

**AN EMPIRICAL ANALYSIS OF THE IMPACT OF TRADE ON
PRODUCTIVITY IN SOUTH AFRICA'S MANUFACTURING
SECTOR**

by

CHARLES AUGUSTINE ABUKA

Submitted in partial fulfilment of the requirements for the degree of

PhD (ECONOMICS)

in the

Faculty of Economic and Management Sciences

at the

University of Pretoria

ACKNOWLEDGEMENTS

It is with great pleasure that I thank my supervisors, Prof. Chris Harmse and Prof. Steven F. Koch for guiding me through the analysis of trade and productivity in manufacturing, for their enthusiastic supervision and for their interest in the issues addressed in this thesis. The study leaders are especially thanked for the stimulating discussions and helpful suggestions on several issues that arose during the preparation and writing up of the thesis.

I am most grateful for and acknowledge the support, material or otherwise, provided by the Department of Economics at the University of Pretoria and the conducive environment extended by its staff.

The moral support and constant encouragement by my wife Slyvia and children (Tony, Kevin and Keith) has been priceless, and I am heavily indebted to them.

I acknowledge, with gratitude, the generous financial support from the Bank of Uganda and the AERC scholarship award, without which this end product would not have seen the light of the day.

Charles Augustine Abuka

SUMMARY
AN EMPIRICAL ANALYSIS OF THE IMPACT OF TRADE ON
PRODUCTIVITY IN SOUTH AFRICA'S MANUFACTURING
SECTOR

by

CHARLES AUGUSTINE ABUKA

SUPERVISOR:	PROF. CHRIS HARMSE
CO-SUPERVISOR:	PROF. STEVEN F. KOCH
DEPARTMENT:	ECONOMICS
DEGREE:	PhD (ECONOMICS)

This study contributes to the debate regarding the impact of trade on manufacturing productivity and labour demand over the period 1980 to 2002. The analysis extends existing work in a number of ways. First, total factor productivity is decomposed into efficiency and technical change in order to provide more directions to policy makers. Second, an industry specific time varying measure of total factor productivity is estimated from an underlying production function using panel data of South African industrial sectors. Third, total factor productivity is interacted with trade measures, industry characteristics and macroeconomic factors to determine its key drivers. Finally, the impact of trade on derived labour demand is examined.

Panel data econometric techniques are applied to estimate productivity loss due to technical inefficiency in South African manufacturing industries. Technical

change and efficiency are estimated using stochastic frontier approaches that allow inefficiency to be either time invariant, or to evolve in a time varying decay mode. A generalised time index is employed to introduce more flexibility on the measurement of technical change. The results account for periods of technical progress as well as regress and indicate the presence of significant room for efficiency improvement, while the pattern of technical change was found to have been particularly slow over the period. The fact that a substantial amount of intermediate inputs into South African manufacturing are imported implies that significant improvement in industry efficiency will be related to the openness of trade policy in South Africa. More importantly, efficiency scores are also likely to be related to how labour force adjusts to these imported inputs. Skill improvements for the labour force are, therefore, fundamental, because the mix of goods manufactured and the factor proportions used to produce them depend on the skill competencies of local technicians. Skills are important for the labour force to produce at its full potential, avoiding waste in inputs and time.

The estimation of the determinants of total factor productivity is able to account, in a simultaneous context, for the impact of trade policy, industry level characteristics and the role of macroeconomic factors. The results suggest positive payoffs for industrial productivity of an appropriately managed liberalisation of the external sector. Liberalisation of the external sector is good for competition and learning. Learning is available through increased access to world class intermediate inputs and technology.

The evolution of derived labour demand in manufacturing is investigated using the dynamic Generalised Method of Moments estimator (GMM). The results indicate greater induced efficiency effects from some products entering South Africa that are produced at lower cost abroad than obtain for similar products in South Africa; such commodities have tended to displace South African products

and labour. Increased import penetration serves to reduce inefficiency and encourages the use of new technology. The positive impact of export expansion on derived labour demand supports results from efficiency estimates that indicate the importance of skilled labour. Increased trade requires emphasis on skill development for the labour force, because intra-industry trade benefits can only arise in an environment in which the skill competencies of labour are improved. In a nutshell, trade has the potential to exact factor adjustment. It is therefore, important to identify the product specific effects that are inimical to some manufacturing sectors and which effects serve to reduce the level of employment in manufacturing for the sake of policy intervention.

Increased trade with developed countries is found to provide South Africa with global production networks, where it supplies to the world market. In this arrangement, South Africa benefits from the use of the latest internationally available production and marketing techniques. These networks are important for accelerating the country's development by transferring technology and innovation, as well as bringing new ideas, to increase its competitive advantage. This comparative advantage should be used to expand the untapped trade potential, particularly with the rest of Africa. However, more needs to be done to improve the technical competencies of industrial labour. Policies are also still required to significantly improve the speed of labour market adjustment.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	iii
LIST OF TABLES	xi
LIST OF FIGURES	xii
CHAPTER 1.....	1
TRADE AND MANUFACTURING: AN OVERVIEW	1
1.1 INTRODUCTION AND BACKGROUND.....	1
1.1.2 An overview of the debate	1
1.1.3 Linking trade, productivity and labour demand in industry.....	5
1.1.4 Problem statement, motivation and point of departure	8
1.1.3.1 Panel data application	11
1.1.3.2 Components of total factor productivity.....	11
1.1.3.3 Determinants of total factor productivity.....	12
1.1.3.4 Understanding derived labour demand in manufacturing.....	12
1.2 HYPOTHESES INVESTIGATED.....	13
1.3 TRADE POLICY IN SOUTH AFRICA	13
1.4 EMPLOYMENT ISSUES IN MANUFACTURING.....	21
1.5 STRUCTURE OF THE THESIS.....	28
1.6 CONCLUDING REMARKS.....	28
CHAPTER 2.....	31
EFFICIENCY AND TECHNICAL CHANGE IN MANUFACTURING.....	31
2.1 INTRODUCTION.....	31
2.2 MEASURING EFFICIENCY AND TECHNICAL CHANGE.....	32
2.2.1 Importance of decomposing total factor productivity.....	32
2.2.2 The stochastic frontier production function.....	35
2.2.2.1 Measuring technical efficiency.....	37
2.2.2.2 Measuring technical change.....	38
2.2.2.3 Panel data production frontier models	39

2.3 ECONOMETRIC SPECIFICATION.....	40
2.4 THE DATA AND SAMPLE CHARACTERISTICS.....	41
2.5 ECONOMETRIC RESULTS	43
2.5.1 Univariate data analysis	43
2.5.1.1 Summary statistics	43
2.5.1.2 Correlation analysis	43
2.5.1.3 Intuition behind panel unit root tests	45
2.5.1.4 Testing for cointegration in the production function	49
2.5.2 Multivariate model results: production functions	51
2.5.2.1 A time invariant inefficiency model	51
2.5.2.2 A time varying inefficiency decay model	54
2.5.3 Technical change in South African manufacturing.....	56
2.5.4 Technical efficiency in South African manufacturing.....	58
2.5.5 The relationship between trade and manufacturing efficiency	61
2.5.5.1 Causality between trade and manufacturing efficiency	62
2.5.6 Some determinants of manufacturing efficiency	63
2.6 CONCLUDING REMARKS.....	66
CHAPTER 3.....	69
TRADE AND TOTAL FACTOR PRODUCTIVITY IN MANUFACTURING... 69	
3.1 INTRODUCTION.....	69
3.2 TRADE AND MANUFACTURING PRODUCTIVITY	70
3.2.1 Foreign input push	72
3.2.2 Competitive push and the elimination of X-inefficiency.....	73
3.2.3 Competitive elimination.....	73
3.2.4 Higher incentives for technological innovation	74
3.2.5 Economies of scale	75
3.3 APPROACHES TO THE STUDY OF TRADE AND PRODUCTIVITY	76
3.3.1 The macro- level approach.....	76
3.3.2 The industry-level approach.....	77
3.3.3 The micro-level approach	78

3.4 MEASURING TOTAL FACTOR PRODUCTIVITY.....	79
3.5 ECONOMETRIC SPECIFICATION.....	83
3.6 THE DATA AND VARIABLES	84
3.7 ECONOMETRIC RESULTS	88
3.7.2 Estimating TFP determinants using static panel data estimators.....	88
3.8 CONCLUDING REMARKS.....	95
CHAPTER 4.....	98
TRADE AND LABOUR DEMAND IN MANUFACTURING.....	98
4.1 INTRODUCTION.....	98
4.2 TRADE AND LABOUR DEMAND.....	99
4.2.1 Approaches to the study of effects of trade on employment.....	102
4.2.1.1 The factor content approach.....	103
4.2.1.2 The growth accounting approach.....	105
4.2.1.3 Labour demand in a regression framework	107
4.3 ECONOMETRIC SPECIFICATION.....	109
4.3.1 The analytical framework	109
4.3.2 The estimating equation.....	113
4.3.2.1 The moment conditions.....	114
4.4 DATA AND DESCRIPTIVE STATISTICS.....	116
4.5 ECONOMETRIC RESULTS	119
4.5.2 Labour demand equation results	119
4.5.2.2 Role of product and time specific effects	125
4.5.2.3 Interpretation of the overall results	127
4.6 CONCLUDING REMARKS.....	129
CHAPTER 5.....	132
SUMMARY AND POLICY IMPLICATIONS.....	132
5.1 INTRODUCTION.....	132
5.2 CONCLUSION: OVERALL POLICY IMPLICATIONS.....	133

5.2.1 Trade and industrial productivity policies	133
5.2.2 Trade and labour market policies.....	135
5.3. AREAS FOR FURTHER RESEARCH	136
REFERENCES	138
APPENDIX.....	161
Appendix A1: Technical efficiency in panel frontier models.....	161
Appendix A2: The Battese and Coelli (1992) specification.....	166
Appendix A3: Variable definitions	171

LIST OF TABLES

Table 1: Tariff phase down under the WTO	17
Table 2: Changes in manufacturing tariff structure	18
Table 3: Variability in employment, production and wages	21
Table 4: Two digit level variability in selected trade measures, 1980 and 2002 ...	25
Table 5: Import share and variability within three-digit sector, 1980 and 2002 ...	25
Table 6: Export share and variability within three digit sector, 1980 and 2002	26
Table 7: Summary statistics for inputs and outputs	43
Table 8: Correlation between inputs and output measures.....	44
Table 9: Non parametric tests for production function variables	44
Table 10: Group unit root tests for production function variables	49
Table 11: Production function cointegration.....	50
Table 12: Time invariant inefficiency: Cobb-Douglas production function	52
Table 13: Time invariant inefficiency: Translog production function.....	53
Table 14: Time varying inefficiency: Cobb-Douglas production function	54
Table 15: Time varying inefficiency: Translog production function	55
Table 16: Non parametric tests correlation tests for efficiency and trade.....	60
Table 17: Determinants of efficiency	64
Table 18: Proportion of industry sales to total manufacturing sales	85
Table 19: Descriptive statistics for productivity variables	87
Table 20: Estimating TFP determinants by maximum likelihood regression	93
Table 21: Estimating TFP determinants by fixed effects within regression	95
Table 22: Summary statistics for employment variables.....	117
Table 23: Correlation between employment and determinants.....	118
Table 24: Non parametric tests for employment and its determinants.....	119
Table 25: Baseline labour demand models for South African manufacturing....	122
Table 26: Import origin and manufacturing labour demand	124
Table 27: Product and time specific effects in manufacturing.....	126

LIST OF FIGURES

Figure 1: Evolution of employment in the manufacturing sector, 1980-2002	22
Figure 2: Capital stock and productivity in manufacturing sector, 1980-2001	23
Figure 3: Labour productivity in the manufacturing sector, 1980-2001.....	24
Figure 4: Import penetration and export shares, 2002.....	27
Figure 5: Evolution of employment and output in manufacturing, 1980-2002	42
Figure 6: Technical change in manufacturing: Cobb-Douglas function	57
Figure 7: Technical change in manufacturing: Translog function	58
Figure 8: Technical efficiency scores by sector	60
Figure 9: Manufacturing machinery and equipment expenditure, 1980-2001.....	86

Notation and Used

This part of the thesis lists the symbols and abbreviations used in the main text. The symbols that are not standard, if not explained here will be explained in areas where they first emerge in the text.

Symbol	Interpretation
N	Number of observations or firms
T	Number of time points
$\hat{\beta}$	Estimate of β
ΔY	Change in Y
∞	Infinity
E	Expectation operator

Acronym	Meaning
DEA	Data Envelopment Analysis
EU	European Union
EU-SAFTA	European Union-South Africa Free Trade Agreement
et al	et alii – and others
GATT	General Agreement on Trade and Tariffs
GEIS	Generalised Export Incentive Scheme
GLS	Generalised Least Squares
GMM	Generalised Method of Moments
ISIC	International Standard Industrial Classification
LP	Linear Programming
LSDV	Least Squares Dummy Variables
MC	Marginal Cost
MLE	Maximum Likelihood Estimation

OLS	Ordinary Least Squares
SADC	Southern Africa Development Community
SARB	South African Reserve Bank
STATSSA	Statistics South Africa
TC	Technical Change
TE	Technical Efficiency
TFP	Total Factor Productivity
TIPS	Trade and Industrial Policy Strategies Secretariat
VCM	Varying-Coefficient Model