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Predicting South African Trade in Services

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ABSTRACT

Using cross-sectional econometric techniques the paper tries to identify and quantify the main determinants of trade in eight different service sectors. The resulting models are then used to predict South African trade in each of these sectors.

EXECUTIVE SUMMARY

Economists seem to agree that the theory of comparative advantage can be extended to trade in services. Countries with relatively large endowments of skilled labour and capital and relatively few natural resources should export more services and less mining or agricultural goods than those relatively rich in land or resources.

Although some econometric work has been done on the determinants of trade in services, the results are inconclusive. This paper improves on these studies, applying similar methodologies but using better and more comprehensive data that are now available.

One important spin-off from the econometric analysis is that the models can be used to identify and quantify the most important determinants of trade in services in each sector. The resulting coefficients can also be used to predict South African trade in services.

In total, four different models are presented for each of the eight service sectors. First, a simple two-factor Heckscher-Ohlin model is tested against two different dependent variables. A further two models are developed by incorporating and testing a much wider selection of explanatory variables.

The results are encouraging and offer some empirical support to the application of comparative advantage to trade in services. They show that human capital and economic development are important determinants of competitiveness in the service industry. On the other hand, countries with abundant land or labour are less likely to specialise in services.

South Africa is not predicted to specialise in any of the eight service sectors. In all but one sector (tourism), South African service exports are predicted at less than 1% of merchandise trade. Moreover, in all eight sectors the predicted ratio of South African service trade to merchandise exports is lower than the actual trade ratios for more than half of the countries included in the sample.

1. INTRODUCTION

The primary objective of this paper is to identify and quantify the main determinants of trade in services and to apply the resulting models to South Africa. Of secondary importance the results may provide some new insight into the application of conventional and modern trade theory to trade in services.

1.1 Empirical analyses of trade in services

Despite the apparent consensus on the applicability of trade theory to services, very little analytical work has been done in support of this view. Moreover, the work that has been done is far from conclusive. More progress has been made in the application of general equilibrium models to trade in services and the calculation of the welfare benefits emanating from service liberalisation.

1.1.1 Econometric studies

In their review of the theoretical literature on trade in services, Sapir and Winter (1994) cite just two "systematic" econometric studies of the determinants of trade in services: Dick and Dicke (1978) and Sapir and Lutz (1981). These studies employ similar methodologies, but their results and conclusions are largely contradictory.

In the first of these two studies, Dick and Dicke (1978) attempt to describe the specialisation of OECD countries in trade in knowledge intensive goods and services through the theory of comparative advantage. They find that the share of knowledge intensive goods and services combined in total exports is positively related to private R&D expenditure and country size, but negatively related to natural resource endowments and a country's long-term current account position. But when the model is applied, separately, to knowledge intensive goods and to services, distinctly different results emerge. The model still explains the pattern of goods trade, but for knowledge intensive services none of the estimates are statistically significant. Even when disaggregated into three different service sectors (freight and insurance on merchandise; other transportation; and other private services), the results appear spurious.

Dick and Dicke conclude that trade in knowledge-intensive services cannot be explained by factor endowments. Instead, they suggest that high levels of protection, international differences in production functions, and the strong complementarities between commodity and services trade may be more important.

Sapir and Lutz (1981) adopt a similar approach, but at a more disaggregated level. Their results are encouraging and strongly suggest conventional trade theories also explain trade in services. Despite high levels of protection in the service sector, economic determinants of comparative advantage emerge as statistically significant. For example, trade in transportation services appears to bear some relation to a country's capital endowments, whereas trade in insurance services depends on human capital. They also find that location and scale can be important determinants of revealed comparative advantage in some service sectors.

1.1.2 Descriptive studies

There have also been a number of descriptive studies, focusing on just one service sector or a limited number of countries. Langhammer (1991) adopted the latter approach, using the balance-of-payments data of France, Germany, Japan and the USA to show that trade in services can be explained by relative factor endowments. "The study also emphasised the limitation of studies based on balance-of-payments statistics with high sectoral aggregation and suggested the need for detailed work on international activities of individual service industries" (Sapir and Winter 1994: 284).

Sapir (1986) adopts a similar approach in examining developing country exports of investment-related technological (IRT) services, defined as " the intellectual activities involved in conceiving, managing and realising specific investment projects" (Sapir 1986: 605). He concludes that a handful of developing countries have become major exporters of IRT services, particularly to other developing countries. The success of these countries can largely be explained by the role of the public sector in investment projects and technology transfers from abroad. This, he argues, demonstrates that developing countries can gain comparative advantages in specific services exports.

1.1.3 Computable general equilibrium (CGE) analysis

Hoekman and Mattoo (2000) argue that any assessment of the welfare and efficiency gains emanating from services liberalisation, must use a general equilibrium (GE) approach, and a number of GE analyses have been attempted[1]. All of these studies show that services liberalisation can contribute to large increases in economic welfare, which in some cases exceed the gains from goods liberalisation.

1.2 Purpose of this analysis

Although some econometric work has been done on the determinants of trade in services, the results, as presented above, are inconclusive. This is largely because the samples used are too small and are restricted to a narrow group of OECD countries and just three service sectors. The main purpose of this paper is to improve on these studies, applying similar methodologies but using better and more comprehensive data that are now available. An attempt is also made to update these analyses by incorporating recent developments in the literature on trade in goods.

One important spin-off from the econometric analysis is that the models can be used to identify and quantify the most important determinants of trade in services in each sector. This will not only enable a comparison of the importance of different variables within and between sectors, but the resulting coefficients can be used to predict South African trade in services.

It is important to note that econometric models are typically unable to explain a large proportion of the cross-country variation in trade in goods. Such models are likely to perform even worse when applied to trade in services, where non-economic factors play a much greater role.

[1] See Drusilla et al (1996) and Dee and Hanslow, Findlay and Warren, Hoekman and Konan, Chadha and Hertel, Anderson, Francois, Hoekman and Martin (cited in Hoekman and Mattoo 2000).

2. ECONOMIC SPECIFICATION

Economists seem to agree that the theory of comparative advantage in general, and the Heckscher-Ohlin (H-O) model in particular, can be extended to trade in services. Countries with relatively large endowments of skilled labour and capital and relatively few natural resources should export more services and less mining or agricultural goods than those relatively rich in land or resources.

Modern variants of the H-O model extend well beyond the conventional two-factor model to explain the effects of scale, product differentiation, home bias and technology on trade. Some of these factors can be expected to impact on trade in services and need to be incorporated into the proposed analysis.

2.1 Dependent variables

Deardorff (1994) argues that net exports is the most commonly used and his preferred trade variable. There are numerous ways to define net exports and in this analysis the methodology used by Wood and Berge (1997 in Aldaz-Carrol 2002) to calculate the net export ratio of manufactured and primary goods is employed:

$$NE = \sqrt{\frac{X_b}{X_a}\frac{M_a}{M_b}}$$

The main advantage of this particular method is that the net export ratio is always positive and can therefore be used in the log-linear form.

But barriers to trade in some service sectors are sufficiently high to suffocate imports. This may lead to an inflated net export figure in those countries where barriers are highest. Moreover, the composition of imports differs less between countries than exports (Wood and Mayer 1998). For these reasons, the simple ratio of service exports to goods exports is also tested.

2.2 Explanatory variables

Leamer (1974) identifies three groups of explanatory variables, all of which he applies to trade in goods: resource variables, development variables and resistance variables. These same classifications are used below to distinguish between the possible determinants of trade in services.

2.2.1 Resource variables

2.2.1.1 Human capital

Most services are knowledge intensive and trade patterns are expected to depend strongly upon relative endowments of human capital. Following the approach of Wood and Mayer (1998) human capital is measured by the average number of years of schooling of the adult (over 15) population. Wood and Mayer argue that the inability of this variable to describe differences in quality or type of education are

offset, statistically, by the strong cross-country correlation between years of schooling and these other characteristics of skill.

2.2.1.2 Physical capital

Wood (1994a) argues that the case for including physical capital in trade models is weak. Buildings can be constructed relatively quickly, machinery is mobile, and there is little cross-country variation in real interest rates. According to Wood, the only type of physical capital that can impact on trade is infrastructure, which is immobile and differs markedly in terms of quantity and quality across countries. Given the increasingly important role of telecommunications in service provision, a measure of telephone lines per capita is considered in this analysis.

2.2.1.3 Natural resources

Again, this study follows the approach of Wood and Mayer (1998), dividing the size of each county by its adult population to obtain an estimate of land per worker. Although this variable is unable to distinguish between cross-country variations in the quality of land, or different allocations of water and minerals, Wood and Mayer argue that it is an unbiased measure of "natural-resource availability". Moreover, introducing specific measures of mineral and water reserves had almost no effect on their results and did not improve the overall fit of their model.

2.2.1.4 Technology

Deardorff (1984) argues that technology variables should be included in the analysis of industries where technology is important. Technology is a key input into the services sector and must be reflected in this analysis. Winters (1992) identifies two main proxies for technological leadership: research and development expenditure and patents registered. Both of these variables are tested in this analysis. To address problems of reverse causation between trade and patent registrations (raised by Deardorff 1984), only domestic patents are included.

2.2.2 Development variables

2.2.2.1 Economic development

Relative levels of economic and human development are already captured by the specific resource variables described above. One would expect these measures of education, infrastructure and technology to be strongly correlated with more general indicators, such as GDP/capita, and there are therefore good statistical reasons for excluding it from the analysis. But in some cases GDP/capita may prove a more powerful and encompassing explanatory variable and it is therefore retained and tested against these other variables.

2.2.2.2 Size

Modern trade theory highlights the role of imperfect competition and economies of scale in international trade. Van Marrewijk et al (1997) argue that economies of scale do apply to producer services and there is sufficient evidence to suggest that trade in some service sectors is dominated by relatively few service providers (e.g. financial and insurance services). Both Dick and Dicke (1978) and Sapir and Lutz (1981) find

country size a significant determinant of trade and variables of population and economic size are therefore included in this analysis.

2.2.2.3 Export orientation

Dick and Dicke also suggest that service exports are strongly related to merchandise trade and a measure of export orientation (merchandise exports as a share of gross national income) is included.

2.2.3 Resistance variables

2.2.3.1 Protection

There have been two major attempts to calculate cross-country levels of service protection. Hoekman and Braga (1997) calculates quantitative "guestimates" of protection by allocating weights to each country's GATS commitments and multiplying the resulting indices by benchmark tariff equivalents of the most restrictive country in each sector. More recently, the Australian Productivity Commission, in collaboration with the Australian National University (in Findlay and Warren 2000) has calculated indices of protection for 136 countries, across 8 different services sectors. Where possible, both of these indicators are used to test the impact of domestic protection on net exports. Because bilateral trade in services is not available on a disaggregated basis it is not possible to test for the impact of foreign barriers on domestic exports.

2.2.3.2 Geography

Modern gravity-type models incorporate transport costs through a measure of the geographic distance between the exporting country and major foreign markets (Deardorff 1984). Although transport costs are much less important to trade in services, in sea transport, access to international waters is expected to be significant. A measure of the percentage of the population living within 100km of the coast is therefore included, but only in the sea transport sector.

2.2.3.3 Language

Finally, many service transactions require some form of interpersonal communication between service provider and consumer. Countries that speak a common language are more likely to trade in these services, whilst others may find language a significant barrier to trade. To test the impact of language on trade a dummy variable is included to identify all English-speaking countries.

2.3 Model description

In total, four different models are presented for each of the eight service sectors. First, a simple two-factor Heckscher-Ohlin model (based on Wood and Mayer 1998) is tested against the two dependent variables. These models are then expanded by incorporating and testing all of the other explanatory variables. Only those variables that are significant at the 5% level are included in the resulting models.

These four models are presented algebraically in the log-linear form below:

(i) $\log NE_i = \alpha + \beta_1 \log E + \beta_2 \log LW$

(ii) $\log SM_i = \alpha + \beta_1 \log E + \beta_2 \log LW$

(iii) $\log NE_i = \alpha + \beta_1 \log E + \beta_2 \log LW + \beta_3 \log Y + \beta_4 \log P + \beta_5 \log T + \beta_6 \log AW + \beta_7 \log RY + \beta_8 \log MY + \beta_9 \log I + \beta_{10} \log C + \beta_{10} \log D$

(iv) $\log SM_i = \alpha + \beta_1 \log E + \beta_2 \log LW + \beta_3 \log Y + \beta_4 \log P + \beta_5 \log T + \beta_6 \log AW + \beta_7 \log RY + \beta_8 \log MY + \beta_9 \log I + \beta_{10} \log C + \beta_{10} \log D$

where:

NE = Net exports

SM = Ratio of service exports to merchandise exports

and:

E = Average years of adult schooling

LW = Surface area per adult

Y = Gross National Income (GNI)

P = Population

T = Telephone main lines per 1000 people

AW = Domestic patents registered per adult

RY = Research and development expenditure as a share of GNI

XY = Ratio of merchandise exports to GNI

I = Index of domestic protection

C = Access to international waters

D = English language dummy

2.4 Data

The data used is summarised in table 1 below:

Table 1

Data	Source	Year
Trade in services	IMF Balance of Payments Statistics Yearbook 2001	2000/1999
Trade in merchandise goods	World Bank Development Report	1999

Average years of schooling	Barro and Lee	2000
Adult population	Barro and Lee	2000
Surface area	World Bank Development Report 2001	1999
Gross national income	World Bank Development Report 2001	1999
Population	World Bank Development Report 2001	1999
Telephone main lines per 1000 people	World Bank Development Report 2001	1999
Domestic patents registered per adult	World Bank Development Report 2001	1999
Expenditure on research and development	World Bank Development Report 2001	1999
Ratio of merchandise exports to GNI	World Bank Development Report 2001	1999
Index of domestic protection 1	Hoekman	1997
Index of domestic protection 2	Australian Productivity Commission	2000
Access to international waters	The Center for International Development	1998/99
Language	Haveman, J.	2002

3. RESULTS AND PREDICTIONS

The results are encouraging and satisfy the primary objectives of this analysis. They also offer some empirical support to the application of comparative advantage to trade in services.

Although the basic Wood and Mayer model performs poorly, the education variable is significant in six of the eight sectors. Moreover, in all but one of these sectors, years of schooling has a positive impact on trade in services. The land per worker variable is only significant in three of the sectors (and only once in the Wood and Mayer form of the model), but the sign of the co-efficient is negative in all of these cases. Countries with abundant land are less likely to specialise in these services. There does therefore seem to be support for the application of comparative advantage to trade in services, at least in some of the sectors considered. Moreover, human capital, as measured by average years of schooling, does seem to be a particularly important determinant of competitiveness in the service industry.

Incorporating additional economic and some non-economic variables improves the explanatory power of the models significantly and in most sectors it is possible to explain a fair proportion of the cross-country variation in trade in services. A summary of the signs of the co-efficients of the most significant independent variables emerging from all four models is provided in table 2 below.

Table 2

Sector	Independent variables									
	e	**lw**	**p**	**c**	**y**	**t**	**aw**	**xy**	**d**	**s**
Construction		-		-		+	-	-		
Communication	-		-	-		+		-		
Insurance	+		-				-			
Financial		-	-		+			-		
IT	+		-	+					+	
Sea transport	+		-	-	+			-		+
Air transport	+		-					-		
Travel	+	-	-	-	-	+	-	-	+	

In all but one of the eight sectors, the co-efficient of the population variable is negative and significant. This lends further support to the theory of comparative advantage: countries abundant in labour resources are less likely to specialise in high-skilled service industries. Only the IT and financial service sectors show a consistent and positive relationship with per capita income (in the case of financial services this can be derived from the positive *y* and negative *p* co-efficients). On the other hand, there is evidence to suggest that wealthy countries are less likely to specialise in travel, sea transport, construction and communication services.

Six sectors show a negative export orientation co-efficient. When modelled on *SM*, an *xy* co-efficient greater (less negative) than -1.1 indicates that an increase in export orientation contributes to a higher level of service exports. For example, if *xy* equals -0.5, a 1% increase in exports as a share of GDP leads to 0.5% decline in the ratio of service exports to merchandise exports. But as a share of GDP, service export have also increased, by just under 0.5%. In all but one sector the *xy* co-efficient is greater than -1. This suggests that service exports respond positively to increases in merchandise exports.

In almost all cases the *SM* variable is more instructive than the *NE* ratio, though the results across the two different dependent variables are generally consistent. Thus, for the purpose of predicting South African trade in services, the extended SM model (the second model in tables 3 to 10 below) is preferred in all eight sectors.

Finally, in applying the chosen models to the South African exogenous data, South Africa is not predicted to specialise in any of the eight service sectors. In all but one sector (tourism), South African service exports are predicted at less than 1% of merchandise trade. Moreover, in all eight sectors the predicted ratio of South African service trade to merchandise exports is lower than the actual trade ratios for more than half of the countries included in the sample.

These results are described in more detail, by sector, below.

3.1 Construction

Construction exports are positively and strongly related to telecommunications infrastructure. Moreover, the models do explain a significant share of the cross-country variation in trade in construction services. Less easy to explain is the negative relationship between construction services and the technology and land per worker variables.

It would seem that advances in technology draw resources away from the construction sector, which is perhaps less dependent upon high-skilled labour than some other services. There is also likely to be some splintering of high value-added activities, such as design and construction management services, from the construction process, and these would not be captured in the balance of payments as construction exports. This line of argument is supported by Sapir (1986) in his study of the South Korean and Indian construction sectors. Finally, larger and less populous countries are more likely to specialise in natural resource and agricultural related activities (Wood 1994b) rather than the labour and skill intensive construction sector.

There does therefore seem to be evidence in support of the application of comparative advantage to the construction services sector. Countries endowed with labour and sufficient investment in infrastructure are more likely to specialise in construction services than those with relatively large endowments of land or technology. It would seem that advanced developing countries with sufficient capacity and expertise in construction-related activities may benefit from increased trade in this sector.

Table 3

Dependent variable	Constant	Independent variables				R^2	n
		e	lw	t	aw		
SM	-3.65**	-0.53	-0.32*			0.10	51
	(-3.45)	(-1.19)	(-2.10)				
SM	-14.39		-0.49**	1.57**	-0.49**	0.52	46
	(-7.94)		(-4.07)	(5.75)	(-3.57)		
NE	1.70*	-0.46	-0.22*			0.14	47
	(2.62)	(-1.69)	(-2.18)				
NE	-2.46		-0.39**	0.52**	-0.19	0.33	42
	(-2.16)		(-3.19)	(3.13)	(-2.01)		

* < 5% significance

** < 1% significance

To accurately predict South African trade in services the variables must not only be significant, but the residuals must be homoscedastic (of equal variance over the sample) and display a normal distribution. The residuals of the extended SM model fail both of these tests[2]. On closer inspection of the residuals it is clear that the observation for South Korea is particularly problematic, with the fitted value well

[2] The Microfit test of normality is based on the Bera and Jarcque (1981) test of the skewness and kurtosis of the residuals. The programme tests for heteroscedasticity by regressing the squared residuals on the squared fitted values.

above the actual trade ratio. By including a dummy variable to account for this unexplained and large deviation, the residuals prove normal and homoscedastic. Moreover, the explanatory power of the model is greatly improved with two additional variables significant. The final model is presented in table 4 below.

Table 4

Dependent variable	Constant	Independent variables					R^2	n
		lw	t	aw	c	xy		
SM	-11.62**	-0.61**	1.87**	-0.28*	-0.47*	-0.51*	0.71	45
	(-6.80)	(-6.51)	(7.10)	(2.40)	(-2.42)	(-2.37)		

* < 5% significance

** < 1% significance

South Africa is expected to be a relatively minor exporter of construction services, with construction exports predicted at just 0.06% of merchandise trade.

3.2 Communication

The results for the communication sector are robust and significant but the signs of most of the coefficients are difficult to interpret. In particular, the negative relationship between communication exports and per capita income raises problems as one would expect more developed economies to specialise in trade in communication services.

It would seem that non-economic factors have a strong influence over trade in communication services. Protection in this sector is high and international revenues are allocated according to complex multilateral agreements. It is therefore impossible to describe or predict trade in this sector without a better understanding of the arrangements governing trade in communication services.

Table 5

Dependent variable	Constant	Independent variables						R^2	n
		e	lw	c	t	p	xy		
SM	-4.47**	-0.09	-0.08					0.01	73
	(-6.15)	(-0.29)	(-0.67)						
SM	-3.06**			-0.60**	0.49**	-0.25**	-0.87**	0.34	86
	(-3.73)			(-3.72)	(2.93)	(-2.90)	(-0.43)		
NE	1.05**	-0.32*	-0.04					0.06	72
	(2.71)	(-2.02)	(-0.68)						
NE	1.17*			-0.31**	0.22*		-0.39**	0.27	85
	(2.52)			(-3.49)	(2.31)		(-3.49)		

* < 5% significance

** < 1% significance

Again, the residuals from the extended SM regression are heteroscedastic and not normally distributed. By adding separate dummy variables to explain the large residuals of Guatemala, Venezuela, Botswana and Brazil these problems are resolved and the final model is presented in table 6 below.

Table 6

Dependent variable	Constant	Independent variables				R^2	n
		c	t	p	xy		
SM	-3.29**	-0.51**	0.40**	-0.26**	-0.95**	0.50	82
	(-5.49)	(-4.36)	(3.29)	(-3.96)	(-6.19)		

* < 5% significance

** < 1% significance

South Africa is not likely to be a major exporter of communication services, with exports predicted at just 0.7% of merchandise exports.

3.3 Insurance

Barriers to trade in insurance services are uniformly high, equated to a tariff of 200% by Hoekman (1997). Moreover, a few very rich countries dominate exports in this sector, with the majority of countries recording a negative trade balance. It is therefore not surprising that the resulting models are unable to explain much of the cross-country variation in this sector. The positive co-efficients of the education, income per capita (positive income, negative population) and telephone infrastructure variables suggest that developing countries are less likely to export insurance services.

Table 7

Dependent variable	Constant	Independent variables						R^2	n
		e	lw	y	p	aw	t		
SM	-6.31**	0.27	0.02					0.01	75
	(-8.05)	(0.80)	(0.20)						
SM	-7.25**			0.50**	-0.63**	-0.33**		0.16	63
	(-9.92)			(2.69)	(-3.23)	(-2.88)			
NE	-1.18**	0.49**	-0.06					0.15	74
	(-3.33)	(3.23)	(-1.12)						
NE	-1.23**						0.16**	0.14	87
	(-5.74)						(3.73)		

* < 5% significance

** < 1% significance

The residuals of the extended SM model are normally distributed and homoscedastic.

South African exports of insurance services are predicted at 0.1% of merchandise exports.

3.4 Financial

Trade in financial services is positively related to income but negatively related to the population and land per worker. It would therefore seem that a country's total endowment of labour is less important than the level of development and concentration of the population. Wealthy and densely populated nations are more likely to specialise in trade in financial services. To the extent that developed nations do boast a greater proportion of high skilled labour these results do tend to support the application of comparative advantage to this sector.

The relatively low and negative export/GDP ratio coefficient suggests a positive relationship exists between merchandise and financial service exports. For every one percent increase in the ratio of exports to GDP, the service to merchandise export ratio falls by 0.8%, thereby indicating that service exports have also risen as a share of GDP (a co-efficient of around 1.1% indicates no change in the level of service exports). Thus exports of merchandise goods do appear to support trade in financial services.

Table 8

Dependent variable	Constant	Independent variables					R^2	n
		e	lw	y	p	xy		
SM	-5.38**	0.41	-0.22				0.08	59
	(-6.61)	(1.19)	(-1.80)					
SM	-5.14**		-0.31**	0.32**	-0.66**	-0.83**	0.28	59
	(-8.69)		(-2.70)	(2.89)	(-3.84)	(-3.07)		
NE	0.33	-0.07	-0.03				0.01	58
	(0.78)	(-0.36)	(-0.54)					
NE	No significant results							

* < 5% significance

** < 1% significance

The residuals of the extended SM model are normally distributed and homoscedastic.

OECD countries dominate trade in financial services. It is therefore not surprising that South African exports of financial services are predicted at just 0.3% of merchandise exports.

3.5 Information technology

Information technology (IT) is strongly influenced by per capita income, which in turn seems to account for much of the difference in skills' levels between countries. Thus the education variable is only significant when per capita income is excluded from the model. On the other hand, population size is not fully explained by per capita income, thereby suggesting that smaller developed countries are more likely to specialise in IT services. Interestingly, the English language dummy variable has a positive impact on net exports of IT services.

Table 9

Dependent variable	Constant	Independent variables					R^2	n
		e	lw	c	p	d		
SM	-8.53**	1.35*	-0.05				0.12	53
	(-7.76)	(2.58)	(0.34)					
SM	-9.86**			0.54**	-0.28*		0.36	60
	(-10.19)			(4.97)	(-2.59)			
NE	-0.13	0.12	-0.05				0.02	52
	(-0.25)	(0.53)	(-0.79)					
NE	-0.14					0.58*	0.09	60
	(-1.50)					(2.36)		

* < 5% significance

** < 1% significance

The deviation between the actual and fitted value for South Korea is too large and the extended SM model fails the normality test. This is rectified through the inclusion of a single dummy variable and the final model is described in table 10 below.

Table 10

Dependent variable	Constant	Independent variables		R^2	n
		C	p		
SM	-10.13**	0.57**	-0.24*	0.42	59
	(-11.69)	(5.85)	(-2.47)		

* < 5% significance

** < 1% significance

Given the significance of the GDP/capita variable South Africa is not expected to specialise in this sector and IT service exports are predicted at just 0.1% of merchandise exports.

3.6 Sea transport

The initial regression analysis provides little indication of what determines trade in sea transport services. The results are however consistent with the general prescriptions of comparative advantage, with educated and less populous nations more likely to specialise in transport services.

Table 11

Dependent variable	Constant	Independent variables				R^2	n
		e	lw	p	xy		
SM	-4.76**	0.33	0.00			0.01	57
	(-4.78)	(0.84)	(0.01)				
SM	-4.48**			-0.44**	-0.98**	0.21	61
	(-9.34)			(-3.29)	(-3.37)		
NE	-1.54**	0.64**	0.00			0.26	56
	(-3.81)	(4.19)	(0.03)				
NE	-1.54**	0.64**				0.26	56
	(-5.44)	(4.34)					

* < 5% significance

** < 1% significance

The predicted value of El Salvador is much higher than the actual trade ratio, presumably because war and political instability has prevented it from achieving its potential as an exporter of sea transport services. With a dummy variable included to account for this deviation, the residuals prove normally distributed and homoscedastic. The resulting model is able to explain around 50% of the cross-country variation in trade, with a number of additional variables significant. Access to international waters is an important determinant of comparative advantage in this sector, as is economic size. But population and income per capita continue to have a negative impact on trade in sea transport services. Finally, the relatively low openness co-efficient suggests that countries tend to specialise in either the manufacture or transportation of goods.

Table 12

Dependent variable	Constant	Independent variables					R^2	n
		p	xy	y	c	s		
SM	31.41*	-5.77**	-1.24**	5.42**	-5.41**	1.82*	0.50	59
	(2.51)	(-3.19)	(-5.11)	(2.95)	(-2.93)	(-2.58)		

* < 5% significance

** < 1% significance

Exports of sea transport services are generally higher than those of the other service sectors, with South Africa predicted to export 0.9% of merchandise exports.

3.7 Air transport

The results for the air transport sector are very similar to those for sea transport, with the education and population variables significant. In both the sea and air transport sectors the export orientation variable is close to -1 and therefore has little or no impact on trade in services (a rise in export orientation leads to an almost equal fall in the service to merchandise export ratio).

Table 13

Dependent variable	Constant	Independent variables				R^2	n
		e	lw	p	xy		
SM	-5.47**	0.72*	-0.01			0.10	58
	(-7.33)	(2.41)	(-0.05)				
SM	-6.90**	1.00**		-0.23*	-0.95**	0.26	56
	(-8.81)	(3.28)		(-2.11)	(-3.54)		
NE	-0.74	0.43**	-0.06			0.17	57
	(-1.99)	(2.97)	(-0.95)				
NE	-0.99**	0.46**				0.16	57
	(-3.63)	(3.23)					

* < 5% significance

** < 1% significance

The residuals of the extended SM model are normally distributed and homoscedastic.

High levels of protection in this sector clearly impact upon the predictive power of the model. Small developing countries that are able to sustain (protect) national carriers show a relatively high degree of dependence on air transport exports. This apparent specialisation is unrelated to some underlying comparative advantage in this sector. The model is unable to account for this protection with South Africa predicted to export the equivalent of 0.6% of merchandise exports in the form of travel services.

3.8 Travel

Education and infrastructure have a strong bearing on service quality and it is therefore not surprising that they are significant determinants of trade in travel services. Population, economic size, per capita income, technology and land per worker, on the other hand, seem to impact negatively on tourism. Populous and industrialised countries are more likely to specialise in manufacturing or high-skilled services and import travel services.

The relatively low export/GDP ratio coefficient suggests a strong but positive relationship between merchandise exports and exports of travel services. If merchandise exports rise as a share of GDP, the ratio of travel services to merchandise exports falls, but by a lesser amount. This suggests that trade in merchandise goods and travel service are complementary, though the direction of causality is perhaps open to dispute.

Interestingly, the positive co-efficient on the dummy variable in table 13 suggests that English-speaking countries are more likely to export travel services.

Table 14

Dependent variable	Constant	Independent variables					R^2	N
		e	lw	p	c	Xy		
SM	-3.16**	0.47	-0.06				0.04	85
	(-4.95)	(1.74)	(-0.61)					
SM	-2.46**	1.18**	-0.23*	-0.38**	-0.22*	-0.91**	0.31	81
	(-2.91)	(3.37)	(-2.60)	(-4.48)	(-2.01)	(-4.39)		
NE	0.41	-0.00	-0.07				0.02	84
	(1.20)	(-0.02)	(-1.36)					

* < 5% significance
** < 1% significance

Table 15

Dependent variable	Constant	Independent variables						R^2	n
		lw	y	t	xy	aw	d		
NE	-1.40*	-0.09*	-0.15**	0.32**	-0.26*	-0.13*	0.37*	0.34	67
	(-2.31)	(-2.07)	(-3.47)	(3.74)	(-2.34)	(-2.63)	(2.33)		

* < 5% significance
** < 1% significance

The residuals of the extended SM model are normally distributed and homoscedastic.

Tourism is the largest of the eight export industries analysed and is of particular importance for developing countries. South Africa is predicted to earn 4.9% of merchandise exports from tourism.

4. CONCLUDING COMMENTS

The econometric analysis does tend to support the application of comparative advantage to service exports. In general, human capital and economic development are important determinants of competitiveness in the service industry. Population size, on the other hand, has a negative impact on comparative advantage. Clearly, the size of the labour force is far less important than the aggregate level of education it has achieved.

One would therefore expect relatively small industrialised countries to specialise in services trade, but this is not always borne out by the sector specific data. Instead, a small group of developing countries seem to display a greater dependence on service exports than OECD countries in six of the eight sectors analysed. In some instances, this can probably be explained by higher levels of protection, but there may be other reasons for the apparent competitiveness of some developing countries in specific service sectors.

South Africa is a relatively populous country with modest education and development indicators. It is therefore unlikely to display a comparative advantage in services and the models predict relatively low service to merchandise export ratios in all eight sectors. The next step in this research project is to compare the theoretical predictions to actual South African services data and try explain some of the resulting deviations.

REFERENCES

Aldaz-Carroll, E. (2002). "Testing the Grandsons of Heckscher and Ohlin", *Unpublished manuscript of the University of Sussex Economics Department*.

Deardorf, A. V. (1994). "Testing Trade Theories and Predicting Trade Flows," in Jones R.W and P. B. Kenen (eds.) (1994) *Handbook of International Economics, Amsterdam*, North Holland Publishing Co.

Findlay, C. and T. Warren (eds) (2000). *Impediments to Trade in Services: Measurement and Policy Implications.* London and New York, Routledge.

Hoekman, B and C. Braga (1997). "Protection and Trade in Services: A Survey", *World Bank Paper prepared for The Open Economies Review*, Washington.

Hoekman, B and A. Mattoo (2000). "Services, Economic Development and the Next Round of Negotiations on Services", *Journal of International Development 12(2)*.

Langhammer, R. J. (1991). "Trade in Services between Brazil and the European Community: Empirical Trends and Preliminary Hypotheses on Determinants", *Kiel Working Paper No. 464*. Kiel, The Kiel Institute of World Economics.

Leamer, E.E. (1974). "The Commodity Composition of International Trade in Manufactures: An Empirical Analysis", *Oxford Economic Papers Vol. 24*: 350-374.

Sapir, A. (1986). "Trade in Investment-related Technological Services". *World Development 14(5):* 605-622.

Sapir, A. and E. Lutz (1981). "Trade in Services: Economic Determinants and Development-Related Issues", *World Bank Staff Working Paper No. 480*. Washington, World Bank.

Sapir, A and C. Winter (1994). "Services Trade" in Greenaway, D and L. A. Winters (eds) *Surveys in International Trade*. Oxford, Basil Blackwel.

Van Marrewijk, C., J. Stibora, A. de Vaal, and J-M. Viaene (1997). "Producer Services, Comparative Advantage, and International Trade Patterns", *Journal of International Economics 42*: 195-220.

Winters L. A. (1992) **"**International economics". London, Routledge.

Wood, A. (1994a.). "Skill, Land and Trade: A Simple Analytical Framework", *Institute of Development Studies Working Paper 1*. Brighton, IDS.

Wood, A. (1994b) "North-South Trade, Employment, and Inequality : Changing Fortunes in a Skill-driven World". Oxford, Clarendon Press.