together in a trade balance variable neutralises some of the effect of the explanatory variables. The negative coefficient on the skilled labour requirement and the positive result on the natural resource variable, are the only results significantly different from zero at all conventional levels. Interpreting this result, the probability of being a net exporter declines as its level of skilled labour requirements rises. Since South Africa is argued to have a relative scarcity of labour that exceeds that in countries at a similar stage of development, this scarcity is reflected in higher costs of skilled labour, in turn rendering the industry less competitive in international markets. Conversely the probability of being a net exporter increases with the level of natural resource intensity of a sector.

Since the probit model examining the probability of an industry being a net exporter did not reveal any particularly enlightening results, another probability model was attempted with the dependent variable in this instance defined as above average export performance rather than net exports. Approximately 9 percent of the output of manufacturing sector as a whole was exported across this period. If an industry exported more than 10 percent of its output it was considered an above average exporter and was represented by a binary variable set at unity. An industry exporting below ten percent of its production was represented by a binary variable of zero. A probit model was then used to evaluate how factor content in production affected the probability of an industry achieving above average export performance. The results of this estimation are presented in Table 5.

Table 5 : The likelihood of industries exhibiting above average export success given factor intensity of production

EXPLANATORY VARIABLES	DEPENDENT VARIABLE
Economies of scale (SE <sub>i</sub> )	4.52 (0.704)
Unskilled labour requirements (LU <sub>i</sub> )	55.94 (2.855)*
Semi Skilled labour requirements (Lsm <sub>i</sub> )	-67.91 (2.198)*
Skilled labour requirements (LS <sub>i</sub> )	-160.02 (2.795)*
Capital Requirements (K <sub>i</sub> )	0.109 (2.132)*
Research and Development (RD <sub>i</sub> )	132.69 (0.523)
Natural Resource dummy (NR <sub>i</sub> )	0.86 (0.796)
1988 Year dummy variable	-0.41 (1.456)
Constant	0.46 (1.348)
Number of observations (N)	138
$\chi^2$ (7) Probability > $\chi^2$	21.99 0.000
Pseudo R <sup>2</sup>	0.2219

Note: Figures in parentheses signify z values.

The Chi square statistic suggests that the model offers a significant explanation for the probability of an industry being an above average exporter of its output; the pseudo r-square on this estimate exceeding 22 percent. The results of this probit equation are useful in summarising the profile of South Africa's trade in manufactures in the period 1988 to 1993. Those industries using relatively more intensively unskilled labour and capital are more likely to experience relatively better export performance than the manufacturing sector as a whole. On the other hand, the more intensive use of skilled and semi-skilled labour in production

processes reduces the probability of an exporter displaying above average success in exporting. The result on the year variable indicates that the period in which observations were taken, did not significantly influence the probability of export 'success'. There is a resounding similarity in these findings and those of Rouque and Scerri for the previous decade.

## **5. POLICY RECOMMENDATIONS AND CONCLUSION**

Moura Rouque in finding similar results relating to comparative advantage for the period 1970 to 1980 advances the following proposal, "but for the choice of capital investment rather than human capital investment economic arguments in favour of such policy can be advanced particularly if we accept that the latter type of investment implies a longer amortisation span". This very thinking is reflected in past policy that has been relatively ambivalent in relating the structure of manufacturing to both export performance and employment generation; arguably causing the manufacturing sector to remain entrenched in a pattern of exporting benefited raw materials and low value added commodities.

The effective capital subsidy rate having been heavily biased toward capital intensive subsectors, compounded comparative advantage in capital intensive items. In addition, skill accumulation in the past has been inadequate. The unequal access to educational opportunities afforded to the various races is reflected in the stark difference in occupational attainments of black and white workers in the time period considered in this study. This created a substantial imbalance between the level of human and physical capital in the manufacturing sector. By no means is it suggested that capital intensity is undesirable. However, the relative scarcity of skilled labour inevitably confined export success to low value added sectors. It is difficult to become an exporter of skilled labour intensive commodities if the cost of this input is raised through domestic competition for this quality of labour. Compare this situation to Ha Joon Chang's example of industrialisation in Sweden where higher educational attainments allowed comparative advantage to be established in commodities that required relatively higher skills than those prevalent in South Africa. Sweden although experiencing a relative abundance in minerals and agricultural resources was nevertheless,

able to make the forward linkages to higher value added sectors by virtue of a skilled labour force that was able to complement capital accumulation in order to achieve the diversification in manufacturing and consequently the export base, that is required in South Africa.

The Basic Iron and Steel and Non-ferrous sectors that have traditionally benefited raw materials may in past have been afforded privileged access to capital through policy and related incentives. Other higher value added sectors that require a combination of capital and skilled labour intensity in production may have remained capital hungry. It is therefore, imperative that trade and industrial policy keenly address the capital and skilled labour needs of particular sectors, rather than implementing horizontal industrial policy strategies that are ineffective in addressing the true factor needs of specific sectors.



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