CHAPTER FOUR

MARGINAL PRODUCTIVIVTY ANALYSIS OF SECTORAL WATER DEMAND IN SOUTH AFRICA

4.1 INTRODUCTION

In the preceding chapter, the global sectoral water demand functions were estimated for thirteen production sectors. In summary, the estimated results show that sectoral water demand is generally price elastic, although sector-specific elasticities as well as their marginal values vary from one sector to the other. The findings suggest that water pricing could be a workable policy instrument to achieve sectoral water use efficiency. To be consistent with economic theory, the study recommended sectoral water prices which reflect the marginal value of water. However, global sectoral water demand functions may not accurately reflect country specific water situations. The estimated global sectoral price and output elasticities of demand for water, and their respective sectoral marginal values of water may either be understated or overstated when compared to country specific water demand functions. Country and sector specific water demand functions depend on both the availability of the resource and the intensity of sectoral water use. Therefore, there is a need to validate the estimated results of the global level analysis of sectoral water demand functions at country specific levels and investigate the consistency of the global and country specific water demand functions. Water demand functions have been estimated for a number of developed countries like Canada by Renzetti (1988; 1992); Renzetti and Dupont (2003); France by Reynaud (2003), South East England by Rees (1969) and the United States by Grebenstein and Field (1979). In developing countries and countries in economic transition some studies have estimated the sectoral water demand functions.

These include studies by Wang and Lall (2002) in China; Onjala (2001) in Kenya; Kumar (2004) in India and Feres and Reynaud (2003) in Brazil. As discussed in the problem statement in section 1.4 of chapter One, various studies carried out in South Africa to estimate the value of water have either concentrated on a single sector or a few sectors. They therefore lack inter-sectoral comparative anlysis of the estimated marginal values of water. Thus, there is a need to validate the global water demand analysis by using South Africa as a case study. South Africa is selected for the validation study because the country is in the process of implementing an internationally recognized water reform policy that entails efficiency, equity and sustainability considerations. Moreover, the existence of fairly reliable data sets on sectoral production activities and water use makes the country a suitable option among the many developing countries or countries in economic transition.

Historically, water resource management in South Africa has focused on developing water supply sources through the establishment of complicated engineering supply-side solutions. Due to the increasing cost of such engineering processes, the potential future inelastic nature of water supply and perceived declining per capita water availability in South Africa, supply-side solutions alone no longer viewed as a viable option. This necessitates the switch to demand-side management options to complement the already developed supply-side engineering solutions. However, demand-side solutions to the potential water scarcity in South Africa require knowledge about the value of water in various sectors of the economy. The identified gaps and requirements for a comprehensive assessment of sectoral water use make it necessary to estimate sectoral water demand functions in the country.

The DWAF (2005) document sets the principles and framework for water reform that moves the country from water allocation based on the "riparian" principle to one that is based on the principle of efficiency, equity and sustainability. These principles and framework of water reforms in South Africa are outlined and explained in section 1.3 of chapter one. To achieve these objectives, there is the need for extensive research aimed at providing workable water pricing and allocation policies that can simultaneously address efficiency of water use, equity to access and to the benefits that accrue from the use of the resource, and environmental sustainability, such that the resource is available to future generations. Generally, all the estimated marginal values show that agriculture has the least marginal value of water. However, the exclusion of some of the vital sectors and the lack of consideration for inter-sectoral and institutional linkages in the former studies, and their failure to adequately disaggregate especially the manufacturing sector into sub-sectors requires further investigation into the problem.

Manufacturing water use differs from one sub-sector to another. It is also assumed that there are spatial differences in the sectoral marginal value of water in South Africa because of differences in agro-climatic zones. For efficient and successful policy design and implementation, there is the need to understand how agricultural and non-agricultural sectors respond to price changes and the contribution of water to output in each of these sectors. Against this background, this chapter is designed to critically analyze sectoral water demand in South Africa and make comparative analysis of the sectoral marginal values of water at provincial level. Specifically, this chapter is designed to:

i) Estimate the sectoral water demand functions in South Africa,

ii) Compute the output and price elasticities of water demand for the various production sectors,

iii) Estimate and compare the sectoral marginal values of water at both national and provincial levels, and

iv) Recommend policies that would promote sectoral water use efficiency.

The next section explains the model specification and estimation, and the description and sources of data used for the study. Section 4.3 presents and discusses the estimated results at national and provincial levels of the country, while section 4.4 provides the chapter summary and concluding remarks.

4.2 MODEL SPECIFICATION, ESTIMATION AND DATA SOURCES

This section is divided into two sub-sections. The first sub-section discusses the model specification and estimation procedure and the second sub-section explains the data sources and data extraction procedure.

4.2.1 Model specification and estimation procedure

This chapter applies the modeling procedure which was described in chapter three. To estimate the Cobb-Douglas', the translog and the translog with sectoral dummies production functions, the study uses equations 3.4, 3.6 and 3.8. The Cobb-Douglas' production function is estimated to test how consistent the data is with the model. The translog production function is estimated to compute the combined sectors' output and price elasticities and marginal value of water. The translog model with sectoral dummies is then estimated to facilitate the computation of sector specific elasticities and marginal value of water use. As explained in chapter three, the product of the natural logarithm of water use in each sector and the sector specific dummy accounts for differences between both the intercept and the slope of the combined sectors' water demand function and each sector's water demand functions. This model is referred to as the two-stage model. In the first stage, the overall output and price elasticities and marginal value of water are computed. In the second stage, the coefficient of the product of the sector specific dummies and the natural logarithm of water use are used to compute the sector specific elasticities and marginal values of water.

4.2.2 Description and sources of data

For the estimation of the sectoral water demand functions in this chapter, the study uses three sources of data. The first source is the 1996 census of manufacturing, agricultural, mining, construction and services activities, published by STATSA (2002) in ten volumes, one for each province and one with a national coverage. The information collected from this source included value of output produced by each sector or sub-sector, depreciation in capital stock, the value of intermediate input, and wages and salaries paid to employees. All these variables are measured in millions of Rand. Information on the same variables for the agriculture sector was extracted from the census for agriculture activities for each province and for the whole country.

The second set of data is extracted from the water resources accounts, also published by Statistics South Africa (STASA, 2004). This data source contains information on sectoral water availability and utilization in million cubic meters for each of the nineteen water management areas (WMA) and for the whole country. Using the same procedure in chapter three sectoral water use per employee is converted to water use in each sector by multiplying this ratio by the number of employees in each sector. This figure is compared to the sectoral water use in water resource account. Where a substantial difference exists between the two figures, the conversion factor is adjusted, until the converted figures are consistent with sectoral water use (see equation 3.9). Details of the extracted data can be found on Table B1 in appendix 2.

To compute the marginal value of water over time for each sector, the Trade and Industrial Policy Strategies (TIPS) time series data set is used. The extracted data included the value of sectoral output, total expenditure on wages and salaries, other intermediate inputs, depreciation on capital and new capital investment. To isolate the impact of fluctuations in the value of the currency the values are measured in millions of 1996 Rand. The information on water in millions of cubic meters was extracted from the same source. The study uses the quantity and not the value of water because of current distortions in the municipal prices of water.

For the purpose of this study, data are extracted for the period 1970 to 2004. In the data set there are 43 disaggregated sectors according to the international standard industrial classification (ISIC). Considering the nature of water use by the different sectors, the 43 sectors in the TIPS time series data were aggregated to 13 sectors. The aggregated sectors are agriculture (AGR), which consists of crop production, animal husbandry, forestry and fisheries; agro-based industries (AGI), consisting of beverages, tobacco, and food manufacturing; mining (MIN), which comprises coal mining, gold mining, uranium and other mining, Leather products and wearing apparel (TEX), consisting of textile, wearing apparel, leather and leather products and footwear; wood, paper and paper products (PPP), consisting of wood and wood products, paper and paper products, printing, recording and recorded media; petroleum products (PET); chemicals (CHM), consisting of basic chemicals and other chemicals; heavy manufacturing (HEV), made up of non-metallic minerals, basic iron and steel., basic non-ferrous metals and metallic products excluding machinery; machinery and equipment (MAC), including machinery, electrical machinery and apparatus, television, radio and communications equipment, motor vehicles, and spare parts and professional and scientific equipment, electricity (ELE); construction (CON) including building, civil engineering and other construction; and services (SER) consisting trade services, catering and accommodation, transport and storage, communication, business, medical, dental and veterinary services, other professional and general government services and other manufacturing (OHM) like furniture, rubber and rubber product. These aggregated sectors are consistent with those extracted from the other sources.

4.3 PRESENTATION AND DISCUSSION OF ESTIMATED RESULTS

This section is divided into four sub-sections. These include presentation of:

i) the coefficients of the three estimated models (the Cobb-Douglas', the translog and the translog with sectoral dummies)
ii) the computed elasticities;
iii) sectoral marginal values of water;
iv) sectoral marginal values of water by province and over time

4.3.1 Presentation of the estimated coefficients

Table 4.1 presents the estimated coefficients of the three models. A correlation matrix showed a high degree of correlation between water and intermediate inputs. Since the focus is on water, the intermediate input variable was dropped, while capital, labour and water are retained and their coefficients estimated in the three models.

In the first model, the Cobb-Douglas' production function was estimated and the estimated coefficients are shown in Column 2 of Table 4.1. The estimated coefficients show a one percent level of significance for capital and labour and a five percent level of significance for water. All the estimated coefficients are positive, indicating a positive relationship between the inputs and output. Because the variables are expressed in natural logarithms, their coefficients are interpreted as output elasticities.

The translog production function was then estimated and tested against the null hypothesis that the interaction and square terms are not significantly different from zero. Based on the result of the test statistic, the null hypothesis was rejected. The coefficients of the translog model with their respective significance levels are presented in Column 3 of Table 4.1. The labour variable is significant at one percent level, while capital and water are significant at five percent.

The third model, which imposed the product of the sectoral dummies and the mean level of water use in each sector on the translog model, was estimated, and the coefficients are reported in column 4. This model is estimated to show that both the intercept and slope coefficients differ for the different sectors. It thus facilitates the easy and better estimation of the sectoral elasticities and marginal values. The results for all the variables, including the sectoral dummies, generally indicate that water is a significant input in sectoral production activities. The standard errors, t-scores and p-values of the estimated coefficients are documented on Tables B2,3 and 4.

Table 4.1: Estimated coefficients of the South water demand models

Variables (1)	**Model 1 Cobb-Douglas'** (2)	**Model 2 Translog Production Function** (3)	**Model 3 Translog with Sector Dummies** (4)
Constant	1.0828*[1]	2.0556**	2.0905*
lnK (Capital)	0.1959*	0.1140**	0.2463**
lnL (Labour)	0.2165*	0.1271*	0.8125*
lnW (Water)	0.0665**[2]	0.0665**	0.4731*
lnK*lnL(Capital * Labour)		-0.0065	0.0712
lnK*lnW (Capital*Water)		0.0774	-0.0182
lnL*lnW (Labour*Water)		-0.0052	0.0197
LnKsq (square of capital)		0.0129	-0.0309
LnLsq (square of labour)		-0.0463***[3]	-0.0426
lnWsq (square of water)		-0.0514***	-0.0545***
S1lnW(Beverage and Tobacco)			0.1758*
S2lnW(Agriculture, Fishing and Forestry)			0.0035*
S3lnW(Basic Chemical manufacturing)			0.3019
S4lnW(Construction)			0.4421**
S5lnW(Electricity and Gas)			-0.0134*
S6lnW(Metal Manufacturing)			0.0990**
S7lnW(Machinery and Equipment)			0.5371*
S8lnW(Mining and Quarrying)			0.0569***
S9lnW(Other Manufacturing)			0.0635
S10lnW(Petroleum Products)			0.5434*
S11lnW(Paper, Pulp and Printing)			0.1037**
S12lnW(Services)			0.5371*
S13lnW(Leather Products and Wearing Apparel)			0.6339*
Number of observations	117	117	117
Degrees of freedom	(3, 114)	(9, 108)	(22, 95)
F Score	362.12*	193.35*	97.34*
Durbin Watson Test	2.138	1.975	2.189
R^2	0.65324	0.6157	0.5817
Ajusted R-squared	0.64528	0.6082	0.5743

The coefficients of the product of the sectoral dummies with the mean level of water use for each sector was then tested against the null hypothesis that the differences in water use

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[1] Significant at one percent level

[2] Significant at the five percent level

[3] significant at the ten percent level

by the sectors is not significantly different from zero. The test results show that sectors significantly differ from each other with respect to their various levels of water use.

The last three rows of Table 4.1 present the results of the test-statistics which assess the degree of predictability and appropriateness of the model. The results of the Wald test show that the translog is the most appropriate functional form. An adjusted R^2 of 65% of the translog functional form with sector dummies indicates the model's predictability of the relationship between the output and the input variables. The Durbin Watson statistics of 2.138, 1.975 and 2.189 respectively show that there were no serious problems of autocorrelation among the specified variables.

4.3.2 Computed output elasticities

Output elasticity of water measures the degree of responsiveness of output to a unit change in the level of water application in each sector. It measures the percentage change in the value of output when the level of water application increases by one percent.

The sectoral elasticities and marginal values are computed on the means of the variables. These sectoral means of the estimated variables are presented in Table 4.2. The combined sectors and the sector specific output elasticities are reported in column 2 of Table 4.3. The results show that the combined sectors' output elasticity of water is 0.19. This result indicates that for all the sectors, the value of output increases by 1.9 percent when sectoral water use increases by ten percent. This means that although the value of output increases with increase in the volume of water used by all the sectors, the percentage increase in the value of output is not proportional to the percentage increase in the level of water use. However, output elasticity varies from one sector to the other, although the computed figures indicate that none of the sectors has output elasticity greater than unity. For example, the leather products and wearing apparel sector has the highest output elasticity of 0.82, while electricity records the lowest output elasticity of 0.18. Figure 2 displays the computed output elasticity for each sector.

Table 4.2: Means of estimated variables

Sector (1)	Output (R m) (2)	Capital (R m) (3)	Employment (R m) (4)	Intermediate (R m) (5)	Water (m m^3) (6)
Beverage and Tobacco	1713.54	69.80	183.68	1294.67	2.98
Agriculture	958.84	98.79	153.88	439.72	1403.00
Basic Chemicals	1145.39	46.01	139.00	855.33	18.24
Construction	1361.85	26.90	243.43	945.78	0.15
Electricity	525.88	153.52	126.13	287.51	37.22
Metal Manufacturing	1752.69	97.79	408.79	1253.45	46.33
Machinery & Equipment	2067.08	56.51	316.72	1556.18	0.88
Mining and Quarrying	1874.12	200.02	475.60	812.84	68.00
Other Manufacturing	975.71	23.55	492.33	593.52	29.27
Petroleum Products	598.04	63.52	30.75	416.65	3.49
Paper, Pulp and Publishing	671.08	43.82	163.40	604.71	32.68
Services	13564.92	964.43	4383.42	5497.30	106.19
Leather products & wearing apparel	554.90	17.68	115.91	391.24	0.85
Combined Sectors	2133.42	143.14	555.87	1147.82	134.39

The computed sectoral output elasticities indicate that for each of the production sectors the value of output increases with increase in the volume of water, but the percentage increase in the value of output is not proportionate to the percentage increase in the volume of water. The figure below indicates that when water use increases by one percent in each of the production sectors, the percentage increase in the value of output in the leather products and wearing apparel sector is greater than that in any other sector. However, the policy relevance of the concept of output elasticity needs to be critically investigated before recommending its implementation. Firstly, one percent increase in the volume of water use in the agriculture sector may not be the same as one percent increase in the volume of water use in the other sectors. Secondly, a percentage increase in the value of output in agriculture may be more or less than a percentage increase in the value of output in the beverage and tobacco manufacturing industry. Therefore, direct comparison of the sectoral output elasticities may be misleading. In spite of the differences in percentage changes, the sign and magnitude of the sector specific output elasticity indicate the direction and productivity of water in that sector alone.

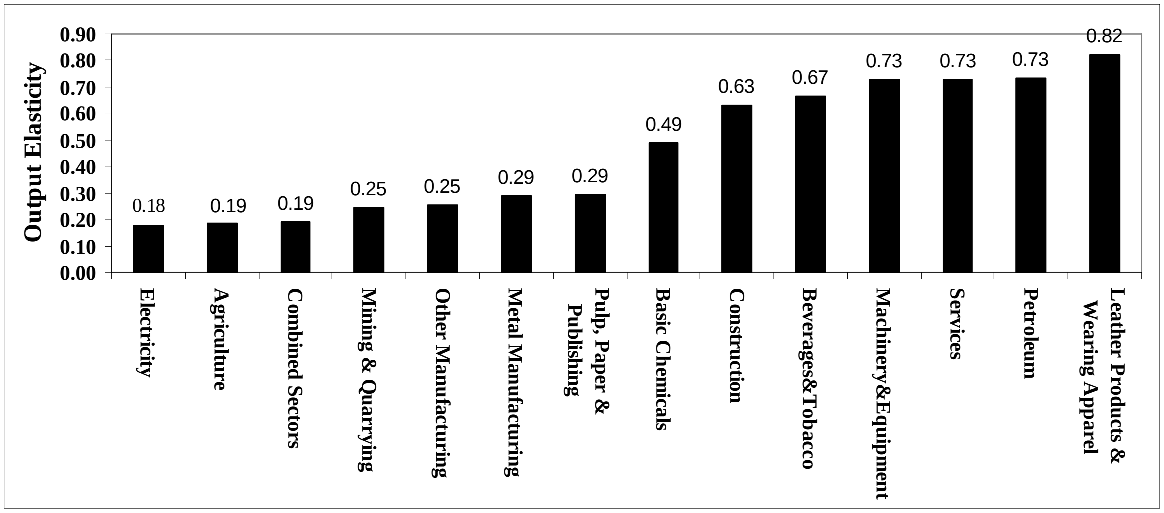

Figure 2: Computed sectoral output elasticities of water in South Africa

This concept indicates that the percentage change in the value of output is positive in all the sectors, but not proportionate to the percentage change in the level of water use. However, the disproportionate relationship between percentage increase in output and percentage increase in the volume of water use is more in the electricity sector than the other sectors.

The above results are also consistent with the findings of Wang and Lall (2002), which show that the sectoral output elasticity is less than unity in all the sectors. They are also consistent with the findings of the global level water analysis in chapter three. The general implication from the findings is that percentage changes in output do not proportionately correspond to percentage changes in the level of water use by the production sectors.

4.3.3 Computed sectoral price elasticities of the demand for water

The sectoral price elasticity of demand for water shows how the production sectors change their demand for water due to a unit change in the price of water. It measures each sector's degree of responsiveness of changes in the volume of water to a unit change in the price of water. The computed price elasticities of water for each and every sector which are reported in column 4 of Table 4.3 indicate that combined sectoral water demand is price elastic, with elasticity measure of -1.03.

Table 4.3: Computed sectoral price elasticities and marginal values of water in South Africa

Sectors (1)	Output Elasticity (2)	Marginal Value (Rand/m^3) (3)	Price Elasticity (4)	10% Increase in the price of water (5)
Beverages &Tobacco	0.67	38.25	-1.44	(14.4)
Agriculture	0.19	0.13	-1.03	(10.3)
Basic Chemicals	0.49	3.08	-1.23	(12.3)
Construction	0.63	58.98	-1.39	(13.9)
Electricity	0.18	2.49	-1.02	(10.2)
Metal Manufacturing	0.29	10.91	-1.08	(10.8)
Machinery & Equipment	0.73	17.16	-1.52	(15.2)
Mining & Quarrying	0.25	6.79	-1.05	(10.5)
Other Manufacturing	0.25	8.43	-1.06	(10.6)
Petroleum	0.73	12.55	-1.53	(15.3)
Pulp, Paper & Publishing	0.29	6.02	-1.08	(10.8)
Services	0.73	9.28	-1.52	(15.2)
Leather products & wearing apparel	0.82	53.68	-1.67	(16.7)
Combined Sectors	0.19	3.01	-1.03	(10.3)

Column 4 of the above table shows that generally, a 10 percent increase (decrease) in the price of water leads to 10.3 percent decrease (increase) in the quantity of water demanded by all the sectors. Since the percentage decrease (increase) in the quantity of water demanded is slightly more than the percentage increase (decrease) in the price, sectoral water demand is said to be price elastic. As with output elasticity of water, the price elasticity demand for water also varies from one sector to the other. This implies that the responsiveness to the same percentage change in the price of water varies from one sector to the other.

For example; a 10 percent increase in the price of water reduces electricity's demand for water by 10.2 percent, while it reduces the demand for water in the leather product and wearing apparel sector by 16.7 percent. The impact of a 10 percent increase in the price of water on the quantity of water demanded by each and every sector is shown in column 5 of Table 4.3.

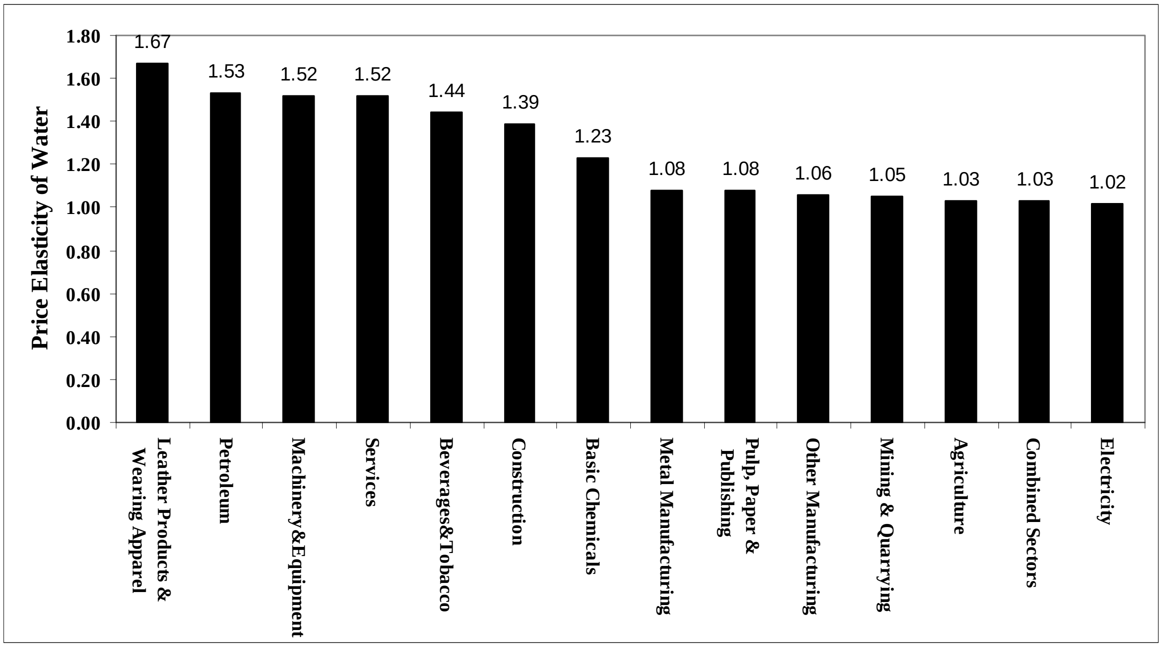

Figure 3: Sectoral price elasticity of water in South Africa

Figure 3 presents a graphical illustration of the absolute values of sectoral price elasticities of demand for water in order of magnitude, showing leather products and wearing apparel with the highest price elasticity and electricity with lowest price elasticity of demand for water. These figures indicate that the overall, production sectors' demand for water is price elastic. Therefore, the percentage decrease in the volume of water demand by each sector is more than the percentage increase in the price of water for that sector. The computed elasticities are fairly consistent with those estimated in the global water demand analysis. These findings have some policy implications which will be discussed in chapter seven.

4.3.4 Presentation of the computed sectoral marginal values of water

Marginal value of water measures the change in the value of output due to a cubic meter change in the volume of water. The marginal value of water in a sector shows the increase or decrease in the value of output per cubic meter change in the volume of water used in that sector. The marginal value of input is an important concept in general production theory. The unit cost of an input (marginal cost) is compared with the unit contribution of that input to output or revenue, which in this study, is the marginal value of water. Where the marginal value is less than the marginal cost, less of that input should be used until at least the marginal value is equal to the marginal cost. In a multi-factor industry, the ratio of the marginal value to the price of the input, must be the same for all the factors and must be equal to unity. The combined sector' and the sector specific marginal values of water are reported in column 3 of Table 4.3. The marginal values are computed at the means of the variables. The combined sectors water use has a marginal value of R3.01/m^3 of water. This implies that on the average, the value of sectoral output increases by R3.01/m^3 of water. As with output elasticity, the marginal value of water varies from one sector to the other. The construction sector, with R58.98/m^3 has the highest marginal value of water in South Africa. This is followed by the leather products and wearing apparel sector with a marginal value of R53.68/m^3. Again, the agriculture sector, with a measure of R0.13/m^3, has the least marginal value of water. Figure 4.2 presents a graphical illustration of the sectoral marginal values of water in order of magnitude.

This implies that in South Africa, the same cubic meter of water is more productive in the construction sector than in all the other sectors, with agriculture being the least productive in terms of marginal returns to water use. However, since the magnitude of a sector's marginal value of water depends on both the level of water use and output, more water-intensive sectors have lower marginal values than the less water-intensive sectors. The marginal value of water in the agriculture sector is lower than the one estimated by Moolman *et al.* (2006:86) which ranges from R25.43/m^3 for mango to R1.67/m^3 for sugar cane. However, it is higher than the one estimated by Nieuwoudt *et al.* (2004:180) which varies from R0.0011/m^3 to R0.2115/m^3. These comparisons show that the marginal values of water differ with different valuation methods. These marginal values can not be compared with studies done in other countries because of differences in currency units.

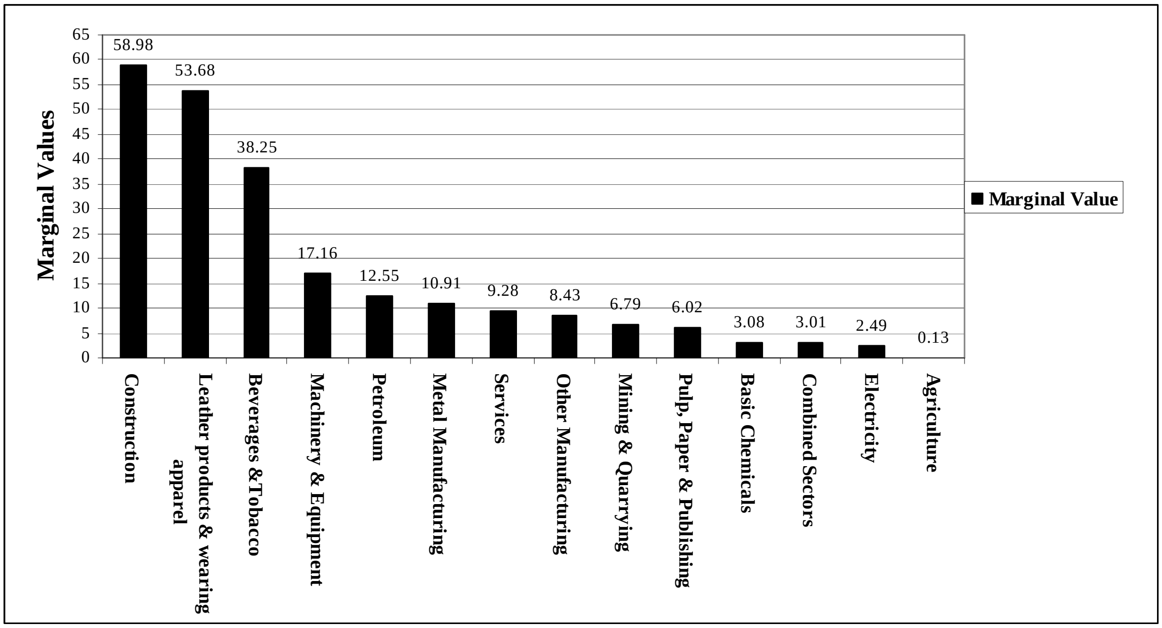

Figure 4: Sectoral marginal values of water in South Africa

The concept of marginal value of water, unlike that of output elasticity, has more practical policy relevance, which will be discussed chapter seven. Generally, in South Africa, the issues of equity, efficiency and sustainability are high on the water policy agenda. The institution of water use efficiency is based on the principles of water pricing and inter-sectoral water transfer/trading. However, the modeling and computational techniques applied in this study imply constant elasticities, but varying marginal values. Therefore, the computed marginal values vary from one province to the other, depending on the level of water use, output and the use of other inputs, including changes in the level of technology.

4.3.5 Provincial sectoral marginal values of water

To investigate spatial variations in inter-sectoral marginal values of water the study computed the marginal values of water for each sector in all the nine provinces of South Africa. Table 4.4 presents the computed results. The data for this exercise were extracted from STATSA's 1996 census of manufacturing, agricultural, construction and services activities published for each of the nine provinces. The information on sectoral water use is reported in these documents in million cubic meters. To make sure that the extracted data is consistent, the water data was compared with the sectoral water use data also published by resource Statistics South Africa (STATSA, 2004).Comparing the country-wide sectoral marginal values presented in Column 3 of Table 4.3 and the provincial sectoral marginal values presented in Table 4.4 it is shown that although country-wide estimations put machinery and equipment manufacturing as the sector with the highest marginal value of water, the situation is different for different provinces. For example, in the Eastern Cape, Free State and North West provinces, construction has the highest marginal value of water, while in KwaZulu Natal, Mpumalanga, Northern Cape and Western Cape provinces beverage and tobacco manufacturing has the highest marginal value of water and metal manufacturing has the highest marginal value of water in the Limpopo provinces.

The marginal value of water in the beverage and tobacco manufacturing sector is highest in the Western Cape and least in Free State, while agriculture commands a higher returns in Gauteng and the least in Western Cape. Also, the marginal value of water in construction sector is highest in the Eastern Cape and least in the Northern Cape.

Table 4.4: Provincial sectoral marginal values of water in South Africa

Sectors	Eastern Cape	Free State	Gauteng	Kwa-Zulu Natal	Mpumalanga	North West	Limpopo Province	Northern Cape	Western Cape
Beverage and Tobacco	30.61	12.59	40.15	39.70	34.38	33.72	48.27	42.07	53.69
Agriculture	1.32	0.94	4.26	1.21	0.65	0.87	3.27	1.09	0.58
Basic Chemicals	1.74	4.48	21.82	8.84	5.04	0.44	20.01	2.13	0.27
Construction	51.04	38.99	14.88	13.26	11.50	33.94	31.86	4.23	8.35
Electricity	6.49	7.13	3.93	4.48	3.72	6.42	21.52	12.87	4.12
Metal Manufacturing	1.67	0.67	26.02	13.16	13.43	1.73	60.37	10.45	0.42
Machinery & Equipment	4.35	1.27	11.24	27.95	19.92	5.22	15.59	18.10	0.66
Mining and Quarrying	1.56	4.77	6.87	1.63	6.45	7.27	1.56	10.52	1.93
Other Manufacturing	9.34	5.53	36.35	9.57	0.95	40.91	17.59	2.84	15.72
Petroleum Products	3.13	0.61	12.81	3.68	0.35	17.71	1.75	0.89	4.89
Paper, Pulp and Publishing	2.52	0.19	63.67	12.49	0.39	22.31	44.54	1.01	6.16
Services	30.21	2.44	5.15	3.24	3.72	6.67	9.13	17.13	6.93
Leather Products and Wearing Apparel	0.78	0.14	9.49	12.18	0.21	18.17	21.66	1.23	4.05

Generally, the marginal value of water for the same sector varies from one region to the other, though the price and output elasticities are assumed to be constant. This is because of variations in sectoral mean production and availability use of water. Sectors that are high intensive water users usually have lower marginal values than those which use less water.

4.5 SUMMARY AND CONCLUSIONS

The need to validate global sectoral water demand analysis and to institute inter-sectoral water use efficiency in South Africa necessitated a study to investigate the responsiveness of industries to water prices, using the data extracted from STATSA’s census of manufacturing, construction agricultural and services activities, and water resource accounts..

Adopting the model used by Wang and Lall (2002) and applied in chapter three, the Cobb-Douglas’ translog production function was estimated, with sectoral dummies for 13 production sectors, from which the price and output elasticities and the marginal values of water were computed for the different sectors.

The results indicate that generally, water use by industries is price elastic in South Africa, implying that industries do respond to changes in water prices. However, there are varying degrees of price elasticities of industrial water demand for the different sectors. The results also suggest that, to improve industrial water use efficiency, water prices should at least reflect the marginal value of water in the different industrial sectors. This policy should be used in conjunction with other mandatory policies like fixed quantity of freshwater intake by industries, water treatment and recycling and effluent charges.

Since water is combined with other inputs, there is the need to investigate whether water and each of the other inputs are either compliments or substitutes. This will produce some interesting results for water policy makers. South Africa has different ecological and climatic zones, so water situation in the country varies from one climatic zone to the other. Therefore, national figures estimated in the study may not be reflective of each and every agro-ecological or climatic zone. Thus, there is a need for a detailed study at the catchment level to estimate the inter-sectoral demand for water use.

The results of this study show that agriculture is among the sectors with lower marginal values of water. From the economic point of view and the concern to maintain a sustainable economic growth, the study recommends an inter-sectoral water reallocation based on marginal values. However, efficiency considerations in inter-sectoral water transfer may undermine the country's principle of equity in water use. Based on the principle of efficiency, water should be reallocated from agriculture to the sectors that have higher marginal values of water. This is likely to affect employment and the income of the poor rural population, the majority of who depend on agriculture for their livelihood because the agriculture sector employs more than 50 percent of the employed unskilled labour (Thurlow and van Seventer, 2002). This requires an investigation of the impact of inter-sectoral water reallocation, on the basis of sectoral marginal values, on sectoral output, factor remuneration, employment and household income generation.