AN INVESTIGATION INTO THE DEMAND FOR ILLUMINATING PARAFFIN AND LIQUID PETROLEUM GAS IN SOUTH AFRICA

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ABSTRACT

This dissertation investigates the demand for Illuminating Paraffin (IP) and Liquid Petroleum Gas (LPG) in South Africa, and also tests the energy transition theory. The energy transition process outlines the substitution of fuels that occurs with rural-urban migration.

Data on income, IP and LPG prices, demographic trends and IP and LPG volumes are incorporated in models to test the energy transition theory: National and regional projections of demand are derived. Income and price elasticities are derived for testing the energy transition theory, where Engel's Law is applied.

The derived price and income elasticities for the regional IP models largely confirm the energy transition process where poorer areas are price inelastic. The models of the urban electrified areas and the predominantly rural areas, produce negative income elasticities which reduce the forecasts and suggest that IP is an inferior good due to the availability of superior electricity or free wood respectively. Electrification will play a role in reducing consumption of IP and LPG. However, it can be concluded that due to the predominant price and income inelasticity of demand, the smooth and exclusive transition from wood to IP and LPG and finally electricity suggested by (Viljoen, 1990) is perhaps misleading.

It is more likely that tardiness in substituting one fuel for another will impede the complete transition among fuels and that the use of a range of fuels, even if electricity becomes available, will be maintained for some time as the newly urbanised household moves up the modernisation index. The forecasts for IP and LPG for the period 1992 to 1995, emanating from the econometric models developed here, forecast lower growth in consumption as compared with the recent past. The national forecasts for 1992 to 1995 are half those achieved in the last upturn of 1986 to 1989. LPG forecasts are similarly about 50% lower than the historic period. However, the growth in both products is still forecast to be double the projected GDP growth. The regional IP forecasts show most of the growth occurring in the urban areas and the "homelands" closer to the metropoles. High growth is particularly forecast for the large PWV complex with its dense concentration of population and high rate of immigration.

In summary, the transitional fuels will remain important energy sources for some time to come. The variables such as population growth, income and IP and LPG prices are significant in determining demand. In spite of Eskom's ambitious plans to provide "electricity for all" a significant proportion of the population will remain without electricity. It is therefore important for policy-makers to ensure that the prices of IP and LPG paid by the consumer are within income constraints as energy is a basic need.

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INTRODUCTION

This dissertation investigates the demand for Illuminating Paraffin (IP) and Liquid Petroleum Gas (LPG) in South Africa, and also tests the energy transition theory. The energy transition process outlines the substitution of fuels by people as they move from a rural environment to an urban environment.

In rural areas, people without electrification are initially biomass dependent, where the principal fuel used for cooking, lighting and space heating is fuel wood. As fuel wood becomes scarce, due to extensive use, a transport cost is incurred in obtaining it from outlying areas. The rural population then moves from wood to the initial transitional fuel which is Illuminating Paraffin (IP). The expanding population causes a migration to urban areas to acquire income as subsistence agriculture can no longer provide for the growing rural population. IP is still the dominant fuel among newly urbanised people - due to its relatively low price particularly when the cost of appliances is taken into account. However, as income increases the consumer moves along the energy transition profile to more amenable transitional fuels, such as Liquid Petroleum Gas (LPG), until the final stage, that of electricity, is reached.

This dissertation combines data on income, IP and LPG prices, demographic trends and IP and LPG volumes in econometric models to test the energy transition theory. The aim is to investigate the demand for IP and LPG, so the models have been developed nationally and regionally to project future demand and investigate the relationships between the variables. Income and price elasticities are derived for testing the energy transition theory, where Engel's Law is applied. A high income elasticity for a fuel would denote a luxury good and would indicate that the consumers had not possibly reached that phase of the energy transition process, whereas lower income elasticity would indicate strong dependence on that fuel.

Finally, the impact of past and proposed electrification is assessed to determine the extent of this structural constraint to the demand for transitional fuels. The growth of the use of IP and LPG has been significant since Black urbanisation gained momentum in the mid-1980's. It is important for policy decisions, to assess future demand, distribution and affordability of transitional fuels such as IP and LPG, as energy is a basic need.

CHAPTER 1

1.1 Introduction

This chapter discusses the energy consumption transition in South Africa from free woodfuel to commercial fuels such as illumination paraffin (IP), liquid petroleum gas (LPG) and finally electricity. In order to fully appreciate this transition, the experience of several developing countries will be highlighted. Emphasis will also be placed on the influence of price and income levels in the energy consumption transition.

The first section will describe the energy consumption transition in general. Section two focuses on the energy transition in some Sub-Saharan African countries and South Asian nations. The energy transition process in South Africa is outlined in section three and the concluding parts refer specifically to the effects of price and income levels in the transition.

1.2. The Concept of Energy Transition

The concept of energy transition is generally described as ... "the complete substitution of biomass fuels before the final stage of complete dependency on electricity is reached" Viljoen (1990,125). The process is often driven by the search for greater amenity and economy (modernization) within the framework of the family budget. The initial fuel, biomass, refers to all combustible or fermentable material of vegetable origin such as wood, charcoal, corn cobs, cotton stalks, rice husks and dung cakes. These fuels are used mostly by populations in villages and other widely scattered rural dwellings (World Bank, 1983). The transitional or intermediate fuels in the modernization process comprise of IP and LPG. IP (also called illuminating kerosene or simply kerosene) refers to any refined petroleum product between gasoline (petrol) and gasoil (diesel) in volatility and free of petrol and lubricating oil. This product is often used as an illuminant in cooking and heating stoves and as a fuel for jets and certain types of spark ignition such as those used for agricultural tractors and stationary engines. On the other hand, LPG is described as propane and butane gas liquified at ambient temperatures by pressure, or refrigerated to minus 45^0C (minus 50^0F) at atmospheric pressure (World Bank, 1983). Both IP and LPG are utilised by populations in emerging urban centres and peri-urban areas.

In a study of six rural villages and five peri-urban areas (all of which were unelectrified) in South Africa in 1985, Eberhard (1986,106) found that wood and dung were consumed largely by people in the villages compared to those residing in peri-urban and other urban areas. Similarly - and as Table 1 below highlights - there was a much greater consumption of IP and LPG by populations in the peri-urban areas as a result of the scarcity of biomass in these areas. From Eberhard's findings (Table 1), it is evident that the energy transition process from biomass to commercial fuels is likely to occur as people become more urbanised.

Table 1.1*: *Fuel Consumption in a Developing Economy

Mean annual household domestic energy consumption in total sample							
	Fuelwood Kg	Dung Kg	Paraffin 1	Candles No	Coal Kg	Gas Kg	Total GJ
Villages	3 212	685	127	171	129	5	73
Peri-Urban	2 078	-	270	298	905	8.8	71
Mean annual per capita domestic energy consumption in total sample							
	Fuelwood Kg	Dung Kg	Paraffin 1	Candles No	Coal Kg	Gas Kg	Total GJ
Villages	604	118	23	27	20	0,66	13,8
Peri-Urban	334	-	46	51	156	1,90	12,0

Source: *Eberhard A. (1986,106): Energy Consumption Patterns in underdeveloped areas in South Africa.*

1.3 Energy Transition in some Developing Countries

In their study on energy consumption in Tanzania, Gielink and Dutkiewicz (1991,14), found that in 1988 the country's total final energy consumption (TFC) was 12,936 million tons of oil equivalent(toe) of which 95% was in the form of traditional fuel (Biomass) and 4% in the form of oil products. In a similar study of Angola, Dutkiewicz (1990,36) found that 59,7% of total final energy consumption was traditional energy with oil, gas and electricity providing 25,1%, 7,8% and 7,4% respectively. This heavy reliance on traditional energy occurs in spite of the fact that Angola has large reserves of oil and hydro-electricity.

In fact, as shown in Table 2 below, Angola's energy consumption per capita is very low. India, with around half the GDP per capita of Angola, consumes 8% more energy per capita, while Ghana, which has 65% of Angola's GDP per capita, uses almost 3 times more energy per capita.

Table 1.2: Comparative GDP/CAPITA and Energy Consumption in some Developing Countries

Comparison of final energy consumption for various countries in 1985. (Figures include traditional energy forms).		
Country	GDP/capita US$	Energy/capita kgOE
Ghana	354	531
Zimbabwe	562	473
Egypt	712	401
Indonesia	522	323
Kenya	294	313
Zambia	388	261
Bolivia	536	247
India	280	211
Angola	547	196

Source: *Dutkiewcz R.K. (1990,15): Energy Profile: Angola,* In Zaire, Dutkiewicz (1990,7) found that fuelwood provides most of the energy consumed in the country; with consumption estimates varying between 75% and 90% of total energy. The abundance and ready availability of wood in the rural areas has resulted in wood being considered a "free good" in these areas. Out of the total population of 34,67 million in 1985, only 36% were urbanised and about 3,5% had access to electricity. In the urban areas charcoal and, to a certain extent, fuelwood were used. The ratio of charcoal use to fuelwood use was 6:4, though in heavily populated Kinshasa the ratio was higher at 17:3 (Dutkiewicz 1990,16).

Dutkiewicz's study also found that the penetration of IP and LPG in the domestic sector in Zaire was virtually non-existent. This is because the country is self sufficient in wood fuel and charcoal. Furthermore, despite the heavy subsidisation of electricity in the domestic sector at present, Zaire's domestic consumption of electricity is not nearly that of charcoal.

Fuel consumption patterns in some South Asian states also show a strong preference for biofuels. A study by Leach (1987,2.1) found that the share of biofuels in total household energy consumption in the rural areas in India, Pakistan and Sri Lanka was around 90% for all income levels. In particular coal briquettes (soft coke) was found to be the most widely used fuel at all income levels in some rural parts of India.

However, there was some preference for IP and LPG in some arid areas in India and Pakistan. In Pakistan, poor peasants sold cattle and other capital assets to acquire LPG.

Leach (1987) identified the limited availability of premium (non-traditional) fuels as the main reason for the strong preference for biofuels in the rural areas of most South Asian states.

Cross sectional data for 1978 - 1979 (India, Pakistan) and 1981 - 1982 (Sri Lanka) show that in rural areas, the share of bio-fuels in total household energy is virtually constant at around 90% for all income levels. Leach (1987) states that the energy transition process is probably severely constrained by limited availability of premium ("non traditional") fuels. Price is found to be not a major constraint in India and Pakistan, where Kerosene and LPG are much cheaper than firewood on a useful heat basis.

In the urban areas where premium fuels are more easily available, Leach found that the share of biofuels in total household energy consumption fell steeply with income levels in India and Pakistan; with figures ranging from 80% to around 30 - 35% in the highest income brackets.

In two surveys Leach conducted in the urban areas in India in 1979 and 1984, he found a massive transition from bio-fuels to premium fuels as income increased. Overall, the share of bio-fuels for cooking and heating (on useful heat basis), fell from 42% to 27% while the Kerosene and LPG shares rose from 19% to 36% and 7% to 12% respectively. All income groups (range of income not disclosed) were included in these changes. As Table 3 below shows, as urban households earned more income there was a decline from 60% to 12,1% in fuelwood use, a rise from 13,2% to 18,9% in IP use and a rise from 0,8% to 32,9% in LPG use in a 1979 survey. A later 1984 survey showed a greater shift from firewood to IP and LPG as income increased.

Table 4 shows similar trends in Sri Lanka, where rural households used firewood for around 95% of their cooking energy needs, while this dropped to 65% for urban households. IP consumption rose from around 6,0% of total fuel consumption in the rural areas, to in the region of 30% for urban households and LPG was similarly consumed at a much higher level in the urban as opposed to rural areas for cooking use in this survey.

TABLE 1.3: ***The Effect of Income on the Type of Fuel used in Urban Households in India.***

Fuel shares for cooking and heating in urban India by household income: 1978 -1979 and 1983 -1984 (percent)							
		Low to High Income					Average
Firewood	1978-79 1983-84	60.0 53.5	40.9 30.8	25.1 17.9	17.4 9.9	12.1 9,6	42.4 27.4
Kerosene	1978-79 1983-84	13.2 23.8	21.3 36.9	21.5 40.2	22.0 38.2	18.9 32.8	18.7 35.7
LPG	1978-79 1983-84	0.8 1.2	4.6 4.6	14.2 15.7	26.9 27.9	32.9 39.3	6.6 11.5
Percent Households	1978-79	31.5	42.8	20.7	2.6	2.4	100

Source: Leach G. (1987,2.5): Energy Transition in South Asia.

TABLE 1.4: ***The Type of Fuel used by Urban and Rural Households in Sri Lanka.***

Percent of households by type of main cooking fuel: Sri Lanka 1973,1979 and 1982			
	Year	**Urban**	**Rural**
Firewood	1973 1979 1982	64.5 58.1 65.3	93.5 92.5 95.2
Kerosene	1973 1979 1982	28.4 30.6 14.0	4.1 6.5 2.5
LPG & Electricity	1973 1979 1982	7.1 11.3 20.7	2.4 1.0 2.3

Source: Leach G. (1987,2.5): Energy Transition in South Asia.

1.4 *The Energy Transition Process in South Africa*

Viljoen (1990,127) categorises the energy transition process in South Africa into six broad phases. In the first stage, called the biomass dependency phase, domestic energy is derived solely from biomass and is spatially located in rural areas. Most of the population in Sub-Saharan African countries such as Angola, Zaire and Tanzania are at this stage. In South Africa people at this stage may include those residing in remote rural areas and whose levels of income do not provide for adequate access to commercial fuels.

In the second stage (rural transitional phase) the level of income is generally higher than in the biomass dependency phase and a significant shift towards paraffin is observed. Reasons for this include the scarcity of biomass and the relatively lower price of paraffin as wood fuel now carries a price due to transportation from outlying areas.

The third stage (the first urban transition phase) is dominated by the complete substitution of biomass for paraffin and occurs as the consumer migrates from a rural environment to an urban environment. This spatial relocation results in a discontinuity with the previous stages of the process.

The fourth stage (the second urban transition phase) is characterised by the use of a multiplicity of fuels. The modernization process causes a search for greater convenience and amenity from appliances and fuels as the migrant is now established as an urban entity. This stage is typified by a falling rate of dependence on paraffin; and gas emerges as the major fuel in terms of expenditure. The majority of black households in the metropolitan areas of South Africa find themselves in this stage. However, access to formal housing, formal employment, education and services is sporadic as certain areas modernize more rapidly than others.

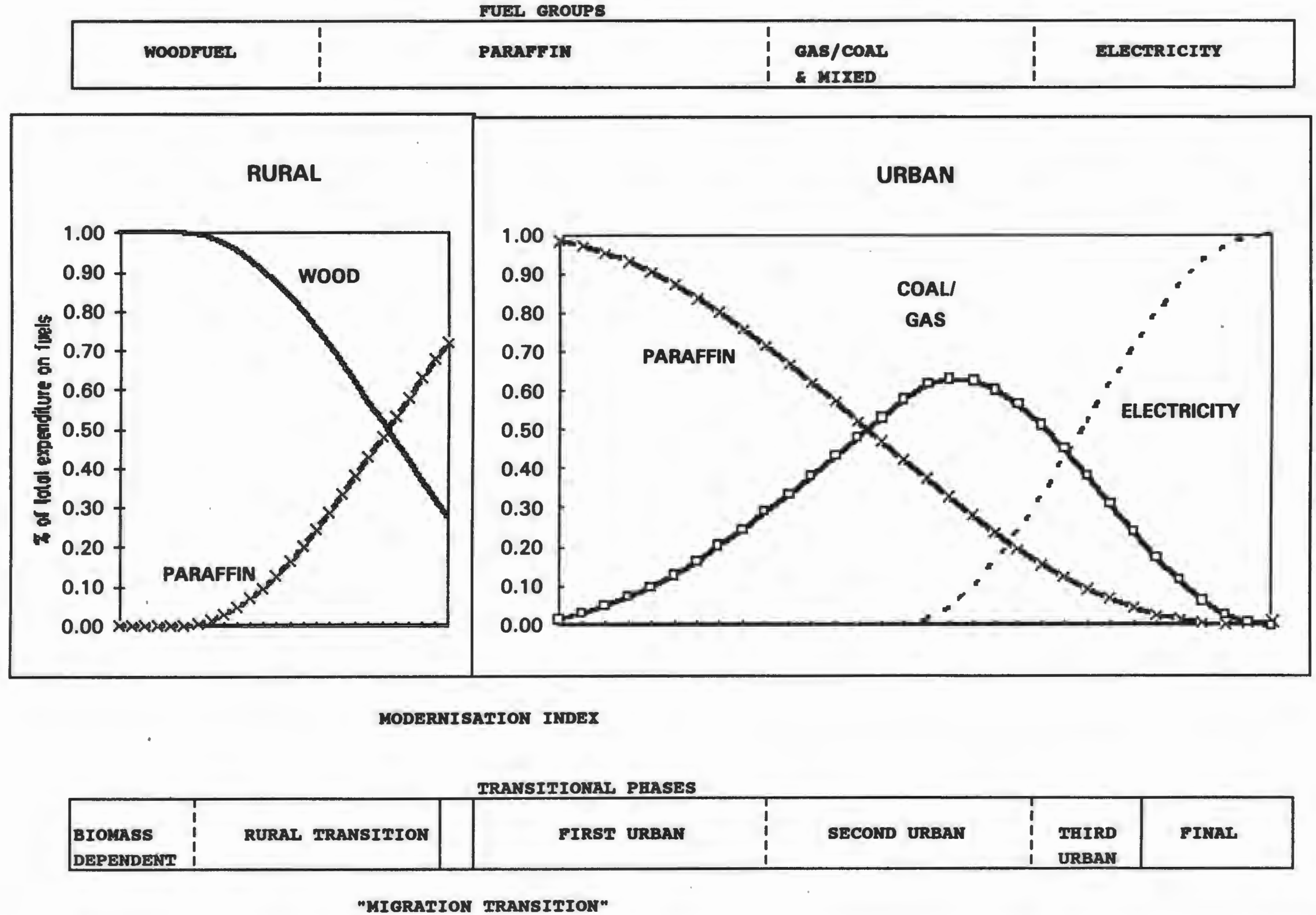
In the fifth stage, (third urban transition phase) there is a partial adoption of electricity and a reduction in the use of paraffin, coal and gas. The use of fuels is governed to a large extent by the cost of new and second hand appliances. Gas is also the dominant fuel but the variables chosen in the Viljoen Study did not adequately explain the reasons for expenditure on this fuel.

In the sixth stage (called the final phase) electricity is the primary fuel in the energy transition process and the amount used is significantly greater than that used in the previous stage. Viljoen (1990) notes however that solar heating and gas stoves also play a small part. In his survey findings less than 5% of the population in South Africa's black townships were in this phase of the process. Suffice it to speculate however, that a recent drive by Eskom to electrify Black townships could see this percentage increase, but only marginally over the next five years.

Figure 1 below, shows the percentage share of the different fuels used by black households during the six phases. For example, the growth of the use of paraffin in the rural transition phase is shown as fuelwood consumption declines. Similarly the use of paraffin declines in the first and second urban phases as LPG and coal use rises. The principal feature moving consumers along the domestic energy transition process in South Africa (Black Householders), depicted in Figure 1, is Viljoen's so-called "Modernization Index". Viljoen (1990) stresses that the length of time that a household has been urbanized is closely linked to the consumption and expenditure on fuels. Urbanisation can be defined as the migration of rural inhabitants to areas where the density of people for a given area is substantially greater. The Office for Regional Development in the National Regional Development Programme, Development Region A, Volume 2, (1991,66), explains the process of urbanisation as part of the development of any country. People who can no longer make a living from agriculture are accommodated in the cities, where they engage in other economic activities. With agglomeration benefits cities give rise to the economically efficient division of labour, the exchange of information and the promotion of entrepreneurship.

Viljoen, (1990,129), goes on to link the variable of time urbanized with others such as car ownership, residential mobility, type of dwelling, TV ownership and whether born in the urban area, to provide a rough modernization index. In his sample this index correlated well with useful energy consumption at 0,46, and total fuel expenditure at 0,42, both Spearman rank correlation coefficients at high levels of significance.

FIGURE 1 : THE DOMESTIC ENERGY TRANSITION PROCESS IN SOUTH AFRICA (BLACK HOUSEHOLDS)



1.5 Influence of Price and Income Levels on Energy Consumption Transition

1.5.1 The Effect of Price

Once fuelwood becomes scarce or expensive, the cost of alternative commercial fuels and the income of the consumer become important. Table 5 below, compiled by Walter Elkan (1987,3.6), gives the cost of comparative fuels in East, West and Central Africa in 1983. Clearly commercial fuels were cheaper in some instances when compared to fuelwood.

Table 1.5: Comparative Cost of Cooking Fuels in East, West and Central Africa.

Comparative cost of different cooking fuels in the principal towns. East, West and Central Africa. Around 1983					
	Fuelwood	Charcoal	Kerosene	LPG	Electricity
Gambia	1.0*	banned	2.0	1.4	2.9
Liberia	1.0*	0.8*	1.6	3.0	1.4
Ivory Coast	1.0	1.5*	1.2	0.8	1.8
Tanzania	1.0	0.8*	1.0	0.3	0.3
Zambia	not used	1.0*	1.1	1.2	0.2
Nigeria	1.0*	0.7	0.8	1.0	1.6
Senegal	1.0	0.5*	0.6	0.7	1.3
Mauritania	1.0	0.3*	0.4	0.3	1.0

Source: Elkan W. (1987,3.6): Alternative to fuelwood in African Towns.

The asterisk * in Table 5 above, denotes the principal fuel used for cooking. In Liberia and Tanzania charcoal is used as it is cheaper than fuelwood. In Senegal and Mauritania most of the alternative fuels such as IP, and LPG are less expensive than fuelwood but charcoal is still used for cooking. The cost of appliances for commercial fuels are high and Table 6 below shows that by adding the discounted cost of appliances in this case in Senegal and Niger, fuelwood is cheaper than most fuel alternatives including IP and LPG.

***Table 1.6:* Comparative Cost of fuels including appliances**

	Senegal		Niger	
	Fuel only	**Including cost of appliances**	**Fuel only**	**Including cost of appliances**
Fuelwood	1.0	1.0	1.0*	1.0*
Charcoal	0.5*	0.9*	0.7	1.4
Kerosene	0.6	1.7	0.8	1.7
LPG	0.07	1.3-1.9	1.0	2.0
Electricity	1.3	3.3	1.6	2.8

Source: *Elkan W. (1987,3.8): Alternatives to Fuelwood in African Towns.*

In summary, fuelwood is on average cheaper than substitutes especially when the discounted cost of appliances is incorporated. Furthermore, the price of fuelwood is low as it is not mainly supplied by commercial woodlots and in some cases, the price is artificially depressed by government to protect the standards of living of urban dwellers. As indigenous wood becomes scarce, the price of fuelwood will rise and a switch to commercial fuels by urban dwellers will become inevitable, purely as a result of the increasing demand for energy. Furthermore the price of oil has decreased substantially in real terms since 1980 which, as long as it is passed on to the consumer, will cause the demand for transitional fuels, such as IP and LPG, to increase. The problem then becomes one of foreign exchange to the non-oil producing countries. However, energy is a basic requirement and the consumption of this resource is necessary to meet certain basic standards of living.

1.5.2 The effect of Income on Fuel Preferences

As mentioned earlier the consumption of commercial fuels is also dependant on income. The World Bank (1991) classifies South Africa as an upper middle income country according to a ranking of GDP per capita in comparative USA dollar terms. Several countries in this category were examined to see if increases in income - here

GDP was used to proxy - affected the consumption of IP and LPG. In the case of Argentina, outlined in Table 7 below, there is a clear correlation between GDP growth and the consumption of IP and LPG. The fall in GDP by 2,13% per annum between 1980 and 1985 saw a substantial decline in the consumption of IP. However, the drop in LPG consumption was less. In the following period between 1985 and 1990, the increase in GDP saw a corresponding rise in the consumption of IP and LPG.

160% more LPG than IP is consumed, completely the opposite to the case in South Africa. In South Africa 75% more IP is consumed than LPG, in spite of the fact that South Africa has major industrial users of LPG such as the Car Manufacturing Industry, the Broiler Industry and others such as Ceramic Manufacturers. It can be assumed therefore that Argentina is more urbanised than South Africa and is further along the energy transition profile.

This is borne out by the fact that Argentina's population was 86% urbanised in 1989, rising from 76% in 1965. Comparable figures for South Africa are 47% urbanised in 1965 while only 59% was urbanised in 1989.

***Table 1.7:** Influence of GDP and Population Growth on the Consumption of IP and LPG in Argentina*

ARGENTINA		
Average annual Increase		
	80 - 85	**85 - 90**
LPG	(0.37)	2.06
IP	(7.58)	0.54
GDP	(2.13)	0.25
Population	1.44	1.28
	1965	1989
% Total Population		
Urbanisation	76	86

Source: *IMF (1991 and 1992): International Financial Statistics.*

Table 8, reflecting the position of Trinidad and Tobago in the West Indies, show a slower decline in GDP for the period 1985 to 1990 compared to the earlier period 1980 to 1985. Similarly population growth slowed between the two periods indicating an improved per capita position. Here again, similar to Argentina, LPG consumption is ten times IP consumption. IP can be regarded as a dying product with consumption falling more than 300% from 1980 to 1990. On the other hand LPG consumption more than doubled over the same period. The rate of urbanisation is higher in South Africa given that only 30% were urbanised in 1965, while the figure rose to 68% in 1989 - compared to 47% in 1965 to 59% in 1989 in the case of South Africa. Clearly there is a possible correlation between per capita GDP and consumption of transitional fuels.

Table 1.8: Influence of GDP and Population Growth on the Consumption of IP and LPG in Trinidad and Tobago.

TRINIDAD & TOBAGO Average annual increase %		
	80 - 85	85 - 90
LPG	6.07	10.09
IP	(15.14)	(6.17)
GDP	(2.56)	(1.95)
Population	1.79	0.83
% Total Population		
	1965	1989
Urbanisation	30	68

Source: IMF (1991 and 1992): International Financial Statistics.

Table 9 below presents the case of Brazil. GDP and GDP per capita increased in the period 1985 to 1990 compared to 1980 to 1985. Here however, IP continued to show a sharp decline in consumption while LPG showed continued strong growth. As in the case of Trinidad and Tobago the consumption of IP was significantly smaller than LPG. Electrification could play a role in this, combined with the high level of urbanisation of 75% of the population by 1989. Here again there exists a possible correlation between increasing GDP per capita and the transition to more expensive but more amenable fuels.

Table 1.9: Influence of GDP and Population Growth on the Consumption of IP and LPG in Brazil.

Brazil		
	80 - 85	**85 - 90**
LPG	5.66	3.84
IP	(9.16)	(9.31)
GDP	1.12	1.99
Population	2.25	2.10
% Total Population		
	1965	1989
Urbanisation	50	74

Source: IMF (1991 and 1992): International Financial Statistics.

1.6 Concluding Remarks

In conclusion, on the evidence of developing countries presented above, it can be seen that there is a transition from free wood to commercial fuels such as IP and LPG as the level of income, development and urbanisation of a country increases.

CHAPTER TWO

IP MODEL

2.1 *Introduction*

This chapter analyses the demand for IP in South Africa. First a national model to forecast IP demand for South Africa as a whole will be outlined. This will be followed by regional models, to assess the impact of urbanisation, price and income on demand and to test the energy transition theory. An aggregate model is developed, combining all the regional models in order to verify the national model results.

2.2 *National IP Model*

The equation for the national IP model was derived as follows:

$D_{IP} = f(I, P_{IP}, D_{IP}(-1), P_{LPG})$

Where D_{IP} represents the demand for IP in Megalitres; I stands for income; P_{IP}represents the real price of IP in cents per litre; $D_{IP}(-1)$ is demand for IP lagged one period; and P_{LPG} stands for the real price of LPG in cents litre. LPG is used as a substitute commodity.

All variables were logged to provide income and price elasticities. The time series was annual data from 1970 to 1991 and the regression equation is shown below.

$$D_{IP} = \underset{(10{,}94)}{-3{,}7863} + \underset{(12{,}85)}{0{,}6673\ PCELOG} - \underset{(13{,}53)}{0{,}2955\ P_{IP}}$$

$$+ \underset{(15{,}58)}{0{,}6181\ D_{IP}(-1)} - \underset{(2{,}87)}{0{,}0670\ DUMMY\ 1973} - \underset{(2{,}56)}{0{,}0608\ DUMMY\ 1983}$$

R-Squared = 0,9928 D.W. = 2,1464 F - Statistic = 446,66

Note: The econometric package used was TSP and reference was made to the Theory of Econometrics, Koutsoyiannis (1983) and Statistics and Econometrics, Salvatore (1982). Programmes were written in the desktop manager package, Sidekick to facilitate the running of the models.

The lagged price of LPG was included as an explanatory variable being the price of a substitute. However, this variable proved to be insignificant with a coefficient of +0,004 and a t-statistic of 0,1006. This suggests that, as indicated in Figure I above, IP is the dominant fuel among IP users as substitutes are inaccessible due to the higher cost or unavailability (free wood). The dummy variable for 1973 and 1983 were needed to adjust for price shocks as the oil price, and consequently the IP, price rose significantly in 1973 and the IP price reduced sharply in 1983.

Correlation Coefficient - the adjusted correlation coefficient of 0,9907 suggests a high degree of significance and consequently good predictive powers of the model.

T-Statistics and significance levels - the t-statistics are all significant which implies that all explanatory variables with the exception of the price of LPG, are significant in explaining IP demand. LPG price was excluded from the final model shown above.

F-Statistic - the F test supports the overall regression.

Coefficients - the income coefficient of positive 0,6672 indicates relative income in-elasticity in the short term while the negative 0,2955 price coefficient also suggests short term inelasticity of IP demand to price. By using the coefficient of the lagged variable, the longer term income and price elasticities can be determined using the following formula: required elasticity coefficient divided by one minus the lagged dependant coefficient.

The following long term price and income elasticities for IP were then derived.

$$\text{Long term Income Elasticity} = \frac{0{,}6672}{1 - 0{,}6181}$$

$$= 1{,}748$$

This suggests that IP demand is income elastic over the longer term and together with its positive sign confirms the theory of energy transition - ie. as income increases people move from IP to more amenable fuels.

$$\text{Long term Price Elasticity} = \frac{-0{,}2955}{1 - 0{,}6181}$$

$$= -\ 0{,}7739$$

Longer term price elasticity is relatively inelastic. This suggests a reluctance to give up the use of IP in spite of changes in price. This confirms the observations that during the energy transition process multiple fuels are used owing to familiarity with their use even if more amenable fuels such as electricity are available, and in addition, the fact that IP appliances have already been purchased and are in operation.

Durbin-Watson Statistic - the Durbin-Watson statistic does not suggest any serial correlation in the model and the residual plot in figure 2 below, confirms that neither positive serial correlation nor negative serial correlation exists.

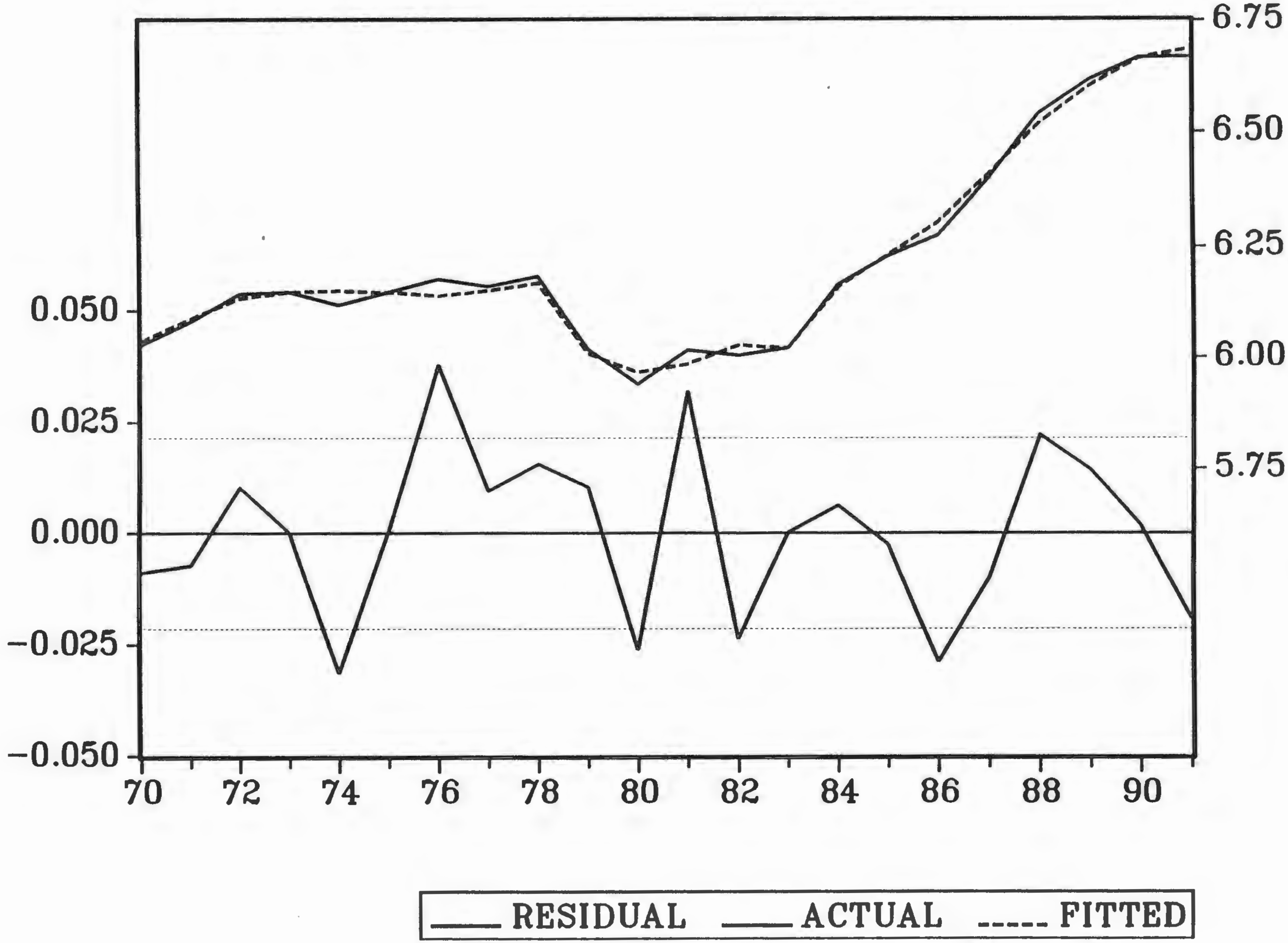
The forecast of PCE for the period 1992 to 1995 reflects the anticipated cyclical upturn. This prediction includes the delay to the upturn caused by the severe drought in 1992 and pressure on consumption owing to ongoing retrenchments, high inflation and relatively low wage increases by historical standards. The real decrease in IP price, forecast for 1992, reflects the fall in the crude price after the Gulf War and the subsequent lowering of posted refined product prices which form the base of the regulated IP price in South Africa. In the period 1993 to 1995 the IP price has been kept constant in real terms.

Table 2.1 below shows the historic and forecast percentage change in the dependent and independent variables. The model forecasts did not track the actuals exactly in the early eighties probably as a result of the substantial changes in price as the OPEC cartel lost control of the oil price. Since 1984 the model has tracked the actuals well in percentage change terms. The forecast of 5.0% per annum for the period 1992 to 1995 compares favourably with the 10.3% per annum IP growth achieved in the last upturn from 1986 to 1989 - given that prices declined by 4.5% per annum over the historic period, while prices are essentially flat in the forecast period and PCE was appreciably higher during 1986 to 1989, compared to the forecast of 1992 to 1995. Structural constraints to IP demand such as electrification are included to the extent that 250 000 connections were made in the eighties and captured by the lagged IP consumption variable (see chapter 4).

Table 2.1: IP National Model Results

IP NATIONAL MODEL ACTUAL AND FORECAST DATA (1980 - 1995)						
	Actual & Forecast					
	IP Volume(ML)	IP % Change (80 - 91 Actual)	IP % Change (80 - 91 Model)	Real PCE % Change	Real Price % Change	CPI % Change
1980	379	(7.56)	(4.13)	8.88	(0.78)	13.81
1981	409	7.91	1.82	7.43	(6.17)	15.22
1982	404	(1.22)	4.42	(0.61)	(0.11)	14.71
1983	411	1.73	(0.65)	3.00	(13.27)	12.39
1984	474	15.37	14.68	4.59	(11.33)	11.54
1985	505	6.68	7.63	(3.45)	(2.86)	16.27
1986	530	4.80	7.59	0.15	(10.29)	18.60
1987	600	13.20	11.08	3.85	(15.82)	16.10
1988	692	15.32	11.66	5.26	0.19	12.85
1989	746	7.91	8.77	2.79	7.88	14.67
1990	784	5.06	6.38	2.07	(0.35)	14.36
1991	785	0.07	2.19	0.16	3.38	15.40
1992	819	4.39	2.40	0.89	(5.69)	13.70
1993	856	4.47	4.47	2.59	0.00	12.60
1994	904	5.60	5.60	4.19	0.00	13.70
1995	952	5.34	5.34	2.80	0.00	13.70

FIGURE 2 : IP NATIONAL MODEL PLOT



2.3 *Regional IP Model*

The regional IP used was as follows:

$D_{IP} = (I, P, P_{IP}, P_{LPG}, D_{IP}$ (-1-to-4)

Where D_{IP} represents the demand for IP in kilolitres; I stands for income; P is population, where the Urban Foundations population estimates and categories are used; P_{IP} represents real price of IP in cents per litre; P_{LPG} stands for the real price of LPG in cents per litre; D_{IP}(-1 to-4) is demand for IP (one variable) lagged one quarter to four quarters where necessary to improve the fit.

All variables were logged to provide income and price elasticities. The time series used was quarterly data from 1986 Quarter 3 to 1992 Quarter 1 and was constrained by available IP data by Magisterial District (MD). A discussion of the exogenous variables and how the forecasts tied in with Energy Transition theory, follows below.

The Urban Foundation's Demographic model (1990) was used to provide the population/urbanisation data for the regional models. It was felt that this data represented the most accurate and relevant demographic information, as there was an emphasis on particularly Black urbanisation and projections by year to 1995 were provided. This time frame was important as this study concentrates on the medium term outlook for the demand for IP and LPG and forecasts are provided to the year 1995.

The principal impact on demographic/urbanisation trends in South Africa over the forecast period (1992 to 1995) will come from the growth in the Black population urban areas. As stated by the Urban Foundation in Population Trends (1990, p 1). "For most of this century South African society has been structured so as to prevent large-scale Black Urbanisation". However, "Increasingly apartheid ideology has come into conflict with the realities of a modern South Africa: the reality of a single interdependent economy, a growing and irreversible rate of urbanisation, and the concomitant interdependency of Black and White South Africans"(ibid).

The Urban Foundation geographic model is "urban driven" with an emphasis on using the functional geographical units recognised by most urban planners. In arriving at its regional segmentation of demographic statistics the Urban Foundation has catergorised four areas:

- Metropolitan areas
- Cities and Towns
- Dense (or closer) settlements
- Rural areas

The Urban Foundation has employed a much more comprehensive and internationally acceptable definition of what qualifies as urban as compared to the South African census. In South Africa, urban areas are defined according to density and economic criteria (ie. the absence of agricultural activity, and high population density). The Urban Foundation however, examines metropolitan population growth rates and then the absorption capacity of towns. This is because metropolitan areas are regarded internationally as the dynamos of change. The Urban Foundation (UF)'s projections also assume the population on farms outside the "Homelands" to stay constant after 1985 with a slight absolute drop in the case of "coloured" people. The "Homeland" rural area is assumed to be a 'residual' in the Urban Foundation approach: that is to say, the area is assumed to be more passive in the pattern of population dynamics.

The data for the other exogenous variables used in this dissertation's model was collected by Magisterial District (MD). However, due to the Urban Foundation's methodology of using rural areas, cities and towns, and dense settlements, which could all occur in one MD, this study has had to aggregate the rural, town and dense settlement population data together to match the other explanatory variable data. The consequence has been to reduce the original 69 Urban Foundation classifications of demographic statistics to 32. However, the Urban Foundation metropolitan and homeland population data is unadjusted and the essence of the aggregation has been to combine rural population statistics with that of towns. Consequently, in terms of the Urban Foundation methodology described above, which is to concentrate on metropolitan population growth rates, the Urban Foundation model is not impaired and this has been verified with the compiler of the Urban Foundation model, Dr Charles Simpkins. The MD's used in this dissertation, comprising the aggregation of town and rural areas, were supplied by the Urban Foundation.

Table 2.2 below outlines the demographic statistics used in the dissertation's regional model. The areas of high population growth are the Metropolitan Areas and the Homelands. The highest growth is in the P.W.V. complex although the projections are lower than the corresponding historic period of 1988 to 1991 in most cases. Cape Town, Orange Free State Goldfields, Port Elizabeth/Uitenhage and East London are the other metropolitan high growth areas. The population growth around Durban is picked up in the Kwazulu statistics which include the MD's of Umlazi, Umbumbulu, Ndwedwe, Ntuzuma and Empumalanga around Durban. All the Homelands show above average population growth except those in Region G comprising the Northern Transvaal.

This region (G) is a particularly poor and depends significantly on migrant income remittances. Consequently a migration from Region G to the metropoles is expected. The trend of population movement out of the region is shown where the areas in Region G, excluding the homelands, are expected to show the second lowest population growth in the country in the period 1992 to 1995. The Urban Foundation stresses that population growth within the metropoles themselves accounts for a large amount of the urban population growth and that migration is certainly not the sole cause for increasing urbanisation. In a related point, the Urban Foundation points out that South Africa has an extremely youthful population by world standards and that only one third of the Black population is 28 years or older. Consequently they conclude that South Africa has an increasingly Black and youthful population and as South Africa passes through its 'Demographic Transition', the challenges posed by this youthful Black population are those that must come to dominate the development agenda (UF Population Trends 1990, 13).

The population data was extrapolated into quarters for regression purposes by using the annual data as the midpoint of the year and arriving at the third quarter using 75% of the previous year and 25% of the following year, the 4th quarter was 50% of the previous annual estimate and 50% of the following annual estimates. The first quarter was compiled by using 75% of the following year and 25% of the previous year. Dr Charles Simpkins of the Urban Foundation suggested this methodology.

TABLE 2.2 : URBAN FOUNDATION POPULATION GROWTH ESTIMATES BY URBAN FOUNDATION REGION

POPULATION GROWTH RATES % 25-Sep-92	1987	1988	1989	1990	1991	1992	1993	1994	1995	88-91	92-95	'1995 % TOTAL
AOM1: W CAPE - METRO	2.70	2.72	2.71	2.71	2.59	2.59	2.59	2.59	2.60	2.68	2.60	6.86
AOUO: W CAPE - URBAN	0.88	0.88	0.88	0.88	0.75	0.74	0.76	0.74	0.75	0.85	0.75	2.45
BOUO: N CAPE - URBAN	1.74	1.73	1.73	1.75	1.76	1.79	1.77	1.81	1.80	1.74	1.79	2.87
COM1: OFS - BFN	2.52	2.60	2.53	2.54	2.60	2.57	2.57	2.57	2.59	2.57	2.57	0.81
COM3: OFS GOLDFIELDS	3.47	3.48	3.45	3.42	3.55	3.51	3.51	3.48	3.50	3.47	3.50	1.31
COUO: OFS URBAN	1.42	1.45	1.46	1.48	1.53	1.55	1.58	1.57	1.59	1.48	1.57	4.62
DOM1: PE/UITENHAGE	3.81	3.83	3.82	3.80	3.69	3.68	3.69	3.68	3.66	3.78	3.68	2.78
DOM2: EAST LONDON	2.53	2.60	2.45	2.57	2.50	2.57	2.50	2.60	2.54	2.53	2.55	0.62
DOUO: E CAPE - URBAN	1.30	1.31	1.32	1.33	1.34	1.36	1.38	1.39	1.40	1.32	1.38	2.11
DXUO: CISKEI - URBAN	3.17	3.17	3.15	3.16	3.17	3.13	3.15	3.12	3.12	3.16	3.13	2.26
EOM1: DBN/PINETOWN	1.99	1.99	1.98	1.98	1.98	1.96	1.97	1.98	1.97	1.98	1.97	3.18
EOM2: PMB	2.39	2.34	2.28	2.40	2.26	2.21	2.32	2.31	2.25	2.32	2.27	0.64
EOUO: NATAL - URBAN	0.39	0.37	0.39	0.41	0.41	0.43	0.44	0.45	0.45	0.40	0.44	2.67
EZUO: KWAZULU - URBAN	2.81	2.80	2.79	2.78	3.06	3.04	3.03	3.03	3.01	2.86	3.03	13.89
FNUO: KANGWANE	2.63	2.61	2.61	2.58	2.68	2.73	2.70	2.70	2.67	2.62	2.70	1.31
FOUO: E TVL - URBAN	0.78	0.80	0.80	0.83	0.86	0.88	0.89	0.91	0.92	0.82	0.90	3.75
GLUO: LEBOWA	2.28	2.26	2.24	2.23	2.36	2.35	2.34	2.33	2.31	2.27	2.33	5.90
GOUO: N TVL - URBAN	0.37	0.39	0.39	0.43	0.45	0.43	0.47	0.46	0.48	0.42	0.46	1.18
GVUO: VENDA	1.89	1.85	1.86	1.81	1.96	1.94	1.94	1.88	1.88	1.87	1.91	1.42
GYUO: GAZANKULU	2.02	2.03	1.99	1.97	2.10	2.10	2.08	2.07	2.04	2.02	2.07	1.56
HOM1: JHB/RANDBURG	2.52	2.52	2.52	2.52	2.73	2.74	2.74	2.74	2.73	2.57	2.74	5.87
HOM2: EAST RAND	5.44	5.37	5.31	5.27	3.51	3.50	3.50	3.50	3.50	4.86	3.50	5.45
HOM3: WEST RAND	3.95	3.95	3.96	3.94	3.39	3.41	3.39	3.42	3.39	3.81	3.40	2.09
HOM4: PRETORIA	3.43	3.42	3.44	3.43	2.95	2.95	2.96	2.95	2.97	3.31	2.96	3.03
HOM5: VEREENIGING +	5.68	5.61	5.54	5.46	3.72	3.72	3.71	3.69	3.69	5.08	3.70	2.38
HOM6: BRITS	3.93	3.78	3.74	3.80	3.57	3.53	3.58	3.54	3.58	3.72	3.56	0.31
HOM8: CULLINAN +	4.19	3.91	3.99	3.83	3.90	3.55	3.73	3.59	3.83	3.91	3.68	0.27
HSM6: ODI/BAFOKENG	5.05	4.98	4.93	4.88	4.56	4.51	4.50	4.46	4.42	4.84	4.47	3.63
HWM8: KWANDEBELE	5.04	4.99	4.95	4.89	4.58	4.53	4.50	4.45	4.43	4.85	4.48	1.45
JOUO: W TVL - URBAN	0.94	0.96	1.00	0.99	1.04	1.06	1.06	1.09	1.11	1.00	1.08	2.85
JSUO: W TVL - BOP	2.62	2.59	2.59	2.59	2.73	2.69	2.69	2.68	2.68	2.63	2.69	1.71
TTUO: TRANSKEI - URBAN	1.75	1.73	1.70	1.68	1.82	1.80	1.78	1.76	1.74	1.73	1.77	8.76
TOTAL - RSA ONLY	2.50	2.50	2.51	2.51	2.43	2.43	2.44	2.45	2.45	2.49	2.44	100.00

SOURCE: URBAN FOUNDATION (1990) : POPULATION TRENDS: DEMOGRAPHIC PROJECTION MODEL

The source of the Gross Geographic Product (GGP) data was the Central Statistical services publication of Gross Geographic Product of Factor Incomes by Magisterial District (eg. P0401 - 1984, 10 July 1989, Central Statistical Services), and taxable income. The annual data was compiled by the CSIR using the shift share technique. The data, methodology and calculation of forecasts are outlined below and have been checked by Professor van Wyk of the Bureau for Market Research at Unisa. He believes the data is good and the techniques used are sound.

GGP by MD was aggregated into Urban Foundation Regions by Economic Sector (RSA & Independent States Transkei, Lebowa, Bophuthatswana)
For 1978, 1981, 1984, 1988.

The data was checked with Taxable income (homelands excluded) for years 1984 and 1988 - the most recent years. 1988 GGP was derived from 1984 and 1988 taxable income figures.

The Methodology used to calculate GGP comprised the following:

- 1971 and 1981 were added together divided by 0.5
- 1984 and 1988 were added together and divided by 0.5
- the differential shift between 1978 and 1981 to 1984 and 1988 was calculated as follows:

Average 1981 and 78 multiplied by (Average 1984 & 88 - average 1981 &78) per UF region.
Average 1981 & 1987

- Total of average 1984 & 1988 - Total of Average 1981 & 1978
  Total of Average 1981 & 1978

Summary: Percentage change in Urban Foundation region minus the percentage change in the total, multiplied by average of 1981 and 1978 for each Urban Foundation Region.

1984 = 1984 Urban Foundation region GGP **multiplied** by total GGP @ 1985 prices i.e. GDP by kind of economic activity.
1984 Total GGP

1988 = Total sum GGP @ Constant 1985 prices in 1984 **multiplied** by Urban Foundation region in 1984.
Total sum GGP in 1984

1994 = The 1988 calculated GGP Urban Foundation region weighted by the total for 1988, + 6 divided by 6.5, multiplied by the Shift, + 1988 multiplied by the percentage increase in the total for 1994 over 1988.

The growth from 1988 to 1994 was derived by calculating the average annual increase from 1988 to 1994 calculated above.

As discussed in the section on population data above quarterly figures were required because the dependent variable annual data was not reliable further back than the second quarter of 1986, and this provided insufficient degrees of freedom on an annual basis. The CSIR was approached to attempt the difficult task of supplying the GGP annual data above in quarters. Various quarterly time series such as number of telephone calls by Magisterial District and tonnages carried by the South African Railways by station were acquired to act as proxy for GGP by quarter. In both cases the aggregate national data correlated well with GGP but both time series were too short to give anything but an indication of GGP by quarter by Urban Foundation region. Consequently the formula of seven eighth of the previous year and one eight of the following year was found to best approximate quarter one, four eighths/four eigths for second quarter and the reverse of the first quarter provided the third quarter.

The annual data was also checked with the office for Regional Development who have forecasted GGP by Development Region for the period 1985 to 1995. A comparison of the two sets of forecasts is shown in Table 2.3 below.

Table 2.3: Comparison of GGP Data.

RSA excl. TBVC - CSIR GGP vs Govt. Office for Regional Development					
REGIONS	CSIR 87 - 95%	GOVT. 85 - 95%	Diff. CSIR vs Govt.	1995 % Total(CSIR)	1985 % Total (Govt).
REGION A	1.1	2.8	(1.7)	11.6	14.6
REGION B	0.5	1.4	(0.9)	1.6	2.0
REGION C	1.2	0.9	0.3	6.5	6.7
REGION D	0.6	1.9	(1.3)	5.0	5.4
REGION E	1.0	1.1	(0.1)	12.9	14.6
REGION F	4.5	1.1	3.4	12.5	8.0
REGION G	0.1	3.1	(3.0)	2.0	2.4
REGION H	2.2	1.7	0.5	40.8	41.3
REGION J	2.3	0.5	1.8	7.0	5.0
RSA	1.9	1.7	0.2	100.0	100.0

Source: ***CSIR (1990), Government Office for Regional Development (1991)***

The TBVC (Transkei, Bophuthatswana, Venda and Ciskei) countries had to be excluded from the CSIR GGP numbers for this comparison as the Government Office for Regional Development excluded TBVC in their calculation. The most notable differences occurred in the projections for Region G and Region F. Historically Region F has grown strongly due to the establishment of Sasol 2 and 3 in the area and the building of the Eskom power stations. The area also has substantial export coal deposits. The office for Regional Development derived its forecast in conjunction with the Private Sector of each region. However, it is essentially a subjective forecast without much econometric input. The CSIR data uses historical trends to a significant degree. In the case of Region F the expansion of the export of coal and continuing investment by Sasol is used in this dissertation to justify the forecasts.

The CSIR data was broken down into the historic period, 1987 to 1991 and the forecast period 1992 to 1995 in an annual time series on the basis of national GDP at factor cost. This is in comparison to the Office for Regional Development which provided a single forecast for the period from 1985 to 1995. In the CSIR data Region F growth is high at 5.2% during the period 1987 to 1991 and this falls to 3.6% in the forecast period from 1992 to 1995. Region G relies to a significant extent on migrant remittances for the survival of its inhabitants. This dissertation does not share the optimism of the office for Regional Development and this is discussed in detail when the individual Urban Foundation IP region forecasts are made below. Table 2.4 below outlines the historic and actual GGP growth rates (annualized) used in the models.

One price time series has been used for all 32 Urban Foundation geographic regions. The reason is that the only difference in the price of IP throughout the country is the transport price or grid differential. Work done by Glass (1991) noted that there was high correlation between Petrol prices at the coast, on the Reef and at Grid 10. The Grid 10 price represents the point approximately equidistant from areas of demand. To test the hypothesis he ran a petrol demand model with all three price sets. Petrol, diesel and IP prices are administered by the South African Government and are subject to almost the same price structure. Diesel and petrol are exactly the same whereas the fuel levy or petroleum tax is not applied in the case of IP. He then forecast petrol demand for the period 1970 to 1990 for all three prices and arrived at mean growth rates of 4.48%, 4.47% and 4,5% over the twenty year period. He consequently concluded that there was no significant difference between the price sets used in the model. The exercise has been repeated for IP and the same conclusion arrived at for this product. The logic is that the grid differential has been increased uniformly over time as the geographic/spatial differences have not changed. Consequently in time series analysis it makes no significant difference whether one price set is used or if the grid differential is taken into account when forecasting petroleum products on a geographically differential basis.

TABLE 2.4 : CSIR ANNUALISED GROSS GEOGRAPHIC PRODUCT GROWTH RATES BY URBAN FOUNDATION REGION

GGP GROWTH RATES %											Sep-92	'1995 %
UFCODE	1987	1988	1989	1990	1991	1992	1993	1994	1995	'87-'91	'92-'95	TOTAL
AOM1: W CAPE - METRO	0.96	3.06	(0.92)	(1.51)	(1.08)	0.29	2.81	3.50	2.56	0.09	2.28	9.30
AOUO: W CAPE - URBAN	4.62	6.63	(2.78)	(2.10)	(1.25)	0.14	2.62	3.30	2.38	0.95	2.10	2.17
BOUO: N CAPE - URBAN	1.53	4.82	(0.67)	(2.35)	(2.21)	(1.05)	1.36	2.19	1.50	0.19	0.99	1.61
COM1: OFS - BFN	(4.87)	(2.56)	3.94	(1.20)	(1.79)	(0.37)	2.20	2.94	2.06	(1.34)	1.70	1.54
COM3: OFS GOLDFIELDS	8.23	4.92	0.73	(2.04)	(1.99)	(0.62)	1.93	2.73	1.95	1.89	1.49	2.76
COUO: OFS URBAN	(4.40)	1.00	13.28	0.17	(1.73)	(0.48)	1.95	2.75	2.00	1.49	1.55	2.16
DOM1: PE/UITENHAGE	3.34	2.12	(4.05)	(2.45)	(1.50)	(0.08)	2.48	3.21	2.33	(0.55)	1.98	2.61
DOM2: EAST LONDON	2.65	0.63	(3.32)	(1.61)	(0.81)	0.53	3.02	3.70	2.76	(0.51)	2.49	1.10
DOUO: E CAPE - URBAN	(2.15)	2.38	2.17	(0.80)	(0.90)	(4.18)	2.93	3.61	2.66	0.12	1.20	1.23
DXUO: CISKEI - URBAN	(2.19)	(6.32)	(4.31)	(1.80)	(1.01)	(4.16)	2.87	3.57	2.65	(3.15)	1.18	0.17
EOM1: DBN/PINETOWN	(1.06)	2.26	1.69	(1.42)	(1.45)	(0.03)	2.53	3.26	2.37	(0.01)	2.02	6.93
EOM2: PMB	4.68	2.04	(3.80)	(0.50)	0.46	1.60	3.94	4.48	3.42	0.54	3.35	1.26
EOUO: NATAL - URBAN	4.95	2.21	(0.05)	1.22	1.76	(6.43)	4.79	5.15	3.85	2.01	1.72	4.04
EZUO: KWAZULU - URBAN	(9.07)	(10.48)	(8.30)	(6.54)	(5.64)	5.60	(1.31)	(0.31)	(1.03)	(8.02)	0.70	0.58
FNUO: KANGWANE	(3.19)	(9.46)	(8.03)	(5.99)	(5.31)	(3.85)	(1.11)	0.02	(0.48)	(6.42)	(1.36)	0.06
FOUO: E TVL - URBAN	7.32	7.14	3.98	4.41	3.78	(2.18)	5.91	6.10	4.75	5.31	3.59	12.30
GLUO: LEBOWA	(3.35)	(9.08)	(7.59)	(5.58)	(4.72)	(3.14)	(0.43)	0.59	(0.04)	(6.09)	(0.77)	0.29
GOUO: N TVL - URBAN	(8.20)	4.39	15.89	(0.14)	(2.31)	(1.02)	1.44	2.21	1.39	1.61	1.00	1.52
GVUO: VENDA	(2.19)	(6.32)	(4.31)	(1.80)	(1.01)	0.36	2.87	3.57	2.65	(3.15)	2.35	0.18
GYUO: GAZANKULU	(4.68)	(7.99)	(6.06)	(4.08)	(3.23)	(1.65)	1.11	2.04	1.27	(5.22)	0.68	0.14
HOM1: JHB/RANDBURG	0.32	2.02	2.35	(1.47)	(1.63)	(0.19)	2.37	3.12	2.25	0.30	1.88	11.88
HOM2: EAST RAND	3.64	3.65	1.25	(1.12)	(1.07)	0.28	2.79	3.50	2.59	1.25	2.28	8.96
HOM3: WEST RAND	5.35	4.14	1.08	(0.76)	(0.65)	0.65	3.13	3.79	2.83	1.80	2.59	3.19
HOM4: PRETORIA	1.26	12.41	10.99	1.04	(0.17)	1.06	3.48	4.10	3.11	4.97	2.93	12.13
HOM5: VEREENIGING +	7.66	5.86	(2.05)	(0.82)	(0.07)	1.19	3.57	4.14	3.12	2.04	3.00	3.59
HOM6: BRITS +	(5.59)	8.42	12.90	1.11	(0.43)	0.85	3.31	3.95	2.99	3.07	2.77	0.31
HOM8: CULLINAN +	(9.15)	4.80	8.79	0.09	(0.93)	0.42	2.93	3.62	2.69	0.54	2.41	0.17
HSM6: ODI/BAFOKENG	(7.49)	(11.59)	(10.08)	(7.87)	(7.12)	(5.64)	(3.01)	(2.12)	(2.95)	(8.85)	(3.44)	0.13
HWM8: KWANDEBELE	4.62	(4.54)	(3.05)	0.57	(2.12)	(7.96)	4.54	4.91	3.72	(0.96)	1.16	0.05
JOUO: W TVL - URBAN	5.47	7.56	2.62	(1.29)	(1.41)	(0.10)	2.34	3.12	2.31	2.53	1.91	6.94
JSUO: W TVL - BOP	(7.49)	(11.59)	(10.08)	(7.87)	(7.12)	(5.64)	(3.01)	(2.12)	(2.95)	(8.85)	(3.44)	0.13
TTUO: TRANSKEI - URBAN	(10.57)	(10.95)	(8.54)	(6.86)	(6.02)	(4.30)	(1.59)	(0.61)	(1.41)	(8.61)	(1.99)	0.56
TOTAL - RSA (RM)	2.10	4.20	2.30	(0.46)	(0.57)	(0.44)	3.07	3.73	2.77	1.50	2.27	100.00

SOURCE: CSIR (1990)

The geographic model forecasts are made up of 32 aggregated Urban Foundation regions. The Magisterial District's that comprise each region are shown in Appendix A. The Urban Foundation Regions are subdivisions of the 9 Development Regions namely, A to J (see maps in Appendix B, below). The discussion that follows will cover the nine development regions and subsequently split up the Urban Foundation regions making up each Development region.

2.4 *Region A - Urban Foundation Regions AOM1 and AOUO*

Region A comprises the South - Western parts of the Cape Province and extends from Namaqwaland, bordering on Namibia to Knysna along the South Coast of R.S.A. It contains the metropole of greater Cape Town. The aggregation of Magisterial Districts from Somerset West, False Bay to Malmesbury up the West Coast comprise the Urban Foundation code AOM1 (Western Cape - Metro). This Urban Foundation region contributes 9.3% to the GDP of South Africa and can be compared to the other UF region AOUO which contributes 2.17% to the GDP of RSA and makes up the balance of Region A (see Map in Appendix B below).

The main types of economic activity in the Region are manufacturing (21,6% of GGP), Financial Services (14.7% of GGP), Trade (13,3% of GGP) and Agriculture (10.6% of GGP) - all figures refer to the position in 1985. Manufacturing was by far the largest employer at 20.6% in the same year, followed by Trade at 14.5% and Agriculture at 14.4%. During the period 1975 to 1985 the GGP of the region grew at a rate of 2.3% per annum compared to the national average of 2.2%. The regions manufacturing sector is well diversified with food, beverages, textiles and clothing as the most important industries. The Cape West coast accounts for around 90% of the countries total annual fish catch and the Boland area comprises some of the best deciduous fruit growing areas in the world.

Per capita Income in the region in 1985 was 27.7% higher than the national average with most economic sectors, particularly manufacturing, above that of the total R.S.A. However, population growth, principally due to immigration of Blacks from the Ciskei and Transkei, was higher than the RSA during the period 1980 -1985 and is shown in Table 2.5 below. This high population growth is also reflected in Table 2.2 above for Urban Foundation code AOM1 (Western Cape Metro).

Table 2.5: Demographic Statistics in Region A

POPULATION GROWTH AND COMPOSITION IN REGION A AND THE RSA				
	REGION			RSA
	PERCENTAGE			PERCENTAGE
POPULATION GROUP	Average Annual Change	Composition		Average Annual Change
	1980-1985	1980	1985	1980-1985
WHITES	1.6	26.9	25.3	2.0
COLOUREDS	2.0	61.0	58.5	2.3
ASIANS	2.1	0.7	0.6	2.0
BLACKS	9.4	11.5	15.6	3.0
Total	2.9	100.0	100.0	2.7

Source: *Office for Regional Development and Regional Development Advisory Committee A 1991: Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991)*

The population is furthermore highly urbanised, particularly amongst Blacks and this has significant implications for energy transition and consequently the consumption of IP.

Table 2.6: Urbanisation in Region A

RURAL AND URBAN DISTRIBUTION OF THE POPULATION IN REGION A AND THE RSA IN 1985				
	REGION		RSA	
POPULATION	RURAL	URBAN	RURAL	URBAN
GROUP	%	%	%	%
WHITES	10	90	12	88
COLOUREDS	23	77	23	77
ASIANS	2	98	9	91
BLACKS	17	83	62	38
Total	19	81	47	53

Source: *Office for Regional Development and Regional Development Advisory Committee A (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991)*

The variable used in forecasting IP consumption is Income or GGP. Economic growth in the Region did not exceed that of RSA in the period 1988 to 1991. However, it is anticipated to improve to around the national average in the forecast period. The Western Cape Metropole will benefit in particular. The relatively low dependency ratio is reflected in Table 2.7 below.

The model projections for IP consumption for the Urban Foundation regions in shown in Table 2.8 below. Volumes in the metropolitan area are double that of the balance of the region. The regression equations are shown below:

$$AOMI\ D_{IP} = -50.03 - 0{,}3723\ P_{IP(-1)} + 4{,}714\ P - 0{,}9753\ D_{IP(-2)} + 0{,}0551AR(2)$$

(7,82) (2,39) (10,14) (23,11) (0,97)

R squared= 0,974 D.W. = 2,4259 F-Statistic= 131,64

The price of substitute (LPG) was insignificant.

Table 2.7: Dependancy ratios in Region A

AGE DISTRIBUTION OF THE POPULATION IN REGION A AND THE RSA IN 1985								
AGE	REGION				RSA			
GROUP	WHITES	COLOUREDS	ASIANS	BLACKS	WHITES	COLOUREDS	ASIANS	BLACKS
0-4 %	6.9	12.2	10.7	10.5	8.1	12.6	11.6	15.9
5-14 %	14.7	24.0	20.0	16.4	17.1	24.4	22.5	24.9
15-64 %	67.3	60.6	66.0	71.0	66.3	59.7	63.1	56.6
65+ %	11.1	3.1	3.4	2.1	8.5	3.3	2.8	2.7
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: *Office for Regional Development and Regional Development Advisory Committee A (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991) and Department of National Health and Population Development (1991).*

The price elasticity of (0,374) was slightly more elastic than the national model. It is significant that Income (GGP) was insignificant and not included on the model, however, population had a high coefficient. The price effect was also lagged one quarter. This reflects the high degree of urbanisation and possible lack of a substitute to IP among rapidly urbanising people - hence the delay in reaction to price changes.

$$\text{AOUO } D_{IP} = -98{,}3306 - 0{,}2975\, P_{IP} + 7{,}4474P + 0{,}6058\, D_{IP}(-4)$$
$$(1{,}45) \quad (0{,}62) \quad (1{,}48) \quad (2{,}81)$$

R - squared = 0,4848 D.W. = 1,2179 F- Statistic = 4,70

This model provided one of worst fits of the 32 Urban Foundation regions. However, the signs of the coefficients are as would be expected. The Durbin-Watson statistic is also low and suggests positive serial correlation. However, when the autoregressive term was added the Durbin-Watson increased to 2,6975 which would now suggests negative auto correlation and was consequently excluded.

Table 2.8: UF Region IP Forecasts in Region A

MODEL FORECASTS AND ACTUALS				
	AOMI		AOUO	
	% Growth	Volume (KL)	% Growth	Volume (KL)
1987		28 486		9 697
1988	12.38	32 013	8.70	10 541
1989	3.73	33 207	0.41	10 584
1990	8.02	35 871	8.96	11 532
1991	0.37	36 005	1.27	11 678
1992	9.15	39 301	5.65	12 337
1993	4.44	41 045	3.52	12 772
1994	2.98	42 267	3.97	13 279
1995	4.15	44 019	1.47	13 475
88 - 91	6.03		4.76	
92 - 95	5.15		3.64	
1995 % of Total RSA		**5.00**		**1.53**

2.5 ***Region B - Urban Foundation Region BOUO***

Region B comprises the Northern and Central Cape, bordering on Namibia, the Transvaal and Orange Free State. The principal city in the region is Kimberley in the East (see map in Appendix B below). It is the largest development region and is remote from most inland markets and harbours in South Africa. Consequently transport costs affect economic activities in the region. The largest economic sectors in 1985 were Mining and Transport.

Agriculture (comprising mainly extensive farming) has declined in importance due to adverse climatic conditions. The area has low rainfall and it is necessary to rely heavily on the available underground water potential. Agriculture provides 33% of the job opportunities in the region and despite the poor profitability of this sector in 1985 relative to agriculture in the rest of the country, GGP per capita in agriculture in 1985 was similar to RSA as a whole. The principal sector, mining, provided 96% of the countries manganese ore in 1989, 76% of zinc concentrate, 75% of the iron ore and 60% of the diamond production. This sector provides 52.6% more GGP per capita than the average for RSA but only provides 10.5% of the region's employment. Most of the other economic sectors have lower GGP per capita than the national average and consequently the regions overall GGP per capita, in 1985, was 22.7% below that of RSA. It is a poor region and only contributes 1.6% to the national GDP.

The region is only expected to grow at around 1% per annum in the forecast period, 1992 to 1995 (see Table 2.4 above). The population growth in the Region between 1980 and 1985 was well below the national average. This is mainly the result of migration out of the region particularly amongst whites (see Table 2.9 below).

Table 2.9: Demographic Statistics in Region B

POPULATION GROWTH AND COMPOSITION IN REGION B AND THE RSA				
POPULATION GROUP	REGION			RSA
	PERCENTAGE			PERCENTAGE
	AVERAGE ANNUAL GROWTH	COMPOSITION		AVERAGE ANNUAL CHANGE
	1980-1985	1980	1985	1980-1985
WHITES	(0.7)	17.7	16.5	2.0
COLOUREDS	1.9	36.0	38.1	2.3
ASIANS	0.0	0.3	0.3	2.0
BLACKS	0.5	45.9	45.2	3.0
Total	**0.8**	**100.0**	**100.0**	**2.7**

Source: *Office for Regional Development and Regional Development Advisory Committee B (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991).*

However, the dependency ratio in 1985 as reflected in Table 2.10 below is high amongst the dominant coloured population group. Here over 40% of this group was below the age of 14 in 1985 and in the same year, comprised 36% of the population. The total fertility figure, defined below, is similarly high for Blacks and Coloureds which will increase the dependancy burden and lower GGP per capita. (See Table 2.11 below)

The total fertility is the average number of children a woman, who is at present at the beginning of her fertile years (15-49 years), can expect to give birth to if present fertility trends continue unchanged.

Table 2.10: Dependancy Ratios in Region B

AGE DISTRIBUTION OF THE POPULATION IN REGION B AND THE RSA IN 1985								
AGE	REGION				RSA			
GROUP	WHITES	COLOUREDS	ASIANS	BLACKS	WHITES	COLOUREDS	ASIANS	BLACKS
0-4								
%	9.1	14.9	10.6	14.6	8.1	12.6	11.6	15.9
5-14								
%	17.5	26.7	18.5	22.8	17.1	24.4	22.5	24.9
15-64								
%	65.5	54.5	62.3	60.3	66.3	59.7	63.1	56.6
65+								
%	7.9	3.9	8.7	2.3	8.5	3.3	2.8	2.7
1995 % Total of RSA	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: *Office for Regional Development and Regional Development Advisory Committee B (1991): Regional profile and Development Guidelines - based on Development Bank of Southern Africa (1991) and Department of National Health and Population Development (1991).*

Table 2.11: Fertility Figure Comparison in Region B

TOTAL FERTILITY FIGURE IN REGION B AND THE RSA				
POPULATION GROUP	REGION		RSA	
	1985	1987	1985	1987
WHITES	2.6	2.0	2.0	1.7
COLOUREDS	3.5	3.1	3.2	2.9
ASIANS	NA	NA	2.5	2.3
BLACKS	4.5	NA	3.9	3.7

Source: *Office for Regional Development and Regional Development Advisory Committee B (1991): Regional Profile and Development Guidelines - based on Department of National Health and Population Development (1991).*

Pertinent to Energy Transition theory is the level of urbanisation (See Table 2.12 below). Here, the Black population which comprises the largest population group is more urbanised and consequently a shift towards more commercial fuels can be expected. The relative poverty of the area would, however, act as a drawback to IP consumption.

Table 2.12: Urbanisation in Region B

RURAL AND URBAN DISTRIBUTION OF THE POPULATION IN REGION B AND THE RSA IN 1985				
	REGION		RSA	
POPULATION	RURAL	URBAN	RURAL	URBAN
GROUP	%	%	%	%
WHITES	30	70	12	88
COLOUREDS	41	59	23	77
ASIANS	56	34	9	91
BLACKS	50	50	62	38
TOTAL	**43**	**57**	**47**	**53**

Source: *Office for Regional Development and Regional Development Advisory Committee B (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991).*

The regression equation used to forecast the Urban Foundation region BOUO which comprised the whole of Region B is outlined below:

$$\text{BOUO } D_{IP} = \underset{(3.02)}{-60{,}758} - \underset{(2.22)}{0{,}24\,P_{IP}} + \underset{(2.99)}{3{,}1229\,P} + \underset{(3.45)}{1{,}9325\,I}$$

$$+ \underset{(1.24)}{0.1673\,D_{IP}(-4)} - \underset{(8.19)}{0.9157\,AR(2)}$$

R squared = 0.9308 D.W = 2.9586 F-Statistic = 29.614

The relatively high Durbin-Watson suggests that there may be an element of negative serial correlation. The autoregressive term has been used so as to rectify this problem. Price is relatively inelastic and more inelastic than in the national model (national model price coefficient = -0.2955). This suggests that there are possibly no substitutes to IP. This is supported by the fact that the LPG price is insignificant when introduced into the model. The relative poverty of the region is shown by the high income elasticity where consumption is sensitive to the level of income.

The forecasts and volumes of IP for the region are given in table 2.13 below.

Table 2.13: UF Region IP Forecasts in Region B

MODE FORECASTS AND ACTUALS		
	BOUO	
	% Growth	Volume (KL)
1987	-	16 764
1988	17.34	19 671
1989	4.29	20 515
1990	2.94	21 119
1991	(1.84)	20 730
1992	2.83	21 317
1993	3.21	22 002
1994	2.26	22 499
1995	2.70	23 107
88 - 91	**5.45**	
92 - 95	**2.75**	
1995 % of Total RSA		**2.62**

2.6 Region C - Urban Foundation Regions COM1, COM3 AND COUO

Region C occupies the total area of the Orange Free State with the exception of Sasolburg in the north. Sasolburg is incorporated in Region H (see Map in Appendix B below). This region occupies up to 10.5% of RSA and is the fourth largest. However, it is a relatively poor region with the 6th highest per capita income out of the nine development regions. It contributes only 6.5% to the RSA GDP. Its main sectors are mining and agriculture. The Free State Gold mines produced approximately 26% of the total gold production of the RSA in 1984 and 22% of the uranium production. Mining made up 36.5% of the regions GGP in 1985 and was the biggest employer at 25.5%.

Agriculture was the second largest sector in 1985, making up 11% of the GGP and providing 24.1% of the region's employment. However, both the mining and agricultural sectors declined between 1975 and 1985 and overall per capita GGP was 8% less than the country average in 1985. This relative poverty occurred in spite of better per capita GGP in mining and agriculture in 1985. The region grew at 0.9% between 1987 and 1991, well below the country average of 1.6%, and is forecast to grow at 1.6% per annum between 1992 and 1995, similarly below the RSA average of 2.3%. The dependency ratio's shown in Table 2.14 below are similar to that of the RSA. However, the Region has a relatively low level of urbanisation as can be seen by the low level of Black urbanisation. This is significant as Blacks comprised 83.6% of the region population (See Table 2.15 below).

Table 2.14: Dependancy Ratios in Region C

AGE DISTRIBUTION OF THE POPULATION IN REGION C AND THE RSA IN 1985								
AGE	REGION				RSA			
GROUP	WHITES	COLOUREDS	ASIANS	BLACKS	WHITES	COLOUREDS	ASIANS	BLACKS
0-4								
%	8.3	13.3	9.3	15.6	8.1	12.6	11.6	15.9
5-14								
%	17.3	25.1	20.1	26.6	17.1	24.4	22.5	24.9
15-64								
%	65.3	57.1	61.2	55.1	66.3	59.7	63.1	56.6
65+								
%	9.1	4.5	9.4	2.7	8.5	3.3	2.8	2.7
1995 % Total of RSA	**100**	**100**	**100**	**100**	**1001**	**100**	**100**	**100**

Source: ***Office for Regional Development and Regional Development Advisory Committee C (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern (1991) and Department of National Health and Population Development (1991).***

Table 2.15: Urbanisation in Region C.

RURAL AND URBAN DISTRIBUTION OF THE POPULATION IN REGION C AND THE RSA IN 1985				
	REGION		RSA	
POPULATION	RURAL	URBAN	RURAL	URBAN
GROUP	%	%	%	%
WHITES	18	82	12	88
COLOUREDS	35	65	23	77
ASIANS	70	30	9	91
BLACKS	67	33	62	38
TOTAL	**59**	**41**	**47**	**53**

Source: *Office for Regional Development and Regional Development Advisory Committee C (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991).*

By combining the three Urban Foundation regions, population growth in Region C is expected to be 2.1% in the forecast period of 1992 to 1995 or below the national average of 2.5%. However, there is potential for urbanisation as seen in Table 2.15 but this must be evaluated against the relatively low GGP forecasts.

The model equations used to forecast IP in the three Urban Foundation regions of this area are set out below.

$$\text{COM1 } D_{IP} = \underset{(2.69)}{96.8974} - \underset{(1.42)}{0.385\, P_{IP}} - \underset{(2.26)}{6.1691\, I} - \underset{(8.21)}{0.8567\, D_{IP}(-2)}$$

$$+ \underset{(2.13)}{0.5006\, AR(1)}$$

R squared = 0.8423 D.W. = 1.9625 F - Statistic = 20.03

The price of IP is again relatively inelastic indicating insensitivity to IP price on the part of consumers. When the price of a substitute, LPG, was added to the model it proved to be insignificant. It is surprising that there is an inverse correlation with demand for IP lagged and Income. The volumes of IP consumption are relatively high on a per capita basis, suggesting IP is an important fuel in Bloemfontein. Therefore the sign of income should be positive and boost growth. This point must be noted when using the forecasts.

$$COM3\ D_{IP} = \underset{(0.25)}{-4.99} - \underset{(0.87)}{0.207\ P_{IP}} + \underset{(0.40)}{0.5758\ I} + \underset{(7.85)}{0.7642\ D_{IP}(-2)}$$

R squared = 0.8216 D.W. = 1.54 F - Statistic = 23.02

The lagged dependant is the most significant explanatory variable. However, the signs of the coefficients of income and price are what one would expect. The size of the coefficients of income and price are similar to the national model (National model, price = - 0.295 and income = 0.667).

$$COUO\ D_{IP} = \underset{(4.72)}{51.5176} - \underset{(0.28)}{0.068\ P_{IP}} - \underset{(3.04)}{2.4088\ I} - \underset{(8.13)}{0.9722\ D_{IP}(-2)} + \underset{(6.77)}{0.691\ AR(2)}$$

R squared = 0.64 D.W. = 1.63 F - Statistic = 6.22

Price has the correct sign, although is more inelastic than the national model. Income again has a negative sign and a large coefficient. Here again IP is an important fuel as per capita consumption is high at around 31.6 litres per capita per annum compared to an average 18.9 litres per capita per annum for the whole country. The negative sign on the income coefficient must again be noted as it should be positive and reduces the forecasts.

The IP forecasts and volumes for the three Urban Foundation are shown in Table 2.16 below.

Table 2.16: Urban Foundation IP Forecasts in Region C.

MODE FORECASTS AND ACTUALS						
	COMI		COM3		COUO	
	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)
1987	-	8 283	-	6 779		49 631
1988	21.18	10 037	28.63	8 720	10.48	54 831
1989	(14.86)	8 546	21.14	10 563	(10.26)	49 205
1990	2.86	8 790	3.15	10 896	13.37	55 783
1991	(2.25)	8 592	7.47	11 710	4.03	58 030
1992	4.56	8 983	7.29	12 564	(2.77)	56 425
1993	(1.25)	8 871	(1.81)	12 336	(4.68)	53 784
1994	(3.57)	8 554	(2.29)	12 054	(7.54)	49 727
1995	(3.30)	8 272	(1.36)	11 890	(6.51)	46 489
88 - 91	**0.92**		**14.64**		**3.99**	
92 - 95	**(0.94)**		**0.38**		**(5.39)**	
1995 % of Total RSA		**0.94**		**1.35**		**5.28**

2.7 *Region D - Urban Foundation Regions DOM1, DOM2, DOUO and DXUO*

Region D is situated in the Eastern Cape and includes the metropolitan areas of Port Elizabeth/Uitenhage (Urban Foundation region DOM1) and East London (Urban Foundation region DOM2) (see map in appendix B below). It is the third largest development region covering 12.5% of the RSA. It houses 6.4% of the population but only contributes 5.0% to the national GDP. Its largest sector, manufacturing, declined from 30.2% of the Regions GGP in 1975 to 17.7% in 1985, principally as a result of the divestment of a large number of motor manufacturers. The regions per capita income was 16.5% less than the national average in 1985 and GGP fell further between 1987 and 1991. However, the region's economy is well diversified and is expected to consolidate in the forecast period assuming that the drought is broken. A forecast of 1.9% economic growth per annum is expected between 1992 and 1995, which is marginally below the national forecast of 2.3%.

Urban Foundation region East London, is expected to have the strongest growth in IP in the forecast period. Population growth is expected to be 2.6% in the forecast period of 1992 to 1995 slightly above the national average of 2.4%. This is expected because of the relatively high total fertility figure shown in Table 2.17 below. This population growth is an increase on that of the period 1980 to 1985, however, the age distribution in 1985 was similar to that of the RSA average.

Table 2.17: Fertility Figure Comparison in Region D

TOTAL FERTILITY FIGURE IN REGION D AND THE RSA				
POPULATION	REGION		RSA	
GROUP	1985	1987	1985	1987
WHITES	2.0	1.6	2.0	1.7
COLOUREDS	3.5	3.1	3.2	2.9
ASIANS	2.7	2.4	2.5	2.3
BLACKS	4.6	4.4	3.9	3.7

Source: *Office for Regional Development and Regional Development Advisory Committee D (1991): Regional Profile and Development Guidelines - based on Department of National Health and Population Development (1991).*

The region is relatively highly urbanised as is shown in Table 2.18 below. This fact is reinforced by the high levels of IP consumption per capita. In 1991 Region D excluding DOM1, DOM2 and the Ciskei (Urban Foundation region DXUO) consumed 45.8 litres of IP per capita - more than double the national average.

Table 2.18: Urbanisation in Region D

RURAL AND URBAN DISTRIBUTION OF THE POPULATION IN REGION D AND THE RSA IN 1985				
	REGION		RSA	
POPULATION	RURAL	URBAN	RURAL	URBAN
GROUP	%	%	%	%
WHITES	11	89	12	88
COLOUREDS	20	80	23	77
ASIANS	10	90	9	91
BLACKS	40	60	62	38
Total	**30**	**70**	**47**	**53**

Source: *Office for Regional Development and Regional Development Advisory Committee D (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991).*

The model equations used to forecast IP in the four Urban Foundation regions of this area are set out below:

$$\text{DOM1}\ D_{IP} = -\,0{,}1945\,P_{IP} + 0{,}1603\,I + 0{,}857\,D_{IP}(-4)$$
$$\qquad (1{,}69) \qquad (2{,}31) \qquad (8{,}88)$$

R-squared = 0,8238 D.W. = 1,9779 F-Statistic = 37,42

The signs of the coefficients of price and income are as would be expected. However, IP consumption is insensitive to price and particularly income. This is highlighted by the fact that IP consumption is strong in this region with almost 30 litres per capita consumed in 1991 compared to the national average of 18,8 litres per capita in the same year. When the price of a substitute, in this case LPG, was introduced it proved to be insignificant with a t-statistic of 0,62 and an incorrect negative sign.

$$DOM2\ D_{IP} = \underset{(0,89)}{-44,7506} - \underset{(1,05)}{0,5179\ P_{IP}} + \underset{(1,08)}{4,2545\ I} + \underset{(0,15)}{0,0597\ D_{IP}(-4)}$$

$$+ 0,1782\ AR(4)$$

R-squared = 0,4383 D.W =1,8839 F - Statistic = 1,95

This was the third worst fit of the 32 Urban Foundation regions. The reason is that large numbers of sellers purchase IP in East London and on-sell in other areas of Region D and in the Transkei. However, the coefficient signs are as expected although the t-statistics are low. The equation was however retained for forecasting purposes.

$$DOUO\ D_{IP} = 110,63 - 0,0148\ P_{IP} + 5,5766\ P + 3,8464\ I - 0,6306 D_{IP}(-4)$$

R squared = 0,7054 D.W. = 2,0367 F-Statistic = 9,57

This area has the fourth largest per capita consumption of IP in the country, but has 41% less per capita GGP than the national average. The low per capita GGP would account for the high income elasticity and the dependence on IP is indicated by the area's high price inelasticity.

$$DXUO\ D_{IP} = \underset{(7,52)}{51,0299} - \underset{(1,19)}{0,332\ P_{IP}} - \underset{(5,57)}{3,0164\ I} - \underset{(6,93)}{0,9584\ D_{IP}(-2)} - \underset{(1,91)}{0,4699\ AR(4)}$$

R-squared = 0,7694 D.W. = 1,9174 F-statistic = 10,01

The price coefficient is similar to the national model (- 0,2559). However, the negative income elasticity is cause for concern as compared to the expected positive sign, particularly as this is one of the poorer areas of the country. This affects the forecasts negatively. However access to free wood might imply that IP is an inferior good. The equation has been retained for forecasting purposes.

The forecasts and volumes of IP for the four Urban Foundation regions is shown in Table 2.19 below:

Table 2.19: UF Region IP Forecasts in Region D

MODEL FORECASTS AND ACTUALS								
	DOMI		DOM2		DOUO		DXUO	
	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)
1987	-	26 866	-	6 410	-	30 945	-	16 501
1988	10.34	29 643	21.95	7 817	17.80	36 453	4.25	17 203
1989	3.91	30 802	2.29	7 996	8.28	39 472	8.59	18 681
1990	(1.05)	30 480	(7.09)	7 429	(0.46)	39 292	3 53	19 341
1991	0.02	30 487	(10.45)	6 653	(1.52)	38 695	(5.16)	18 343
1992	6.54	32 481	5.32	7 007	1.36	39 221	2.60	18 819
1993	1.93	33 108	5.10	7 364	9.77	43 052	(0.76)	18 676
1994	(0.36)	32 990	11.98	8 246	8.62	46 764	(0.38)	18 604
1995	(1.27)	32 572	8.68	8 962	6.21	49 670	(0.28)	18 553
88 - 91	**3.21**		**0.93**		**5.75**		**2.68**	
92 - 95	**1.67**		**7.73**		**6.44**		**0.29**	
1995 % of Total RSA		**3.70**		**1.02**		**5.64**		**2.11**

2.8 *Region E - Urban Foundation regions EOM1, EOM2, EOUO and EZUO*

Region E covers the whole of Natal including Kwazulu (UF region EZUO), the metropolitan areas of Durban/Pinetown (UF region EOM1) and Pietermaritzburg (EOM2) (see map in Appendix B below). Although the area covers about 7,5% of the total area of the RSA it carries 25% of the total river run off of the Republic. However, the region has a relatively well developed economy and agriculture only contributed around 7,1% of the GGP of the region in 1985.

Manufacturing is by far the largest sector and it contributed 29,9% of the GGP in the same year. However, manufacturing only provided 21,7% of the employment opportunities in that year while agriculture employed 20,9% of the workforce. The region's economy grew relatively slowly between 1987 and 1991 but is expected to pick up to around 2,0% per annum in the forecast period of 1992 to 1995, compared to the national average of 2,3%.

The population growth of 2,3% per annum between 1988 and 1991 was the third highest in the country. The resultant dependency ratio as shown by the age distribution of the population in Table 2.20 below, will retard economic growth per capita GGP. Similarly, the low level of urbanisation amongst Blacks indicates the relatively underdeveloped nature of the region (see Table 2.21 below). The total fertility figures are similar to the average for RSA.

Table 2.20: ***Dependancy Ratios in Region E.***

AGE DISTRIBUTION OF THE POPULATION IN REGION E AND THE RSA IN 1985								
AGE GROUP	REGION				RSA			
	WHITES	COLOUREDS	ASIANS	BLACKS	WHITES	COLOUREDS	ASIANS	BLACKS
0-4								
%	8.0	11.3	11.4	17.8	8.1	12.6	11.6	15.9
5-14								
%	16.4	25.5	22.9	27.6	17.1	24.4	22.5	24.9
15-64								
%	64.5	60.1	63.0	51.7	66.3	59.7	63.1	56.6
65+								
%	11.0	3.2	2.7	2.9	8.5	3.3	2.8	2.7
1995 % Total of RSA	**100**	**100**	**100**	**100**	**1001**	**100**	**100**	**100**

Source: *Office for Regional Development and Regional Development Advisory Committee E (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa and Department of National Health and Population Development (1991).*

Table 2.21: ***Urbanisation in Region E.***

RURAL AND URBAN DISTRIBUTION OF THE POPULATION IN REGION E AND THE RSA IN 1985				
	REGION		RSA	
POPULATION	RURAL	URBAN	RURAL	URBAN
GROUP	%	%	%	%
WHITES	8	92	12	88
COLOUREDS	10	90	23	77
ASIANS	10	90	9	91
BLACKS	77	23	62	38
Total	**63**	**37**	**47**	**53**

Source: *Office for Regional Development and Regional Development Advisory Committee E (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991).*

The model equations used to forecast IP in the four Urban Foundation regions of the area set out below:

$$\text{EOM1 } D_{IP} = \underset{(0,91)}{16,2343} - \underset{(2,38)}{0,3708}\, P_{IP} - \underset{(0,58)}{0,7127}\, I + \underset{(0,51)}{0,5743}\, D_{IP}(-4)$$

R-squared = 0,5846 D.W. = 1,9586 F-statistic = 7,03

The price coefficient is marginally more elastic than the national model but still indicates a lack of sensitivity to price by IP consumers in this region. The income variable is significant while the lagged consumption variable is important to the model. The R-squared is low but the equation is retained for forecasting purposes. This urban foundation area had the fifth highest GGP per capita and consumed the second highest amount of IP per capita in 1991. It is surprising therefore that the income coefficient is insignificant and of the wrong sign. This negative sign, with a relatively large coefficient, must be noted and affects the forecasts negatively.

$$EOM2\ D_{IP} = -126{,}3221 - 0{,}3838\ P_{IP} + 6{,}6213\ P + 3{,}8935\ I + 0{,}4673\ D_{IP}(-1)$$

(2,65) (0,91) (2,65) (1,73)

R squared = 0,8873 D.W. = 2,2602 F - statistic = 33,48

The coefficient signs are all as anticipated and the price elasticity is similar to that of the national model. The high income elasticity is indicative of the fact that the area consumed the fifth highest IP litres per capita in 1991 but is surprising as the coefficient of LPG, as a substitute, is 0,003 and the t-statistic is insignificant at 0,004.

$$EOUO\ D_{IP} = -409{,}7098 - 0{,}8213\ P_{IP} + 28{,}311\ P + 2{,}0653I$$

(3,60) (1,78) (2,90) (1,06)

R-squared = 0,6735 D.W. = 1,4881 F-statistic = 13,06

IP price although inelastic is significantly less inelastic than the national model (-0,2955) and IP is strongly income elastic. The area has relatively high GGP per capita and consumed the third highest number of IP litres per capita in 1991 (2,7 times more than the national average).

$$EZUO\ D_{IP} = -44{,}0617 - 0{,}9342\ P_{IP} + 4{,}5956\ I + 0{,}0853\ D_{IP}(-4) + 0{,}3173AR(4)$$

(3,22) (3,93) (4,16) (0,71) (4,16)

R-squared = 0,8861 D.W. = 1,75 F-statistic = 19,46

IP price has almost unitary elasticity and income is elastic. This is indicative of the possible availability of cheap wood or crop wastes. The consumption of IP is relatively very low and per capita GGP is similarly poor.

The forecasts and volumes of IP for the four UF regions are shown in Table 2.22 below:

Table 2.22: ***Urban Foundation Region IP Forecasts in Region E.***

MODEL FORECASTS AND ACTUALS								
	EOMI		EOM2		EOUO		EZUO	
	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)
1987	-	62 770	-	3 284	-	45 321		13.190
1988	6.14	66 627	87.24	6 149	13.58	51 476	27.34	16 796
1989	(1.41)	65 690	3.22	6 347	6.04	54 584	26.63	21 268
1990	2.42	67 277	19.08	7 558	9.35	59 688	(9.82)	19 180
1991	(4.31)	64 378	17.41	8 874	(4.58)	56 953	(27.82)	13 844
1992	3.28	66 487	10.77	9 830	0.78	57 396	3.30	14 301
1993	0.13	66 571	19.83	11 779	6.02	60 850	(1.28)	14 118
1994	(0.91)	65 966	21.73	14 339	11.74	67 991	(2.64)	13 746
1995	(1.79)	64 787	17.37	16 830	6.81	72 624	(1.77)	13 502
88 - 91	**0.63**		**28.21**		**5.88**		**1.22**	
92 - 95	**0.16**		**17.35**		**6.27**		**(0.62)**	
1995 % Total of RSA		**7.36**		**1.91**		**8.25**		**1.53**

2.9 *Region F - Urban Foundation Regions FNUO and FOUO*

Region F is bounded by Swaziland and Mozambique to the East, Lebowa and Gazankulu to the North, the PWV and Kwandebele to the West and the Orange Free State and Natal to the South. The region contains no metropoles (see map in Appendix B below). The region has some of the highest potential agricultural soil in the RSA with 16% of the Republics arable and 13% of its irrigable land, although the total area of the region covers only 6% of the country.

Electricity and Water is the regions largest economic sector and 73% of the countries electricity is generated here. Mining follows closely behind contributing 23,7% of the region's GGP and providing employment for 17,8% of the workforce. The region supplies around 80% of the country's coal output and 66% of coal exports. Coal is the second largest export earner for the country as a whole after gold - this gives an indication of the region's importance as a foreign exchange earner. The manufacturing sector also makes a large contribution to the region's GGP and incorporates Sasol 2 and Sasol 3, the largest coal processing plants in the world. The region had the fastest growing GGP during the period 1987 to 1991 as coal exports became prominent. It is also forecast to have the fastest growing regional economy in the forecast period but at a dimished rate.

While Kangwane (FNUO) had one of the lowest GGP's per capita in 1991 the balance of the region had the eleventh highest (out of 32 regions). This is indicative of the low level of urbanisation amongst Blacks and hence development in the Region as shown in Table 2.23 below. The age distribution is marginally younger than the average for the country and consequently the total fertility figure as shown in Table 2.24 is similar to RSA. However, the population growth is expected to increase from 1,2% per annum during the period 1988 to 1991, to 1,4% for the 1992 to 1995 forecast period, but this is well below the country average of 2,6% and 2,5% respectively.

Table 2.23 : Urbanisation in Region F.

RURAL AND URBAN DISTRIBUTION OF THE POPULATION IN REGION F AND THE RSA IN 1985				
POPULATION	REGION		RSA	
	RURAL	URBAN	RURAL	URBAN
GROUP	%	%	%	%
WHITES	39	61	12	88
COLOUREDS	46	54	23	77
ASIANS	19	81	9	91
BLACKS	72	28	62	38
Total	**66**	**34**	**47**	**53**

Source: *Office for Regional Development and Regional Development Advisory Committee F (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991).*

Table 2.24: Fertility Figure Comparison in Region F.

TOTAL FERTILITY FIGURE IN REGION F AND THE RSA				
POPULATION	REGION		RSA	
GROUP	1985	1987	1985	1987
WHITES	2.7	2.1	2.0	1.7
COLOUREDS	4.0	2.4	3.2	2.9
ASIANS	NA	NA	2.5	2.3
BLACKS	5.0	3.7	3.9	3.7

Source: *Office for Regional Development and Regional Development Advisory Committee F (1991): Regional Profile and Development Guidelines - based on Department of National Health and Population Development (1991).*

The model equations used to forecast IP in the two Urban Foundation regions of the area set out below:

$$FNUO\ D_{IP} = -915{,}2135 - \underset{(5{,}25)}{}\ 1{,}5596\ P_{IP} + 59{,}3006\ P + 15{,}1583\ I$$

(5,25) (2,32) (5,64) (4,07)

R-squared = 0,8772 D.W. = 1,6197 F-statistic = 45,24

The high elasticities of IP price and Income are indicative of the low per capita income of the area. A substitute price, that of LPG, was included in the above model and proved to be significant. However, it had the incorrect sign and was therefore excluded from the above final model for predictive purposes. It is more likely that free wood is the substitute and as it has no price is not included.

$$FOUO\ D_{IP} = -190{,}5333 - 0{,}6254\ P_{IP} + 14{,}5236\ P - 0{,}457\ D_{IP}(-3)$$

(7,57) (4,01) (7,86) (3,16)

R-squared = 0,8076 D.W. = 2,2295 F-statistic = 22,39

This is a relatively affluent region and had the second highest per capita consumption of IP in 1991. IP price is inelastic but much less inelastic than the national model (- 0,2955).

The forecasts and volumes of IP for the two urban foundation regions are shown in Table 2.25 below:

Table 2.25: Urban Foundation Region IP Forecasts in Region F.

MODEL FORECASTS AND ACTUALS				
	FNUO		FOUO	
	% Growth	Volume (KL)	% Growth	Volume (KL)
1987	-	1 280	-	32 248
1988	27.19	1 628	2.03	32 903
1989	(18.55)	1 326	10.35	36 308
1990	62.67	2 157	6.94	38 829
1991	157.21	5 548	5.38	40 917
1992	26.88	7 039	2.19	41 813
1993	31.96	9 289	7.27	44 851
1994	35.19	12 558	4.64	46 932
1995	13.74	14 283	4.90	49 233
88 - 91	**44.29**		**6.13**	
92 - 95	**26.67**		**4.73**	
1995 % of Total RSA		**1.62**		**5 59**

2.10 *Region G - Urban Foundation region GLUO,GOUO,GVUO and GXUO*

Region G is situated in the most northern part of the RSA. It includes the self governing states of Lebowa (Urban Foundation region GLUO) and Gazankulu (Urban Foundation region GYUO) as well as the independent homeland of Venda (Urban Foundation region GVUO). The balance of the region comprises Urban Foundation region GOUO (see map in Appendix B below). The area is poor with a GGP per capita of around 20% of the national average. Mining is the largest economic sector making up 23,1% of the GGP in 1985. The second largest sector is Agriculture which comprised 10,5% in the same year. Agriculture is by far the largest employer, at 40,2% of the workforce, but only produces around 40% of the national GGP per capita for this sector. Surface water is scarce and large parts of the area rely on underground water which is under threat.

Population growth did not exceed the national average in the period 1988 to 1991 and is not expected to in the forecast period of 1992 to 1995. However, the region's population is predominantly rural with only 8% of the Black population urbanised, as shown in Table 2.26 below. This indicates the high level of underdevelopment of the area, particularly as 96% of the region's populations is Black. The age structure is young as shown in Table 2.27 and this is indicative of the fact that there is a large amount of migration of people of working age to seek employment. The area relies significantly on migrant remittances for income and has a high total fertility figure.

Table 2.26: Urbanisation in Region G.

RURAL AND URBAN DISTRIBUTION OF THE POPULATION IN REGION G AND THE RSA IN 1985				
	REGION		RSA	
POPULATION	RURAL	URBAN	RURAL	URBAN
GROUP	%	%	%	%
WHITES	40	60	12	88
COLOUREDS	45	55	23	77
ASIANS	16	84	9	91
BLACKS	92	8	62	38
Total	**90**	**10**	**47**	**53**

Source: *Office for Regional Development and Regional Development Advisory Committee G (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991).*

Table 2.27: ***Dependancy Ratios in Region G.***

AGE DISTRIBUTION OF THE POPULATION IN REGION G AND THE RSA IN 1985								
AGE	REGION				RSA			
GROUP	WHITES	COLOUREDS	ASIANS	BLACKS	WHITES	COLOUREDS	ASIANS	BLACKS
0-4								
%	8.8	13.3	11.7	20.9	8.1	12.6	11.6	15.9
5-14								
%	21.3	23.6	19.8	31.1	17.1	24.4	22.5	24.9
15-64								
%	62.6	58.2	62.2	45.0	66.3	59.7	63.1	56.6
65 +								
%	7.4	4.9	6.3	3.0	8.5	3.3	2.8	2.7
Total %	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: ***Office for Regional Development and Regional Development Advisory Committee G (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa and Department of National Health and Population Development (1991).***

The model equations used to forecast IP in the four Urban Foundation regions of the area are set out below:

$$\text{GLUO } D_{IP} = \underset{(3,98)}{792,3411} - \underset{(1,35)}{0,6678}\, P_{IP} - \underset{(3,79)}{39,8213}\, P - \underset{(4,28)}{17,4085}\, I + \underset{(1,78)}{0,2432}\, D_{IP}(-2)$$

$$- \underset{(0,42)}{0,0399}\, AR(4)$$

R-squared = 0,7811 D.W. = 1,5068 F-statistic = 7,85

The fact that income and population have large negative coefficients leads to negative forecast growth rates for IP demand. The region consumed a very low 16% (3,03 litres per capita) of the national average (18,88 litres per capita) of IP in 1991. The area is the poorest Urban Foundation region in Region G and it can be expected that other indigenous fuels such as wood provide the bulk of energy needs in this rural area. The incorrect negative sign for population and income must be noted when using the forecasts.

$$\text{GOUO } D_{IP} = \underset{(4,25)}{367,1495} - \underset{(2,41)}{0,8742}\, P_{IP} + \underset{(4,29)}{28,6759}\, P + \underset{(3.24)}{0,5118}\, D_{IP}(-3) - \underset{(3,02)}{0,3374}AR(3)$$

R-squared = 0,8446 D.W. = 1,5317 F-statistic = 16,31

The signs of the independant variable coefficients are as would be expected. IP price is inelastic but more elastic than the national model (-0,2955). Population has a large positive coefficient which will push up forecasts of IP. In 1991 this area had the highest per capita consumption of IP at more than four times the national average.

$$\text{GVUO } D_{IP} = \underset{(2,29)}{508,815} + \underset{(0,13)}{0,1866}\, P_{IP} - \underset{(2,35)}{28,2903}\, P - \underset{(1,88)}{11,7626}\, I - \underset{(0,40)}{0,1016}\, D_{IP}(-2)$$

R-squared = 0,3206 D.W. = 2,2008 F-statistic = 1,88

This area produced the worst fit out of all the 32 Urban Foundation regions making up RSA. Moreover the coefficient signs are not as could be expected. This area had a low consumption of IP in 1991 on a per capita basis and in the forecast historic trends have been used to adjust the forecast.

$$\text{GYUO } D_{IP} = \underset{(2{,}54)}{27{,}5233} - \underset{(1{,}57)}{0{,}6393}\, P_{IP} - \underset{(2{,}37)}{1{,}9532}\, I + \underset{(1{,}95)}{0{,}3913}\, D_{IP}(-1)$$

R-squared = 0,7299 D.W. = 1,6593 F-statistic = 16,21

The price coefficient is negative and inelastic as expected but more elastic than the national model (-0,2955). The negative income coefficient indicates IP is possibly an inferior good and must be noted when using the forecast. This area had the lowest IP consumption per capita in 1991 so that wood, dung and crop waste substitutes are possibly plentifully available particularly as the population in this area is substantially rural.

The forecasts and volumes of IP for the four Urban Foundation regions are shown in Table 2.28 below:

Table 2.28: Urban Foundation Region IP Forecasts in Region G.

MODEL FORECASTS AND ACTUALS								
	GLUO		GOUO		GVUO		GYUO	
	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)
1987	-	8 418	-	23 241	-	2 954	-	828
1988	(44.67)	4 658	23.00	28 587	28.40	3 793	47.22	1 219
1989	42.85	6 654	(1.99)	28 018	12.34	4 261	8.53	1 323
1990	49.44	9 944	34.05	37 559	(23.28)	3 269	(7.18)	1 228
1991	(30.62)	6 899	13.36	42 576	(36.10)	2 089	10.59	1 358
1992	(0.32)	6 877	14.36	48 689	(25.60)	1 554	2.80	1 396
1993	(3.13)	6 661	9.78	53 449	(6.96)	1 446	(0.91)	1 383
1994	(4.49)	6 362	19.66	63 955	(1.60)	1 423	(2.31)	1 351
1995	(3.14)	6 163	18.75	75 945	1.87	1 449	(1.62)	1 329
88 - 91	**(4.85)**		**16.34**		**(8.30)**		**13.17**	
92 - 95	**(2.78)**		**15.57**		**(8.73)**		**(0.53)**	
1995 % of Total RSA		**0.70**		**8.62**		**0.16**		**0.15**

2.11 *Region H - urban Foundation regions HOM1, HOM2, HOM3, HOM4, HOM5, HOM6, HOM8, HSM6, and HWM8*

Region H is located in the central southern Transvaal and includes the most eastern parts of Bophuthatswana (UF region HSM6), the whole of Kwandebele (UF region HWM8) as well as the Pretoria - Witwatersrand - Vaal Triangle metropolitan area (PWV). The region is the smallest in the RSA covering 2.5% of the land area, however, it houses 28,5% of the total RSA population and produces 40,8% of the country's GDP. The area was one of the fastest growing regions in the period 1987 to 1991 and is also expected to grow at a faster rate than the national average in the forecast period of 1992 to 1995.

Manufacturing is the largest sector providing 26,3% of the regions GGP in 1985 but produced more than 50% of the national manufacturing output in the same year. The region is also the most important mineral producing development region in the RSA contributing 11,2% of the regions GGP in 1985, but 34,0% of the national mining output in the same year. The financial and trade sectors are similarly well developed, contributing almost 50% respectively to the countries GDP in these two economic sectors. The area is highly urbanised as shown in Table 2.29 below. A large number of migrants from other regions find employment in Region H and this is shown by the age distribution in Table 2.30 below. In the case of Black people there is a relatively large percentage of the population group in the 15-64 working age group. As a result of inmigration, Region H had the highest population growth rate of all the development regions in the period 1988 to 1991 and is similarly expected to have the highest rate in the forecast period of 1992 to 1995. The region is wealthy and had the highest per capita GGP in 1985.

Table 2.29: Urbanisation in Region H.

RURAL AND URBAN DISTRIBUTION OF THE POPULATION IN REGION H AND THE RSA IN 1985				
	REGION		RSA	
POPULATION	RURAL	URBAN	RURAL	URBAN
GROUP	%	%	%	%
WHITES	5	95	12	88
COLOUREDS	3	97	23	77
ASIANS	1	99	9	91
BLACKS	9	91	62	38
Total	**7**	**93**	**47**	**53**

Source: *Office for Regional Development and Regional Development Advisory Committee H (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991).*

Table 2.30: Dependancy Ratios in Region H.

AGE DISTRIBUTION OF THE POPULATION IN REGION H AND THE RSA IN 1985								
AGE	REGION				RSA			
GROUP	WHITES	COLOUREDS	ASIANS	BLACKS	WHITES	COLOUREDS	ASIANS	BLACKS
0-4								
%	8.1	12.7	12.6	10.8	8.1	12.6	11.6	15.9
5-14								
%	17.3	22.7	20.9	17.0	17.1	24.4	22.5	24.9
15-64								
%	67.6	61.7	63.7	70.0	66.3	59.7	63.1	56.6
65 +								
%	7.0	3.0	2.8	2.1	8.5	3.3	2.8	2.7
Total %	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: *Office for Regional Development and Regional Development Advisory Committee H (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991) and Department of National Health and Population Development (1991).*

As this region contributes up over 40% of the national GDP it has been divided up into 9 Urban Foundation regions. In terms of Rands per capita in 1991 the richest UF region in the country, HOM4 (Pretoria), is in Region H and all the other "Common" areas have GGP per capita higher than the national average. However, HWM8 (Kwandebele) is the poorest region in the RSA on a per capita basis and HSM6 (Eastern parts of Bophuthatswana) is similarly poor. The model equations used to forecast IP in the 9 regions are set out below:

$$\text{HOM1 } D_{IP} = \underset{(3,35)}{-\,0,6547\, P_{IP}} + \underset{(14,15)}{1,3213\, P} - \underset{(6,41)}{0,7824\, D_{IP}(-2)} - \underset{(0,37)}{0,0423\, AR(3)}$$

R-squared = 0,7941 D.W. = 2,3788 F-statistic = 18,00

The signs of the coefficients are as expected, however, both income and price are more elastic than the national model i.e. I = 0,6672, Price = 0,2955). The Johannesburg/Randburg (HOM1) UF region is relatively affluent. In terms of rand/capita the region is at a level double the national average. However, IP consumption per capita in 1991 was less than the national average indicating the high level of electrification in the area.

$$\text{HOM2 } D_{IP} = \underset{(2,21)}{19,2957} - \underset{(1,27)}{0,4515\, P_{IP}} - \underset{(1,66)}{1,1585\, P} + \underset{(5,45)}{0,9501\, D_{IP}(-4)}$$

R-squared = 0,6956 D.W. = 1,5469 F-statistic = 11,42

The price coefficient is as could be expected but the inverse relationship of IP demand to increasing population in the East Rand (HOM2) is puzzling and must be noted when using the forecasts particularly because of the large coefficient. The income variable has a strong positive coefficient but had a low t-statistic and was omitted from the final equation for forecasting purposes. Consumption of IP per capita was 26,5% less than the national average so that increasing electrification probably plays a large role in IP demand.

$$\text{HOM3 } D_{IP} = \underset{(2,09)}{63,9235} - \underset{(1,05)}{0,27\, P_{IP}} - \underset{(1,99)}{4,4614\, I} + \underset{(5,17)}{0,8420\, D_{IP}(-4)}$$

R-squared = 0,7096 D.W. = 1,309 F-statistic = 12,22

The puzzling inverse relationship between IP and income is countered to some extent by the fact that past IP demand trends are the most significant determinants in the consumption of IP. This possibly reflects the fact that Black townships in this area are more established than the East Rand and are electrified. Consequently the high level of urbanisation and prevalence of electricity will play a large role in IP consumption. Furthermore the income coefficient is large and the negative sign will reduce the forecast.

$$\text{HOM4 } D_{IP} = -56{,}7568 - 0{,}4382\, P_{IP} + 6{,}0119\, P - 1{,}2772\, I + 0{,}3564\, D_{IP}(-4)$$
$$(4{,}84) \quad (2{,}11) \quad (5{,}83) \quad (2{,}82) \quad (2{,}93)$$

R-squared = 0,9408 D.W. = 2,38 F-statistic = 55,69

Once again there is an inverse relationship between income and IP consumption. This indicates that IP could be an inferior good with the prevalance of electrification. However, increases in population play a strong positive role in IP consumption and increasing urbanisation is expected to outpace electrification efforts.

$$\text{HOM5 } D_{IP} = 123{,}6049 - 0{,}5498\, P_{IP} + 3{,}5663\, P + 5{,}9662\, I + 0{,}3238\, D_{IP}(-1)$$
$$(2{,}15) \quad (0{,}78) \quad (2{,}14) \quad (1{,}74) \quad (1{,}59)$$

R-squared = 0,8659 D.W. = 1,8423 F-statistic = 27,45

The signs of the coefficient are as predicted. However, they are significantly more elastic than the national model. This would indicate that this area would show growth in IP consumption. In the past period of 1988 to 1991 this area in the South of Region H had the third highest growth in IP consumption out of the 32 Urban Foundation regions.

$$\text{HOM6 } D_{IP} = -70{,}1589 - 0{,}6388\, P_{IP} + 6{,}8559\, P$$
$$(5{,}03) \quad (0{,}84) \quad (5{,}12)$$

R-squared = 0,6109 D.W. = 1,9425 F-statistic = 15,70

Population trends play a large role in this outlying Urban Foundation region (Brits) of Region H. This region also had high rates of consumption of IP in the period 1988 to 1991. The level of urbanisation and the lack of access to other fuels, as spelt out in Energy Transition theory, played a role. The price of a substitute (LPG) was added but proved to be insignificant. The per capita income in this area is slightly below the national average. However, in terms of litre per capita this region consumed the most of all the Urban Foundation regions in Region H at around 50% more than the national average in 1991.

$$HOM8\ D_{IP} = -20{,}{,}0843 + 2{,}7336\,I - 0{,}8154\,D_{IP}(-3)$$
$$\qquad\qquad (2{,}28) \qquad (3{,}19) \qquad (2{,}82)$$

R-squared = 0,4358 D.W. = 1,4605 F-statistic = 6,56

Although the coefficient signs are as predicted, this Urban Foundation region produced the second worst fit of all 32 UF Regions. Historic growth has fluctuated from large positives to negatives so there could be a problem with the data. However, this model has been retained for forecasting purposes.

$$HSM6\ D_{IP} = 145{,}4307 - 0{,}3807\,P_{IP} - 5{,}9567\,P - 4{,}5428\,I - 0{,}3221\,D_{IP}(-2)$$
$$\qquad (3{,}68) \qquad (2{,}14) \qquad (2{,}97) \qquad (4{,}33) \qquad (1{,}43)$$

R-squared = 0,8839 D.W. = 1,5574 F-statistic = 30,47

The strong negative coefficients for population and Income in this Eastern Bophuthatswana area indicate IP is an inferior good and negatively affect the forecasts. LPG price had a positive coefficient when added but proved to be insignificant. The possibility of the availability of cheaper wood and other fuels and electricity exists.

$$HWM8\ D_{IP} = 34{,}0293 - 0{,}5470\,D_{IP} + 4{,}0111\,P - 1{,}1993\,I + 0{,}4138\,D_{IP}(-1)$$
$$\qquad (1{,}00) \qquad (0{,}88) \qquad (2{,}12) \qquad (0{,}73) \qquad (3{,}94)$$

R-squared = 0,9264 D.W. = 1,8869 F-statistic = 53,56

The fit of this model is good and the price coefficient as one would expect. Population trends have a high positive impact on the consumption on IP. This area had the highest growth in IP demand in the period 1988 to 1991, although in terms of litres per capita it is still below the national average. The incorrect negative income coefficient does not affect the high growth forecasts significantly.

The forecasts and volumes of IP for the nine Urban Foundation regions are shown in Table 2.31 and 2.32 below:

Table 2.31: Urban Foundation IP Forecasts in Region H.

MODEL FORECASTS AND ACTUALS								
	HOM1		HOM2		HOM3		HOM4	
	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)
1987	-	38 431	-	20 582	-	8 032	-	13 325
1988	(5.02)	36 503	18.36	24 361	(8.34)	7 362	22.66	16 345
1989	6.64	38 925	26.25	30 755	(4.52)	7 029	11.32	18 195
1990	(5.42)	36 817	0.45	30 894	1.76	7 153	26.31	22 982
1991	1.62	37 412	(9.70)	27 898	(11.90)	6 302	26.76	29 133
1992	0.50	37 597	1.34	28 272	(2.82)	6 124	20.07	34 980
1993	(3.10)	36 430	2.20	28 894	(5.48)	5 788	16.19	40 645
1994	(2.47)	35 532	1.62	29 362	(7.80)	5 337	15.58	46 977
1995	(2.31)	34 713	0.47	29 501	(7.99)	4 910	17.70	55 294
88 - 91	**(0.67)**		**7.90**		**(5.88)**		**21.60**	
92 - 95	**(1.85)**		**1.41**		**(6.05)**		**(17.37)**	
1995 % of Total RSA		**3.94**		**3.35**		**0.56**		**6.28**

Table 2.32: ***Urban Foundation IP Forecasts in Region H.***

MODEL FORECASTS AND ACTUALS										
	HOM5		HOM6		HOM8		HSM6		HWM8	
	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)	% Growth	Volume (KL)
1987	-	3 562	-	1 346	-	626	-	14 303	-	1 448
1988	193.15	10 442	31.58	1 771	16.77	731	18.91	17 007	144.34	3 538
1989	15.00	12 008	36.14	2 411	13.27	828	16.16	19 756	50.76	5 334
1990	9.33	13 128	16.80	2 816	(3.14)	802	14.02	22 526	27.48	6 800
1991	5.22	13 813	16.41	3 278	21.32	973	(5.54)	21 279	9.31	7 433
1992	6.40	14 697	13.93	3 735	18.13	1 149	(0.16)	21 246	11.01	8 252
1993	16.04	17 054	23.98	4 630	12.20	1 290	3.44	21 976	17.01	9 658
1994	22.30	20 857	22.04	5 650	10.61	1 427	4.88	23 048	33.66	12 908
1995	21.67	25 376	22.13	6 901	9.58	1 563	10.43	25 451	19.81	15 466
88 - 91	**40.33**		**24.92**		**11.66**		**10.44**		**50.52**	
92 - 95	**16.42**		**20.45**		**12.59**		**4.58**		**20.10**	
1995 % of Total RSA		**2.88**		**0.78**		**0.18**		**2.89**		**1.76**

2.12 ***Region J - Urban Foundation regions JOUO and JSUO***

Region J covers the South Western part of the Transvaal and includes Urban Foundation region JSOU (the bulk of Bophuthatswana) and JOUO (balance of Region J) (see map in Appendix B). Region J is the second smallest Development Region, covering around 5,2% of South Africa. However, it contributes around 7% of the countries GDP. The region grew strongly in the period 1987 to 1991 but the growth is expected to decrease marginally in the forecast period of 1992 to 1995. The region's largest sector is mining contributing some 58,7% of the regional GGP in 1985. 26% of South Africa's gold production originates here and 23 mineral commodities, including 97% of the countries nickel production and 51% of the total chrome ore production, originate here. Rustenberg Platinum and Impala Platinum are the world's biggest producers of platinum - group metals, producing 98% of the country's production. Agriculture is the next biggest employer at 22,3% of the region's employed labour. However, serious droughts have reduced its contribution to the regions GGP from 12,2% in 1975 to 0,4% in 1985.

The GGP per capita in Agriculture in 1985 was only 9% of the country's average while mining contributed six times more GGP per capita than the average for the country. These extremes have an important influence on the affordability and therefore consumption of fuels. The area's population is relatively rural as shown in Table 2.33 below. The age structure, shown in Table 2.34 below indicates a relatively low dependency burden however, and this is borne out by the lower total fertility figures for 1987 compared to RSA.

Table 2.33: ***Urbanisation in Region J.***

RURAL AND URBAN DISTRIBUTION OF THE POPULATION IN REGION J AND THE RSA IN 1985				
POPULATION GROUP	REGION		RSA	
	RURAL	URBAN	RURAL	URBAN
	%	%	%	%
WHITES	26	74	12	88
COLOUREDS	31	69	23	77
ASIANS	11	89	9	91
BLACKS	69	31	62	38
Total	**58**	**42**	**47**	**53**

Source: *Office for Regional Development and Regional Development Advisory Committee J (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991).*

The model equation used to forecast IP in the two Urban Foundation regions of the area are set out below.

$$\text{JOUO } D_{IP} = -127{,}7109 - 0{,}4034\, P_{IP} + 2{,}3396\, I + 7{,}2053\, P + 0{,}391\, D_{IP}(-1)$$
$$(0{,}87) \quad (1{,}85) \quad (1{,}05) \quad (0{,}81) \quad (1{,}47)$$

$$+\, 0{,}4457\, AR(4)$$
$$(1{,}44)$$

R-squared = 0,5152 D.W. = 1,5597 F-statistic = 2,55

Table 2.34: Dependancy Ratios in Region J.

AGE DISTRIBUTION OF THE POPULATION IN REGION J AND THE RSA IN 1985								
AGE	REGION				RSA			
GROUP	WHITES	COLOUREDS	ASIANS	BLACKS	WHITES	COLOUREDS	ASIANS	BLACKS
0-4								
%	9.1	13.2	12.9	13.6	8.1	12.6	11.6	15.9
5-14								
%	18.8	24.4	20.8	21.4	17.1	24.4	22.5	24.9
15-64								
%	64.6	58.6	62.0	63.2	66.3	59.7	63.1	56.6
65 +								
%	7.5	3.8	4.4	1.8	8.5	3.3	2.8	2.7
1995 % of Total RSA	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: *Office for Regional Development and Regional Development Advisory Committee J (1991): Regional Profile and Development Guidelines - based on Development Bank of Southern Africa (1991) and Department of National Health and Population Development (1991).*

The size of the coefficients and their signs are what one would expect, however, the t-statistics are low and this is the fourth worst fit of the 32 Urban Foundation regions. The t-statistics could have been improved by eliminating some of the explanatory variables. However, as this was the model used for forecasting purposes the highest fit possible was required. The adjusted R-squared was also the best of all the models attempted for this Urban Foundation region.

$$\text{JSUO } D_{IP} = \underset{(13,32)}{23,9346} - \underset{(3,35)}{0,5621}\, P_{IP} - \underset{(10,71)}{1,2316}\, I$$

R-squared = 0,8594   D.W. = 1,8766   F-statistic = 61,17

This model provided a good fit and the price coefficient showed higher but similar inelasticity to the national model. The income coefficient was negative contrary to what would be expected and reduced the forecasts. The area consumed less litres per capita than the national average in 1991 and was considerably poorer than the national average in terms of rand per capita. The possibility exists that significant wood fuel is available to the population. This is borne out by the relatively low growth in IP consumption between 1988 and 1991 and the rural nature of the region.

The forecast and volumes of IP for the two Urban Foundation regions are shown in Table 2.35 below.

Table 2.35: Urban Foundation IP Forecasts in Region J.

MODEL FORECASTS AND ACTUALS				
	JOUO		JSUO	
	% Growth	Volume (KL)	% Growth	Volume (KL)
1987	-	17 042	-	7 820
1988	13.41	19 328	17.69	9 203
1989	1.62	19 642	11.54	10 265
1990	1.79	19 994	3.30	10 604
1991	(7.14)	18 566	4.42	11 073
1992	5.55	19 597	4.67	11 590
1993	5.35	20 645	5.60	12 239
1994	4.61	21 597	4.92	12 842
1995	3.41	22 334	3.95	13 349
88 - 91	**2.16**		**9.08**	
92 - 95	**4.73**		**4.79**	
1995 of Total RSA		**2.54**		**1 52**

2.13 *Transkei - Urban Foundation Region TTUO*

The Transkei is bordered by Natal, Eastern Province and Lesotho and comprises Urban Foundation region TTUO. The Transkei is a very poor region with a GGP per capita of R240,39 in 1991. This compares to a country average of R3 230,55 in the same year. IP consumption per capita is also below the national average at 18,63 litres per capita in 1991 compared to 18,88 for the country as a whole. The region's population is mostly rural.

The model equation used to forecast IP in this region is set out below:

$$TTUP\ D_{IP} = \underset{(13,80)}{24,8954} - \underset{(2,17)}{0,3215}\ P_{IP} - \underset{(10,10)}{1,1197}\ I$$

R-squared = 0,8484 D.W. = 2,4049 F-statistic = 55,99

The model fit is good and IP price has a similar elasticity to the national model. The puzzling feature is the negative coefficient for income which should be positive and will negatively affect the forecasts. Possibly IP is an inferior good in relation to income as it erodes income whereas other available fuels such as wood, crop wastes and dung probably cost nothing.

The forecast and volumes of IP for the Urban Foundation region are shown in Table 2.36 below:

Table 2.36: Urban Foundation IP Forecasts in the Transkei.

MODEL FORECASTS AND ACTUALS		
	TTUO	
	% Growth	Volume (KL)
1987	-	46 235
1988	15.68	53 483
1989	9.05	58 323
1990	7.80	62 870
1991	2.48	64 429
1992	3.61	66 752
1993	3.48	69 075
1994	2.68	70 928
1995	2.49	72 696
88 - 91	**8.65**	
92 - 95	**3.06**	
1995 % Total of RSA		**8.25**

2.14 *Aggregated IP Model*

The model equation for the country aggregates for all the variables used in the 32 Urban Foundation regions above is shown below.

$$\text{RSA } D_{IP} = -100{,}0104 - 0{,}1231\, P_{IP} + 3{,}7251\, P + 3{,}3754\, I - 0{,}8763\, D_{IP}(-2)$$
$$(11{,}12) \quad 0{,}93 \quad (7{,}39) \quad (5{,}27) \quad (7{,}89)$$

R-squared = 0,9168 D.W. = 2,0899 F-statistic = 44,12

The RSA aggregate model is used to verify and compare with the national model and shows that the inclusion of population is significant in the model. However, the coefficients are large for both income and population and they tend to produce high volume and growth forecasts. This is questionable especially when considering the historic IP growth levels and their relationships with the explanatory variables. The falling real price of IP in the historic period is made constant in real terms in the forecast period and income forecasts are the same as the national model. Clearly then the population variable makes forecasts unacceptably high and the geographic forecasts by Urban Foundation region above have been adjusted down to the level of the national model in aggregate. However, the trends per individual Urban Foundation have been maintained. The price of LPG, as a substitute fuel, was added to this aggregated model but proved to be insignificant in terms of both coefficient (0,1882) and t - statistic (0,2051).

2.15 *Conclusion*

The national IP model shows there is likely to be continued high demand for IP in the forecast period of 1992 to 1995. This is borne out by the regional models where demand in aggregate is forecast to be strong with price being inelastic but with IP demand sensitive to income.

CHAPTER THREE

LPG MODEL

3.1 Introduction

This chapter will deal with the investigation into LPG demand in South Africa. The methodology comprised developing a national econometric model to forecast LPG demand for the whole of South Africa, and subsequently to develop regional econometric models to assess the impact of urbanisation, price and income on demand and test the energy transition theory.

3.2 *National LPG Model*

The equation for the national LPG model was derived as follows:

$D_{LPG} = f(I, P_{LPG}, D_{LPG}(-1), P_{IP})$

Where D_{LPG} represents the demand for LPG in Megalitres. P_{LPG} represents the real price of LPG in cents per litre;

$D_{LPG}(-1)$ is demand for LPG lagged one period; P_{IP} is the real price of IP in cents per litre, (IP is used here as a substitute commodity) and D8488 stands for dummy variables to exclude price shocks.

The time series was annual data from 1978 to 1991 and all variables were logged to provide income and price elasticities. The derived regression equation is shown below.

$$D_{LPG} = -\underset{(2.43)}{3{,}7462} + \underset{(2{,}97)}{0{,}5471}\, I - \underset{(5{,}84)}{0{,}2291}\, P_{LPG} + \underset{(7{,}26)}{0{,}7817} D_{LPG}(-1) + \underset{(4{,}07)}{0{,}0998}\, D8488$$

R-squared = 0,9854 D.W. = 2,0321 F-statistic = 135,22

The price of IP proved to be insignificant with a t-statistic of 0,8978 and a coefficient of -0,0615 and was excluded from the model for forecasting purposes.

Correlation coefficient - the adjusted correlation of 0,9781 suggests a high degree of significance of the model and consequently good predictive powers.

T-Statistics and significance levels - the t-statistics are all well over one which implies all the explanatory variables, with the exception of the price of IP, are significant in explaining LPG demand. IP price was excluded from the final model shown above.

F-statistic - the F test supports the overall regression.

Coefficients - the income coefficient of positive 0,5471 indicates relative income inelasticity in the short term and LPG is even more income inelastic than IP(0,6672). The negative 0,2291 LPG price coefficient suggests short term price inelasticity of LPG demand and is also marginally more inelastic than IP (-0,2955). This suggests that in the short term the relatively higher cost of LPG appliances induces the consumer of LPG to keep on using this fuel even if other fuels are available. This has been confirmed in studies by Viljoen (1990) and Eberhard (1986) where a multiplicity of fuels are used, even when electricity is available.

Longer term income and price elasticities can be determined using the formula of the required explanatory variable coefficient divided by one minus the lagged dependant coefficient. The following longer term LPG price and income elasticities were derived:

$$\text{Long term Income elasticity} = \frac{0{,}5471}{1 - 0{,}7817}$$

$$= 2{,}5069$$

This suggests that the demand for LPG is income elastic in the longer term and confirms the energy transition theory that as income increases people move to more amenable fuels. It is more income elastic than IP confirming its intermediate place in the energy transition frame work.

Long term price elasticity $= \frac{-0,2291}{1 - 0,7817}$

$= -1,0496$

This result reinforces the above observation that LPG is very much a transitional fuel in the longer term. Whereas IP has more consumer support owing to the fact that is is perceived to be inexpensive especially when the cost of appliances is taken into account, LPG is more easily replaced by more amenable fuels such as electricity.

Durbin - Watson Statistic - the Durbin Watson - Statistic does not suggest any serial correlation in the model and the residual plot in Figure 3 below, confirms that neither positive or negative serial correlation exist.

The forecasts for PCE are the same as that used in the IP national model. The forecast period 1992 to 1995 includes a cyclical upturn but at a lower absolute level than the previous 1986 - 1989 upturn, owing to the 1992 drought, ongoing retrenchments, high inflation and relatively low wage increases by historical standards. The price assumptions are also the same as the IP model and have been kept constant in real terms for the period 1993 to 1995.

Table 3.1 below shows the historic and forecast percentage change in the dependent and independent variables. The model forecasts tracked the actual forecasts well for the historical period from 1980 to 1991, shown in Table 3.1. Turning points and changes in the trends of LPG consumption are explained well. The average annual forecast of 6,3% for the period 1992 to 1995 compares well with the last upturn of 1986 to 1989. That historical period saw a growth of 8,4% per annum.

However, PCE growth was higher and there was a signifiant fall in the real LPG price of 11,0% per annum over the period 1986 to 1989, which would increase LPG consumption.

FIGURE 3 : LPG NATIONAL MODEL PLOT

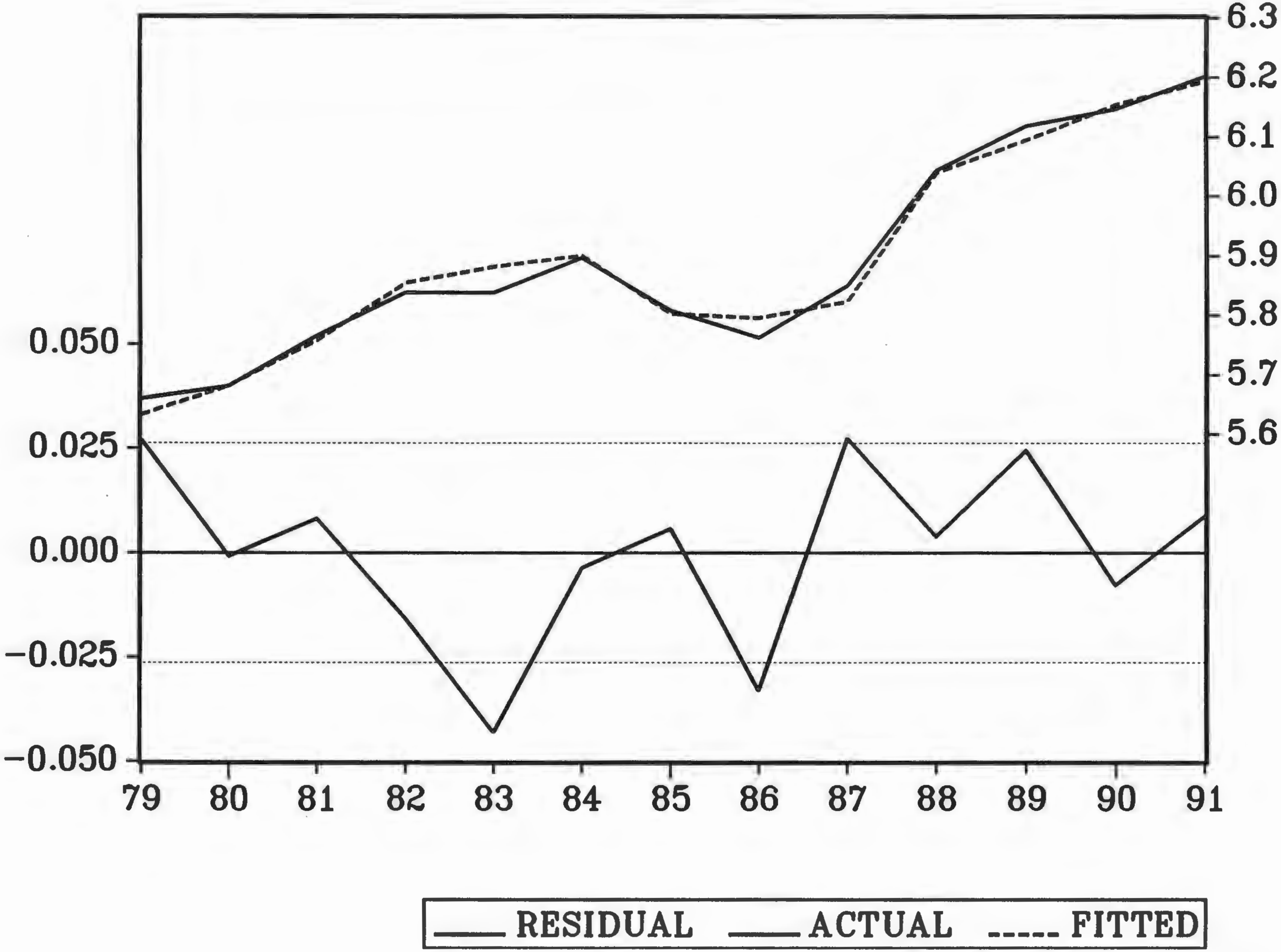


Table 3.1: LPG National Model Results.

LPG National Model Actual and Forecast Data (1980 - 1995)						
	LPG Volume (Ml)	Actual & Forecast LPG % Change	Model LPG % Change	Real PCE % Change	Real Price % Change	CPI % Change
1980	292	2.09	4.98	8.88	(0.89)	13.81
1981	319	8.87	7.89	7.43	(8.58)	15.22
1982	343	7.52	10.13	(0.61)	(13.59)	14.71
1983	343	0.00	2.75	3.00	22.11	12.39
1984	363	6.00	1.92	4.59	58.44	11.54
1985	332	(8.49)	(9.35)	(3.45)	11.39	16.27
1986	317	(4.44)	(0.66)	0.15	(23.65)	18.60
1987	347	9.21	2.80	3.85	(16.95)	16.10
1988	420	21.16	24.05	5.26	(7.80)	12.85
1989	454	7.91	5.71	2.79	4.34	14.67
1990	466	2.84	6.22	2.07	4.64	14.36
1991	493	5.65	3.91	0.16	(6.58)	15.40
1992	520	5.60	6.52	0.89	(6,47)	13.70
1993	551	5.83	5.83	2.59	0.00	12.60
1994	589	6.91	6.91	4.19	0.00	13.70
1995	630	6.96	6.96	2.80	0.00	13.70

3.3 *Regional LPG Model*

The regional LPG econometric model equation used was as follows:

$D_{LPG} = f$ (I, P, P_{LPG}, D_{LPG} (-1 to -4)

Where D_{LPG} represents the demand for LPG in kilolitres; I stands for Income; P is population, where the same Urban Foundation population estimates and categories were used as in the IP regional model above; P_{LPG} stands for the real price of IP in cents per litre; P_{IP} is the real price of LPG in cents per litre and D_{LPG} (-1 to -4) is Demand for LPG (one variable) - lagged one quarter to four quarters where necessary to improve the fit.

All variables were logged to provide income and price elasticities. The time series was quarterly data from 1986 quarter three to 1992 quarter one and was constrained due to available LPG data by MD. A discussion of the exogenous variables was included in chapter two above. The problems experienced in the regional regression equations is discussed below.

LPG is consumed in both the domestic and industrial markets. Initially an attempt was made to forecast total LPG by the 32 Urban Foundation regions by the equation described above. However, the fits in general were poor with half the Urban Foundation models not acquiring the cut off 0,70 R - squared. For this reason it was decided to exclude the regional LPG forecasts from this dissertation.

Work has been done by Mark Borchers and Anton Eberhard of the UCT Energy Research Institute where they provide Household LPG volumes. This was done annually from 1979 to 1989 by surveying suppliers of LPG. An attempt was made to produce quarterly data for some of the main metropolitan areas by expressing the Borchers/Eberhard annual time series as a percentage of the total time series and deriving a household time series for Urban Foundation regions. In all cases the fit improved. However, the improvement was not good enough to meet the criteria specified above. More work would need to be done to survey and create an accurate quarterly time series.

3.4 *Conclusion*

The national LPG model shows there is likely to be continued high demand for LPG in the forecast period from 1992 to 1995. The regional models similarly indicated high future growth but were excluded from this study as the correlations were poor. These poor correlations are due to the high proportion of LPG used in disparate industrial uses.

CHAPTER FOUR

4.1 ***Introduction***

This chapter outlines the demand and supply of electricity in the forecast period. Thus giving an idea of the potential transitional fuel demand such as IP and LPG.

Electricity is the final phase in the energy transition process and is the most amenable fuel. This chapter will examine the state of electrification of households in South Africa and look at the possibilities of extending the supply of electricity to currently unelectrified dwellings, who are satisfying their energy needs from transitional fuels and biomass. Increased reticulation of electricity will clearly reduce the demand for transitional fuels such as IP and LPG. The time period studied will focus on the forecast period of chapter two and three, namely the first half of the nineties.

It is estimated (Dingley, 1992) 30 million people out of a population of 39 million do not have electricity in their homes. Theron (1992) expands on this and estimates that while virtually all "white" South Africans have access to electricity in their homes, only 15% to 20% of Black South Africans have access. This figure is higher in urban areas at around 20% to 30%. However, electricity is available to only 5% to 10% of the population in "Homeland" areas. Electricity is not available to informal housing settlements.

The distribution of electricity in South Africa is highly fragmented and is provided by 400 municipal electricity departments, who supply around 85% of the current 2,4 million consumers. Over half of these municipalities have fewer than 1,000 customers, with the biggest at around 300,000. Eskom is the principal supplier of electricity. (Dingley, 1992).

The goal to extend electricity to unelectrified dwellings is high on the agenda of the suppliers and potential consumers. Cosatu and the ANC strongly advocate the idea of electricity for all. Ben Petersen (1992) of the Metal and Allied Workers Union of South Africa goes further and states that electrification is a right and not a privilege. From the supply point of view Eskom has launched a major drive for a mass electrification programme. The supply of electricity is outstripping demand and Eskom argue that taking electricity supply to the townships would create employment and enhance economic growth. Eskom is currently negotiating with over 100 Black local authorities to either assist in the provision of electricity or take over the supply rights and assets. However, given the politicised nature of service provision to townships, community participation with possible regional institutions cutting across apartheid geographic divisions, with a mandate from a fully representative government, is needed to ensure the success of electricity provision and payment of tariffs. The tariff issue is another source of grievance given the fact that Black consumers often pay more for electricity given the capital costs of reticulation, while "white" electricity provision results in pecuniary surpluses for municipalities, which are used to subsidise other municipal services.

4.2 *Electricity Demand*

Clearly the demand exist for further electrification but the costs are high. Van der Berg (1991) describes three scenarios where urban electrification and competing fiscal demands are outlined.

Table 4.1 below provides Van der Berg's base estimates of rural/urban population, available housing and electricity penetration. It was assumed that the average household is five. The same Urban Foundation demographic model is used here as in the IP demand analysis of chapter two. Using the base provided in Table 4.1 the 3 scenarios were based on the cost of an urban connection of around R 2000 each in 1990 money.

Scenario A focuses on "Redistribution through growth" where macro-economic stability is maintained with classical supply side measures, (such as current government policy to reduce company and personal taxes) - to promote economic growth. Here little attention is paid to the needs of the poor with limited provision of formal housing and electricity to urban dwellers. Informal housing is envisaged as the dominant form of housing expansion. 80,000 electricity connections are forecast per annum to the year 2000 and the proportion of all urban households connected to grid electricity drops slightly.

Scenario B is the optimistic scenario. Here public housing is dramatically expanded, accompanied by electrification to stimulate economic growth. The full housing backlog is eliminated by the year 2000 and 420,000 additional electrical connections are made per year. High inflation and a balance of payments constraint are possible so that economic growth so that economic growth will only be positive if large scale domestic and foreign investment takes place to ensure that economic growth on a broader scale eventuates from this domestic housing and electrification injection.

Scenario C (Intermediate Scenario for electrification) envisages growth and redistribution. Here the new government engages in a social contract with other important actors to ensure confidence and legitimacy in the new socio-political system. This entails economic compromises in that assurances are given to the whites and business community that redistribution will be limited by resource constraints (i.e no untenable tax increases and asset redistribution such as nationalisation). This scenario will require whites to accept substantial cuts in social service provision such as education as well as increased tax rates. Here the same proportion of the urban population will be housed in formal dwellings in the future as is the case now, but all new formal houses will have electricity. The electrification backlog on existing houses will be eradicated by 2010 and a substantial proportion of informal dwellings will also be electrified in this time frame. 190,000 additional electricity connections will be made per annum to the year 2000. Tables 4.2 and 4.3 below outline Van der Berg (1991) scenarios for housing construction and electrification and the costs of the three scenarios.

Table 4.1: Demographic, Housing and Electrification Assumptions.

Base Estimates for scenarios of housing and electrification, 1990 to 2000					
Year	Rural		Urban		Total
		Formal	Informal	Total	
POPULATION					
1990	16m	15m	7m	22m	38m
2000	16m	??	??	32m	48m
HOUSEHOLDS					
1990	3,2m	3,0m	1,4m	4,4m	7,6m
2000	3,2m	??	??	6,4m	9,6m
HOUSEHOLDS ELECTRIFIED					
1990	0,2m	2,2m	0	2,2m	2,4m
PERCENTAGE OF HOUSEHOLDS THAT HAVE ELECTRICITY					
1990	6%	73%	0%	50%	32%

Source: *Van der Berg (1991) estimates based on Urban Foundation (1990), Dingley (1990).*

Table 4.2: Housing and Electrification Scenarios.

Scenarios of housing construction and electrification in urban areas, 1991 to 2000			
	FORMAL HOUSING	INFORMAL HOUSING	TOTAL
Urban Population in Formal and Informal housing 2000 (Assumption)			
Scenario A	19m	13m	32m
Scenario B	32m	0	32m
Scenario C	22m	10m	32m
Urban Households 2000			
Scenario A	3,8m	2,6m	6,4m
Scenario B	6,4m	2,0	6,4m
Scenario C	4,4m	2,	6,4m
Proportion of Urban Households electrified 2000 (Assumption)			
Scenario A	79%	0%	46%
Scenario B	100%		100%
Scenario C	91%	10%	66%
Number of Urban Households Electrified 2000			
Scenario A	3,0m	0	3,0m
Scenario B	6,4m	0	6,4m
Scenario C	4,0m	0,2m	4,2m
New Urban Electricity Connections required per annum 1990 - 2000 (thousands)			
Scenario A	80	0	80
Scenario B	420	0	420
Scenario C	180	10	190

Source: ***Van der Berg (1991): Urban Electrification and competing fiscal demands for social service provision.***

Table 4.3: Housing and Electrification requirements and costs.

Housing and electrification requirements and annual costs (public and private) under three scenarios, 1990 - 2000	
	1990 - 2000
Additional housing units required over period	
Scenario A	0,8m
Scenario B	3,4m
Scenario C	1,4m
Additional Electricity Connections Required	
Scenario A	0,8m
Scenario B	4,2m
Scenario C	1,9m
Cost of Additional Housing Units (1990 R-m per annum)	
Scenario A	R 3 200m
Scenario B	R 13 600m
Scenario C	R 5 600m
Costs of electricity connections (1990 R-m per annum)	
Scenario A	R 160m
Scenario B	R 840m
Scenario C	R 380m

Source: ***Van der Berg (1991): Urban Electrification and competing fiscal demands for social service provision.***

As mentioned above electrification plans have already been launched with Eskom the prime mover. Eskom aims to electrify 900,000 households over the next seven years at a cost of R500 million per annum. As shown in Table 4.4 the total number of unelectrified dwellings by 1997 (5 years away) is expected to be 4,59 million or 61% of total dwellings. If the 900,000 electrical connections take place between 1992 and 1995 the number of unelectrified dwellings would only decrease by 20%. However, the municipalities, which form the bulk of electricity distributors, are envisaged to electrify a further 2,1 million of the remaining unelectrified houses.

There is much scepticism over whether this will be realised. If it does take place, the total of three million over the total seven years would amount to Van der Berg's optimistic scenario (B) with around 430 000 connections per year. Most urban households would then be electrified and transitional fuels would be relegated to providing energy for most of the 2 million people identified as " LEFT OVER " in Table 4.4.

Table 4.4: Competing Electrification Demands in 1992.

ELECTRIFICATION DEMAND IN S.A. - 1997							
	METRO	TOWNS	FARMER	TRUST AREAS	TBVC	NAT STATES	TOTAL
TOTAL DWELLINGS	2 815 472	1 584 193	370 886	85 000	1 273 536	1 398 899	7 527 966
WITH ELECTRICITY	1 769 451	734 004	70 101	36 736	69 604	255 756	2 935 652
WITHOUT ELECTRICITY	1 046 021	850 189	300 785	48 264	1 203 932	1 143 143	4 592 334
% WITHOUT ELECTRICITY	37%	54%	81%	57%	95%	82%	61%
POTENTIAL (A)	802 374	418 535	154 678	27 014	597 082	597 082	2 584 266
% POTENTIAL (B)	95%	75%	60%	75%	50%	50%	-
LEFT OVER (C)	243 647	430 654	146 107	21 250	506 850	506 850	2 008 113
SOURCE: ESKOM, NEC, CSIR, UCT (1991)							

Note:

a) The potential, (A) for electrification refers to what Eskom believes should be electrified

b) The % potential, (B) is the dwellings Eskom plans to electrify

c) The remaining dwellings, (C) deemed not feasible to electrify

Therefore in terms of Eskom's ***plans***, the number of "LEFT OVER" dwellings increases by 5% in the case of metropolitan areas (100% - B) and by 50% in the areas of the TBVC.

However, Van der Berg has pointed out the macro-economic constraints of such a policy. In his likely scenario of 190 000 connections per year it is possible that the total planned Eskom quota (129 000 per annum) plus a balance of 61 000 from the municipalities could be electrified in the 1990's.

In this scenario (C), 34% of urban households will be still unelectrified by the year 2000. This amounts to the same absolute number as in 1990 in the urban areas and excludes any electrification of rural areas (3,2m households in the year 2000 - see Table 4.1)

Clearly if this electrification eventuates then the rapid growth in IP and LPG experienced in the late eighties (10,2% per annum for IP and 8,1% per annum for LPG) could be slowed. Electrification is incorporated in the model projections for IP and LPG to the extent that electrification, eg Soweto, took place in the past i.e 250 000 connections were estimated to have been made in the eighties. Moreover Dingley (1992) criticizes this scenario of 190 000 proposed connections as he states that this will only take up the increase in the population of 1 million per year (assuming households of 5 people) which on its own would require 250 000 additional connections per annum. He believes 350 000 connections are needed over the next twenty years to achieve adequate electrification.

Eskom is only likely to achieve 100 000 connections in 1992 - that is 29 000 short of the 129 000 per annum target. There are socio/political and economic constraints to meeting the demand for electrification and clearly although IP and LPG growth will be constrained over the longer term, it is likely that the 5 - 6% growth per annum in LPG and IP envisaged from 1992 to 1995 will be realised.

4.3 *Conclusion*

In conclusion substantial electrification initiatives are being launched and Eskom, for example, is planning to electrify 129 000 new houses per annum for the next seven years. This would impact on the demand for IP and LPG. However, in the forecast period 1992 to 1995 it must be seen in the light of the increased energy demand coming from urbanisation, and the socio/political and economic constraints which resulted in the low number of connections made by Eskom in 1990 and 1991 shown in Table 4.5.

Table 4.5: Actual connections made historically by Eskom.

No. of Connections Made by Eskom		
	1990	1991
Southern Transvaal	390	4 450
Central Transvaal	1 700	1 410
Western Transvaal	1840	5 280
Eastern Transvaal	1 110	3 630
Northern E. Transvaal	470	880
Eastern Cape	950	3 040
Southern Cape	580	520
Western Cape	2 130	3 320
Eastern Natal	3 960	9 920
Western Natal	1 780	5 970
Orange Free State	660	2 410
Northen Cape	960	1 490
Total	**16 530**	**42 320**

Note: EXCLUDES MUNICIPALITIES

Source: ***Eskom (1991).***

CHAPTER FIVE

5.1 CONCLUSION

The dissertation examined the demand for IP and LPG in South Africa and tested the energy transition theory. As shown in the demographic profile, there will be considerable population growth in the rural and peri-urban areas to which electrification will not be extended in the forecast period of 1992 to 1995. The energy transition process emphasises the use by rural and newly urbanised people, of the transitional fuels, IP and LPG, for energy needs such as cooking, lighting and space heating before the final stage of the use of electricity is reached.

The low short-term price and income elasticities for IP; -0,2955 and 0.6673 respectively, and LPG; -0.2291 and 0.5471 respectively, for the national models, derived in earlier chapters, suggest that these transitional fuels will continue to play an important part in energy provision for people in urban and peri-urban areas without electricity. The derived price and income elasticities for the regional IP models largely confirm the energy transition process where poorer areas are price inelastic. The models of the urban electrified areas and the predominantly rural areas, produce negative income elasticities which reduce the forecasts and suggest that IP is an inferior good due to the availability of superior electricity or free wood respectively. Electrification will play a role in reducing consumption of IP and LPG. However, it can be concluded that due to the predominant price and income inelasticity, the smooth and exclusive transition from wood to IP and LPG and finally electricity suggested by Figure 1 of Chapter 1, (Viljoen, 190) is perhaps misleading.

It is more likely that tardiness in substituting one fuel for another will slow the complete transition among fuels and that the use of a range of fuels, even if electricity becomes available, will be prevalent for some time as the urban household moves up the modernisation index. The forecasts for IP and LPG for the period 1992 to 1995, emanating from the econometric models developed here, forecast lower growth in consumption compared with the recent past, due to the relatively higher projected IP and LPG prices, relatively lower income, and structural constraints such as electrification. The national forecasts for 1992 to 1995 are half those achieved in the last upturn of 1986 to 1989. LPG forecasts are similarly about 50% lower than the historic period. However, the growth in both products is still forecast to be double the projected GDP growth. The geographic IP forecasts show most of the growth occurring in the urban areas and the "homelands" closer to the metropoles. High growth is particularly forecast for the large PWV complex with its dense concentration of population and high rate of inmigration.

In conclusion, the transitional fuels will remain important energy sources for some time to come. The variables such as population growth, income and IP and LPG prices examined in the models have shown to be significant in determining demand. In spite of Eskom's ambitious plans to provide "electricity for all", a significant proportion will remain unelectrified. It is therefore important for policy-makers to ensure that the price of IP and LPG paid by the consumer are within income constraints. The wholesale price of IP paid by the distributors to the oil companies is controlled by government. However, in spite of official guidelines for the final price paid by the consumer these are not enforceable and significant mark-ups by distributors occur in practice. This raises the question of whether oil companies should not extend their distribution chains to ensure that cheaper IP and LPG reaches the consumer. The real income of people without electricity is not likely to rise dramatically in the forecast period, consequently as energy is a basic need, the price of IP and LPG needs to be kept affordable. Similarly, aspects such as safety and amenity should receive priority among policy-makers and suppliers.

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APPENDIX A

MD	UFCODE
BELLVILLE	AOM1
CAPE TOWN	AOM1
GOODWOOD	AOM1
KUILSRIVER	AOM1
MALMESBURY	AOM1
PAARL	AOM1
SIMONSTOWN	AOM1
SOMERSET WEST	AOM1
STELLENBOSCH	AOM1
STRAND	AOM1
WELLINGTON	AOM1
WYNBERG	AOM1
BEAUFORT WEST	AOUO
BREDASDORP	AOUO
CALEDON	AOUO
CALITZDORP	AOUO
CALVINIA	AOUO
CERES	AOUO
CLANWILLIAM	AOUO
FRASERBURG	AOUO
GEORGE	AOUO
HEIDELBERG(CAPE	AOUO
HERMANUS	AOUO
HOPEFIELD	AOUO
KNYSNA	AOUO
LADYSMITH(CAPE)	AOUO
LAINGSBURG	AOUO
MONTAGU	AOUO
MORREESBURG	AOUO
MOSSEL BAY	AOUO
MURRAYSBURG	AOUO
NAMAQUALAND	AOUO
OUDTSHOORN	AOUO
PIKETBERG	AOUO
PRINCE ALBERT	AOUO
RIVERSDALE	AOUO
ROBERTSON	AOUO
SUTHERLAND	AOUO
SWELLENDAM	AOUO
TULBAGH	AOUO
UNIONDALE	AOUO
VAN RHYNSDORP	AOUO
VICTORIA WEST	AOUO
VREDENBURG	AOUO
VREDENDAL	AOUO
WILLISTON	AOUO
WORCESTER	AOUO

MD	UFCODE
BARKLY WEST	BOUO
BRITSTOWN	BOUO
CARNARVON	BOUO
COLESBERG	BOUO
DE AAR	BOUO
GANYESA	BOUO
GORDONIA	BOUO
HANOVER	BOUO
HARTSWATER	BOUO
HAY	BOUO
HERBERT	BOUO
HOPETOWN	BOUO
KENHARDT	BOUO
KIMBERLEY	BOUO
KURUMAN	BOUO
NOUPOORT	BOUO
PHILLIPSTOWN	BOUO
POSTMASBURG	BOUO
PRIESKA	BOUO
RICHMOND(CAPE)	BOUO
TAUNG	BOUO
TLHAPING TLHARO	BOUO
VRYBURG	BOUO
WARRENTON	BOUO
BLOEMFONTEIN	COM1
ODENDAALSRUS	COM3
VIRGINIA	COM3
WELKOM	COM3

MD	UFCODE
BETHLEHEM	COUO
BETHULIE	COUO
BOSHOF	COUO
BOTHAVILLE	COUO
BOTSHABELO	COUO
BRANDFORT	COUO
BULTFONTEIN	COUO
CLOCOLAN	COUO
DEWETSDORP	COUO
EDENBURG	COUO
EXCELSIOR	COUO
FAURESMITH	COUO
FICKSBURG	COUO
FOURIESBURG	COUO
FRANKFORT	COUO
HARRISMITH	COUO
HEILBRON	COUO
HENNEMAN	COUO
HOOPSTAD	COUO
JACOBSDAL	COUO
JAGERSFONTEIN	COUO
KOFFIEFONTEIN	COUO
KOPPIES	COUO
KROONSTAD	COUO
LADYBRAND	COUO
LINDLEY	COUO
MARQUARD	COUO
PARYS	COUO
PETRUSBURG	COUO
PHILIPPOLIS	COUO
REDDERSBURG	COUO
REITZ	COUO
ROUXVILLE	COUO
SENEKAL	COUO
SMITHFIELD	COUO
THABA NCHU	COUO
THEUNISSEN	COUO
TROMPSBURG	COUO
VENTERSBURG	COUO
VILJOENSKROON	COUO
VREDE	COUO
VREDEFORT	COUO
WEPENER	COUO
WESSELSBRON	COUO
WINBURG	COUO
WITSIESHOEK	COUO
ZASTRON	COUO

MD	UFCODE
PORT ELIZABETH	DOM1
UITENHAGE	DOM1
EAST LONDON	DOM2
ABERDEEN	DOUO
ADELAIDE	DOUO
ALBANY	DOUO
ALEXANDRIA	DOUO
ALIWAL NORTH	DOUO
BARKLY EAST	DOUO
BATHURST	DOUO
BEDFORD	DOUO
BURGERSDORP	DOUO
CATHCART	DOUO
CRADOCK	DOUO
ELLIOTT	DOUO
FORT BEAUFORT	DOUO
GRAAFF REINET	DOUO
HANKEY	DOUO
HOFMEYR	DOUO
HUMANSDORP	DOUO
INDWE	DOUO
JANSENVILLE	DOUO
JOUBERTINA	DOUO
KINGWILLIAMSTOW	DOUO
KIRKWOOD	DOUO
KOMGA	DOUO
LADY GREY	DOUO
MACLEAR	DOUO
MIDDLEBURG(CAPE	DOUO
MOLTENO	DOUO
PEARSTON	DOUO
QUEENSTOWN	DOUO
SOMERSET EAST	DOUO
STERKSTROOM	DOUO
STEYNSBURG	DOUO
STEYTLERVILLE	DOUO
STOCKENSTROOM	DOUO
STUTTERHEIM	DOUO
TARKA	DOUO
VENTERSTAD	DOUO
VICTORIA EAST (	DOUO
WILLOWMORE	DOUO
WODEHOUSE	DOUO
HEWU	DXUO
KEISKAMAHOEK	DXUO
MDANTSANE	DXUO
MIDDELDRIFT	DXUO
PEDDIE(CAPE)	DXUO
PEDDIE(CISKEI)	DXUO
VICTORIA EAST(C	DXUO
ZWELITSHA	DXUO

MD	UFCODE
CAMPERDOWN(NATA	EOM1
CHATSWORTH	EOM1
DURBAN	EOM1
INANDA(NATAL)	EOM1
PINETOWN(NATAL)	EOM1
PTRMARITZBURG(N	EOM2
ALFRED(NATAL)	EOUO
BABANANGO(NATAL	EOUO
BERGVILLE(NATAL	EOUO
DANNHAUSER(NATA	EOUO
DUNDEE(NATAL)	EOUO
ESHOWE(NATAL)	EOUO
ESTCOURT(NATAL)	EOUO
GLENCOE(NATAL)	EOUO
HLABISA(NATAL)	EOUO
IMPENDLE(NATAL)	EOUO
IXOPO(NATAL)	EOUO
KLIPRIVER(NATAL	EOUO
KRANSKOP(NATAL)	EOUO
LIONS RIVER(NAT	EOUO
LOWER TUGELA(NA	EOUO
LOWER UMFOLOZI(	EOUO
MOOI RIVER	EOUO
MOUNT CURRIE	EOUO
MTONJANENI(NATA	EOUO
MTUNZINI(NATAL)	EOUO
NEW HANOVER(NAT	EOUO
NEWCASTLE(NATAL	EOUO
NGOTSHE	EOUO
PLPIETERSBURG(N	EOUO
POLELA(NATAL)	EOUO
PT SHEPSTONE(NA	EOUO
RICHMOND(NATAL)	EOUO
UMVOTI(NATAL)	EOUO
UMZINTO(NATAL)	EOUO
UNDERBERG(NATAL	EOUO
UTRECHT	EOUO
VRYHEID(NATAL)	EOUO
WEENEN(NATAL)	EOUO

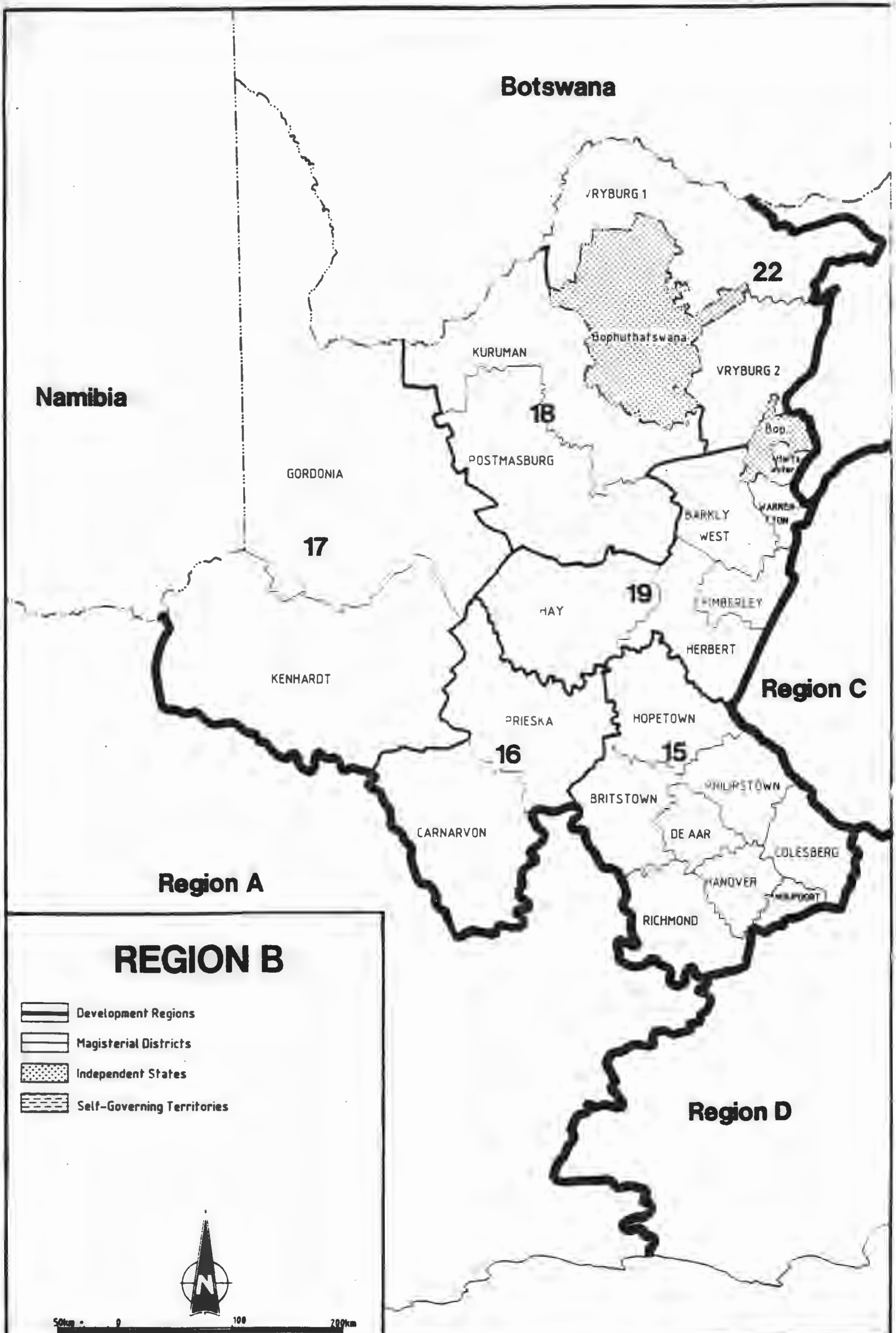
MD	UFCODE
ALFRED(KWAZULU)	EZUO
BABANANGO(KWAZU	EZUO
BERGVILLE(KWAZU	EZUO
CAMPERDOWN(KWAZ	EZUO
DANNHAUSER(KWAZ	EZUO
DUNDEE(KWAZULU)	EZUO
ESHOWE(KWAZULU)	EZUO
ESTCOURT(KWAZUL	EZUO
GLENCOE(KWAZULU	EZUO
HLABISA(KWAZULU	EZUO
IMPENDLE(KWAZUL	EZUO
INANDA(KWAZULU)	EZUO
INGWAVUMA	EZUO
IXOPO(KWAZULU)	EZUO
KLIPRIVER(KWAZU	EZUO
KRANSKOP(KWAZUL	EZUO
LIONS RIVER(KWA	EZUO
LOWER TUGELA(KW	EZUO
LOWER UMFOLOZI(	EZUO
MAHLABATINI	EZUO
MAPUMULO	EZUO
MSINGA	EZUO
MTONJANENI(KWAZ	EZUO
MTUNZINI(KWAZUL	EZUO
NDWEDWE	EZUO
NEW HANOVER(KWA	EZUO
NEWCASTLE(KWAZU	EZUO
NKANDLA	EZUO
NONGOMA	EZUO
NQUTU	EZUO
PINETOWN(KWAZUL	EZUO
PLPIETERSBURG(K	EZUO
POLELA(KWAZULU)	EZUO
PT SHEPSTONE(KW	EZUO
PTRMARITZBURG(K	EZUO
RICHMOND(KWAZUL	EZUO
UBOMBO(KWAZULU)	EZUO
UBOMBO(NATAL)	EZUO
UMBUMBULU	EZUO
UMLAZI	EZUO
UMVOTI(KWAZULU)	EZUO
UMZINTO(KWAZULU	EZUO
UNDERBERG(KWAZU	EZUO
VRYHEID(KWAZULU	EZUO
WEENEN(KWAZULU)	EZUO
EERSTEHOEK	FNUO
KAMHLUSHWA	FNUO
NSIKAZI(KANGWAN	FNUO

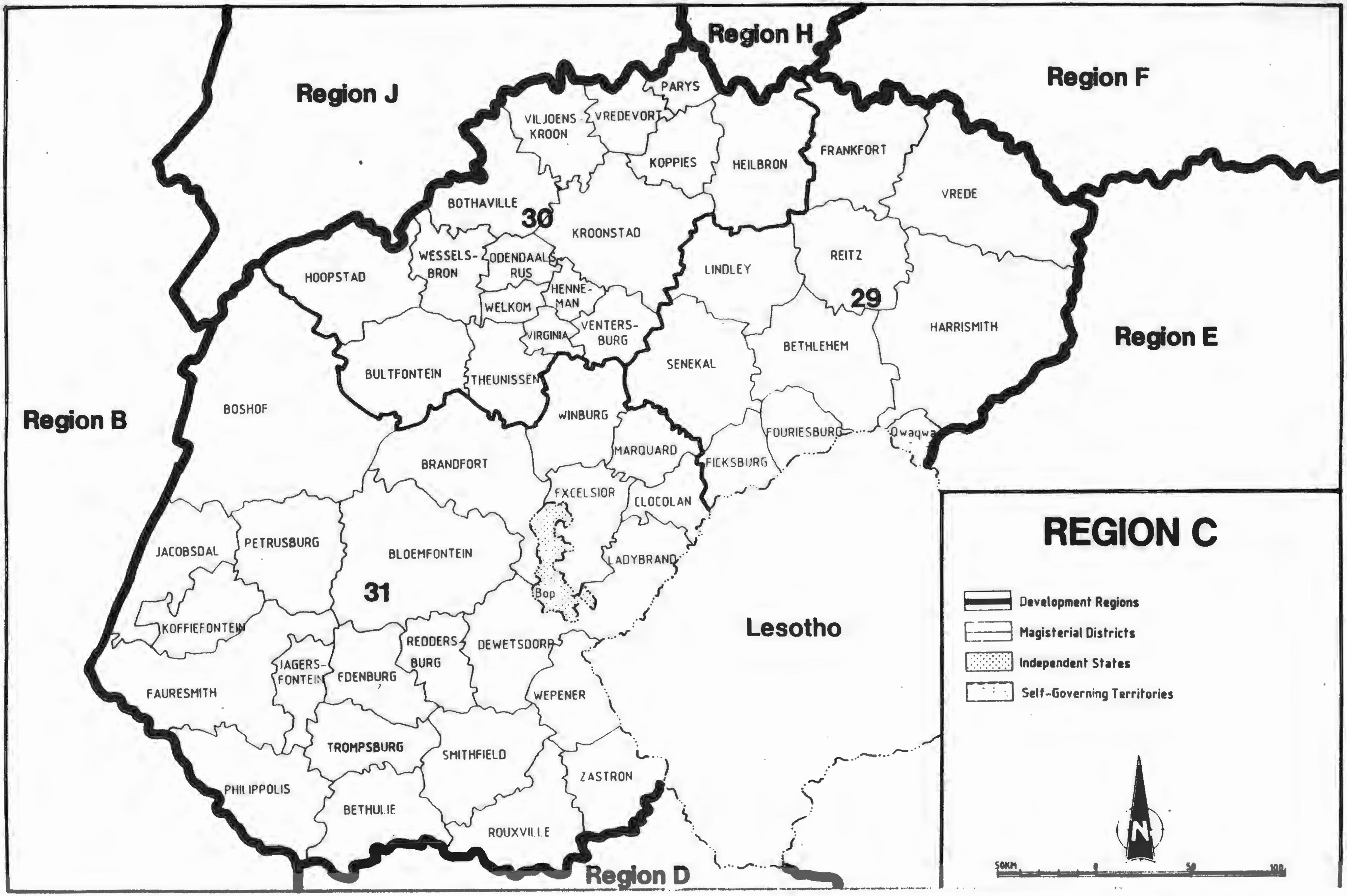
MD	UFCODE
AMERSFOORT	FOUO
BALFOUR	FOUO
BARBERTON(TVL)	FOUO
BELFAST	FOUO
BETHAL	FOUO
CAROLINA(TVL)	FOUO
DELMAS	FOUO
ERMELO	FOUO
GROBLERSDAL	FOUO
HEIDELBERG(TVL)	FOUO
HIGHVELD RIDGE	FOUO
LYDENBURG	FOUO
MIDDELBURG-TVL	FOUO
NELSPRUIT(TVL)	FOUO
NIGEL	FOUO
PIET RETIEF (KA	FOUO
PIET RETIEF(TVL	FOUO
PILGRIMS REST	FOUO
STANDERTON	FOUO
VOLKSRUST	FOUO
WAKKERSTROOM	FOUO
WATERVAL BOVEN	FOUO
WITBANK	FOUO
WITRIVIER	FOUO
BOCHUM	GLUO
BOLOBEDU	GLUO
MAPULANENG	GLUO
MOKERONG	GLUO
NAMAKGALE	GLUO
NAPHUNO	GLUO
NEBO	GLUO
SEKGOSESE	GLUO
SEKHUKHUNELAND	GLUO
SESHEGO	GLUO
THABAMOOPO	GLUO
ELLISRAS	GOUO
LETABA(LEBOWA)	GOUO
LETABA(TVL)	GOUO
MESSINA	GOUO
PHALABORWA	GOUO
PIETERSBURG	GOUO
POTGIETERSRUS	GOUO
SOUTPANSBERG	GOUO
THABAZIMBI	GOUO
WARMBAD	GOUO
WATERBURG	GOUO
DZANANI	GVUO
SIBASA	GVUO
VUWANI	GVUO

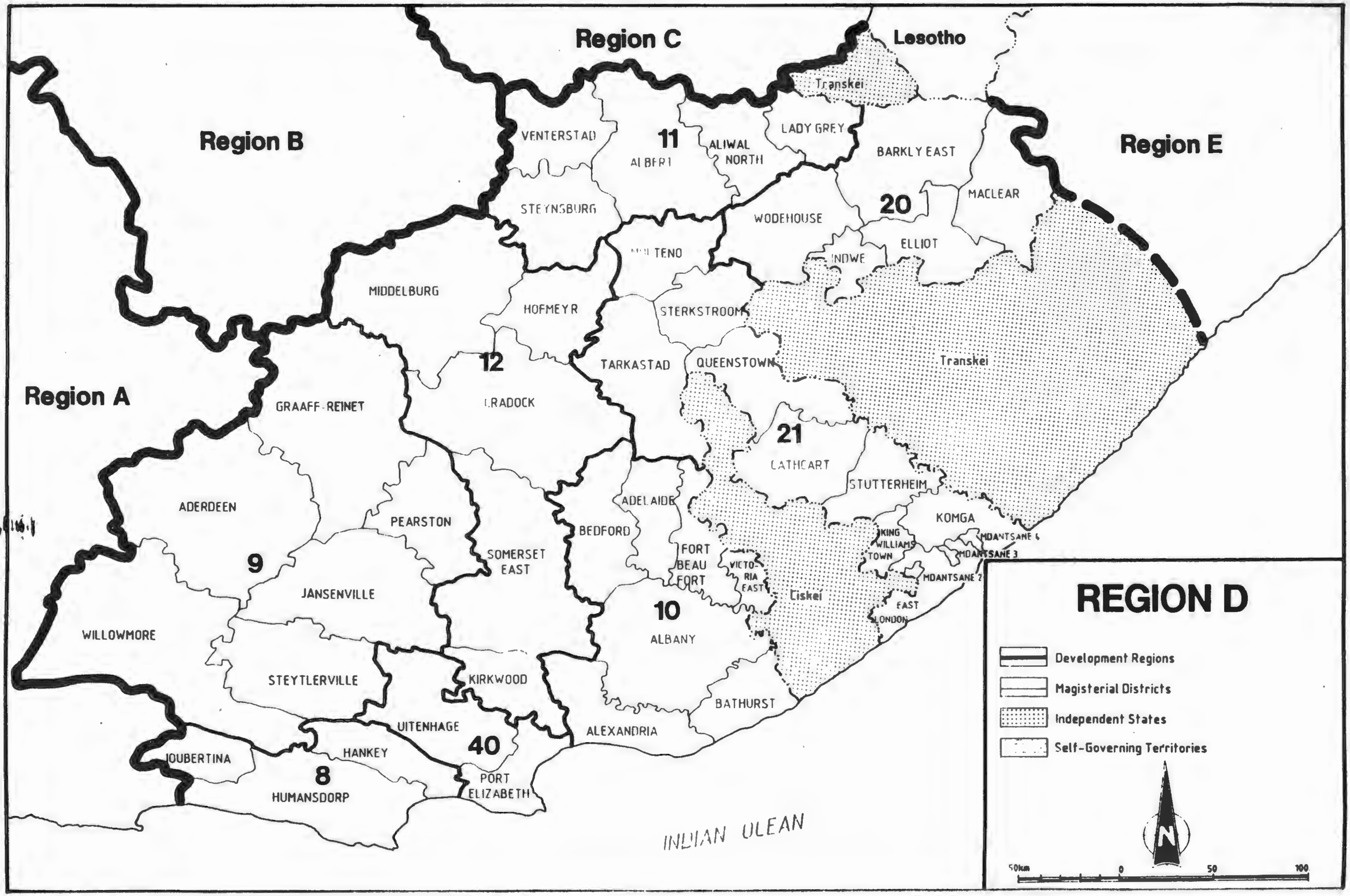
MD	UFCODE
GIYANI	GYUO
MALAMULELE	GYUO
MHALA	GYUO
RITAVI	GYUO
JOHANNESBURG	HOM1
RANDBURG	HOM1
ALBERTON	HOM2
BENONI	HOM2
BOKSBURG	HOM2
BRAKPAN	HOM2
GERMISTON	HOM2
KEMPTON PARK	HOM2
SPRINGS	HOM2
KRUGERSDORP	HOM3
RANDFONTEIN	HOM3
ROODEPOORT	HOM3
WESTONARIA	HOM3
PRETORIA	HOM4
SOSHANGUVE	HOM4
WONDERBOOM	HOM4
SASOLBURG	HOM5
VANDERBIJLPARK	HOM5
VEREENIGING	HOM5
BRITS	HOM6
BRONKHORSTSPRUI	HOM8
CULLINAN	HOM8
BAFOKENG	HSM6
MATHANJANA	HSM6
MORETELE	HSM6
ODI	HSM6
MDUTJANA(SIYABU	HWM8
MKOBOLA	HWM8
MOUTSE	HWM8
BLOEMHOF	JOUO
CHRISTIANA	JOUO
COLIGNY	JOUO
DELAREYVILLE	JOUO
KLERKSDORP	JOUO
KOSTER	JOUO
LICHTENBURG	JOUO
MARICO	JOUO
OBERHOLZER	JOUO
POTCHEFSTROOM	JOUO
RUSTENBURG	JOUO
SCHWEIZER RENEK	JOUO
SWARTRUGGENS	JOUO
VENTERSDORP	JOUO
WOLMARANSTAD	JOUO

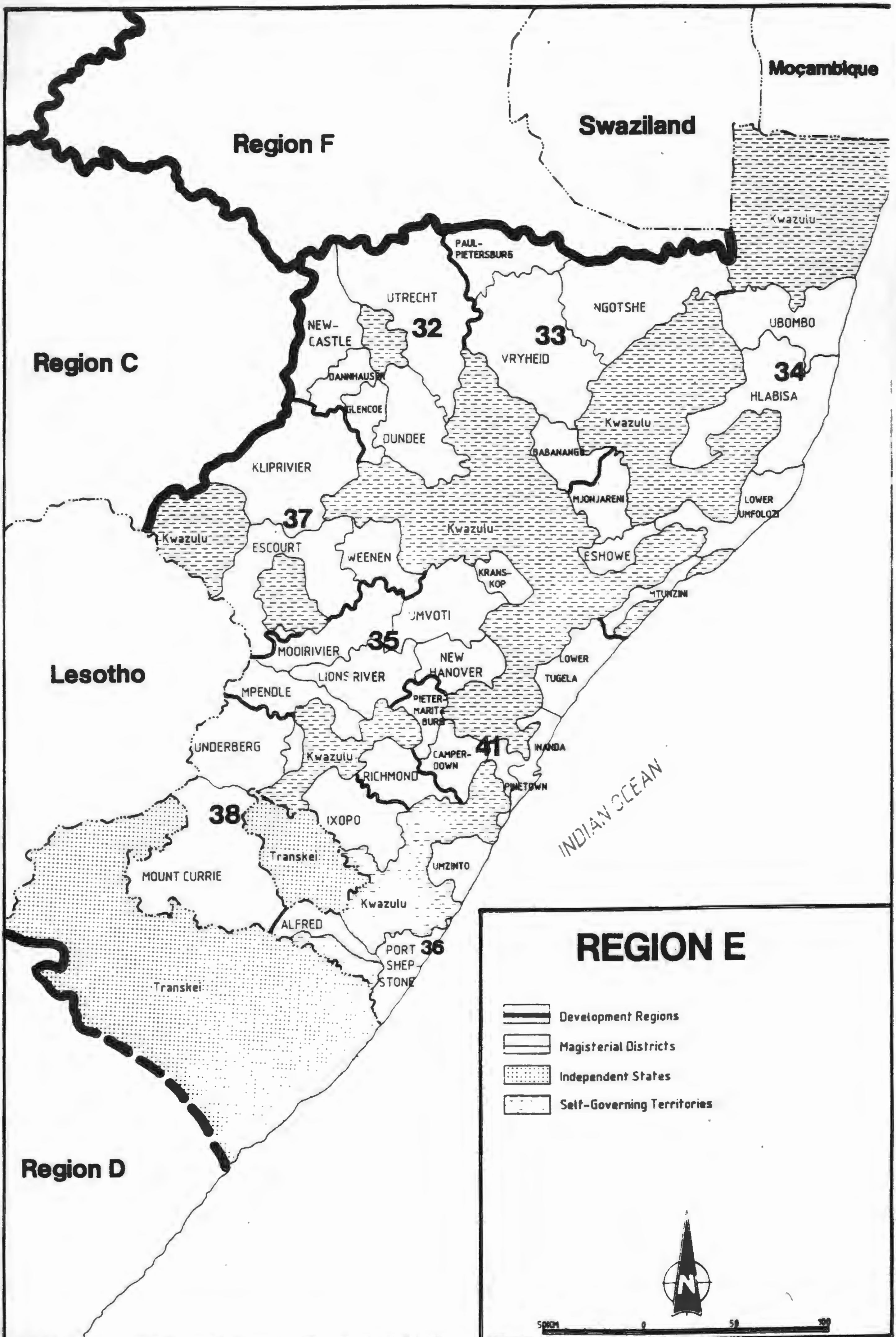
MD	UFCODE
DITSOBOTLA	JSUO
LEHURUTSHE	JSUO
MADIKWE	JSUO
MAFIKENG	JSUO
MANKWE	JSUO
MOLOPO	JSUO
BIZANA	TTUO
BUTTERWORTH	TTUO
ELLIOTDALE	TTUO
ENGCOBO	TTUO
FLAGSTAFF	TTUO
GLEN GREY	TTUO
HERSCHEL	TTUO
IDUTYWA	TTUO
KENTANI	TTUO
LIBODE	TTUO
LUSIKISIKI	TTUO
MATATIELE	TTUO
MOUNT AYLIFF	TTUO
MOUNT FLETCHER	TTUO
MOUNT FRERE	TTUO
MQUANDULI	TTUO
MUTALE	TTUO
NGQELENI	TTUO
NQAMAKWE	TTUO
PORT ST JOHNS	TTUO
QUMBU	TTUO
ST MARKS	TTUO
TABANKULU	TTUO
TSOLO	TTUO
TSOMO	TTUO
UMTATA	TTUO
UMZIMKULU	TTUO
WILLOWVALE	TTUO
XALANGA	TTUO

Namibia
Region B
1
NAMAKWALAND
VANRHYNSDORP
2
CALVINIA
14
WILLISTON
VICTORIA WEST
ATLANTIC OCEAN
FRASERBURG
13
MURRAYSBURG
CLANWILLIAM
BEAUFORT WEST
SUTHERLAND
PIKETBERG
CERES
3
4
LAINGSBURG
PRINCE ALBERT
Region D
TULBAGH
MALMESBURY
WORCESTER
MONTAGU
LADISMITH
OUDTSHOORN
UNIONDALE
PAARL
39
7
GEORGE
KNYSNA
6
STELLENBOSCH
SWELLENDAM
RIVERSDALE
CALEDON
5
BREDASDORP
REGION A
Development Regions
Magisterial Districts
Independent States
Self-Governing Territories
N
50km
0
100
200km

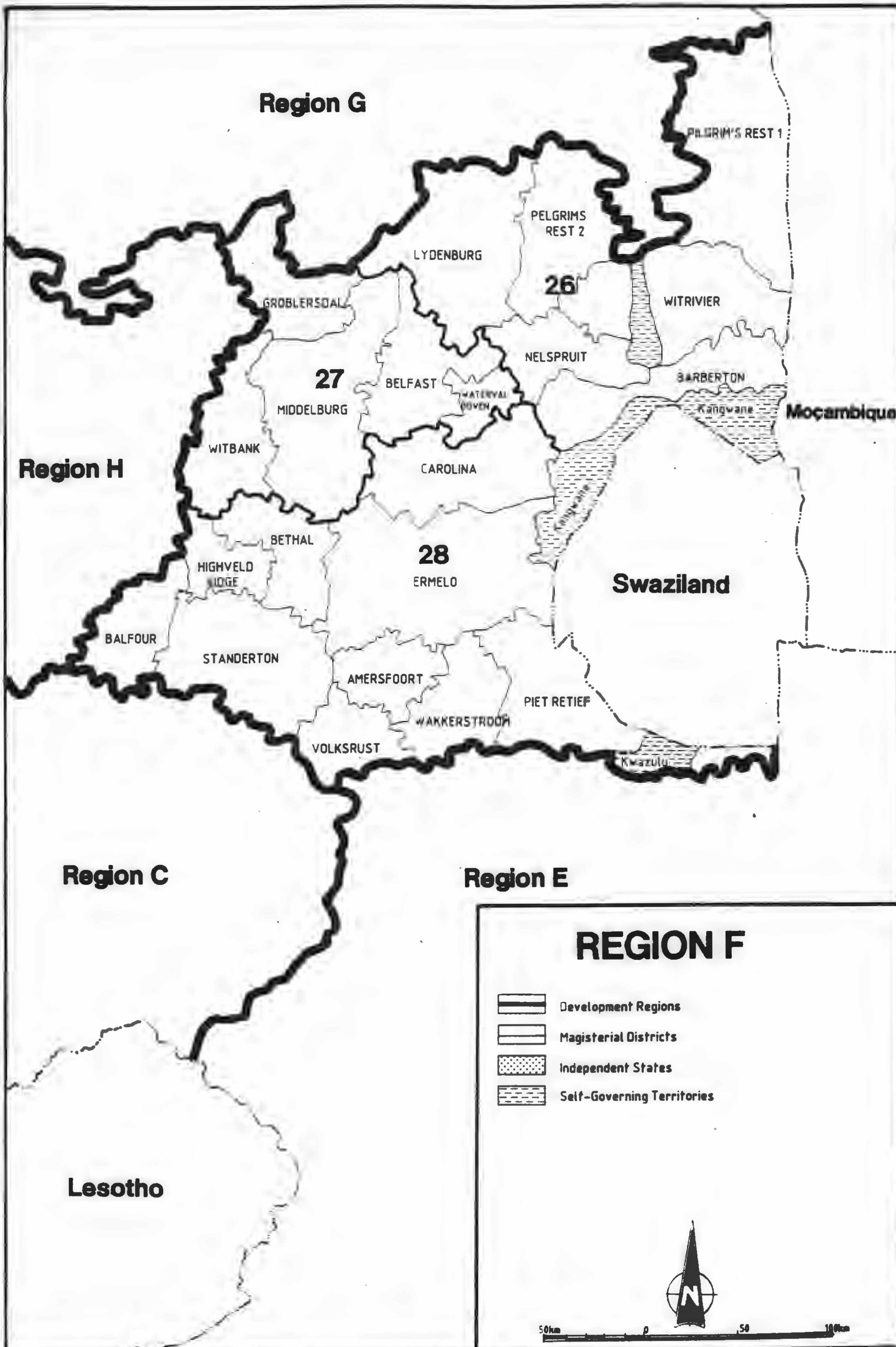

Botswana
Namibia
VRYBURG 1
22
Bophuthatswana
KURUMAN
VRYBURG 2
18
Bop.
POSTMASBURG
GORDONIA
BARKLY WEST
17
19
HAY
KIMBERLEY
HERBERT
KENHARDT
Region C
PRIESKA
HOPETOWN
16
15
PHILIPSTOWN
BRITSTOWN
DE AAR
CARNARVON
COLESBERG
Region A
HANOVER
RICHMOND
REGION B
Development Regions
Magisterial Districts
Independent States
Self-Governing Territories
Region D
N
50km
0
100
200km


REGION C
Region B
Region J
Region H
Region F
Region E
Region D
Lesotho
29
30
31
PARYS
VILJOENS-KROON
VREDEVORT
KOPPIES
HEILBRON
FRANKFORT
VREDE
BOTHAVILLE
KROONSTAD
WESSELS-BRON
ODENDAALS-RUS
HOOPSTAD
LINDLEY
REITZ
HENNE-MAN
WELKOM
VENTERS-BURG
VIRGINIA
HARRISMITH
BETHLEHEM
BULTFONTEIN
THEUNISSEN
SENEKAL
BOSHOF
WINBURG
FOURIESBURG
Qwaqwa
MARQUARD
FICKSBURG
BRANDFORT
EXCELSIOR
CLOCOLAN
JACOBSDAL
PETRUSBURG
BLOEMFONTEIN
LADYBRAND
Bop
KOFFIEFONTEIN
REDDERSBURG
DEWETSDORP
JAGERS-FONTEIN
EDENBURG
FAURESMITH
WEPENER
TROMPSBURG
SMITHFIELD
ZASTRON
PHILIPPOLIS
BETHULIE
ROUXVILLE
Development Regions
Magisterial Districts
Independent States
Self-Governing Territories
N
50KM
0
50
100

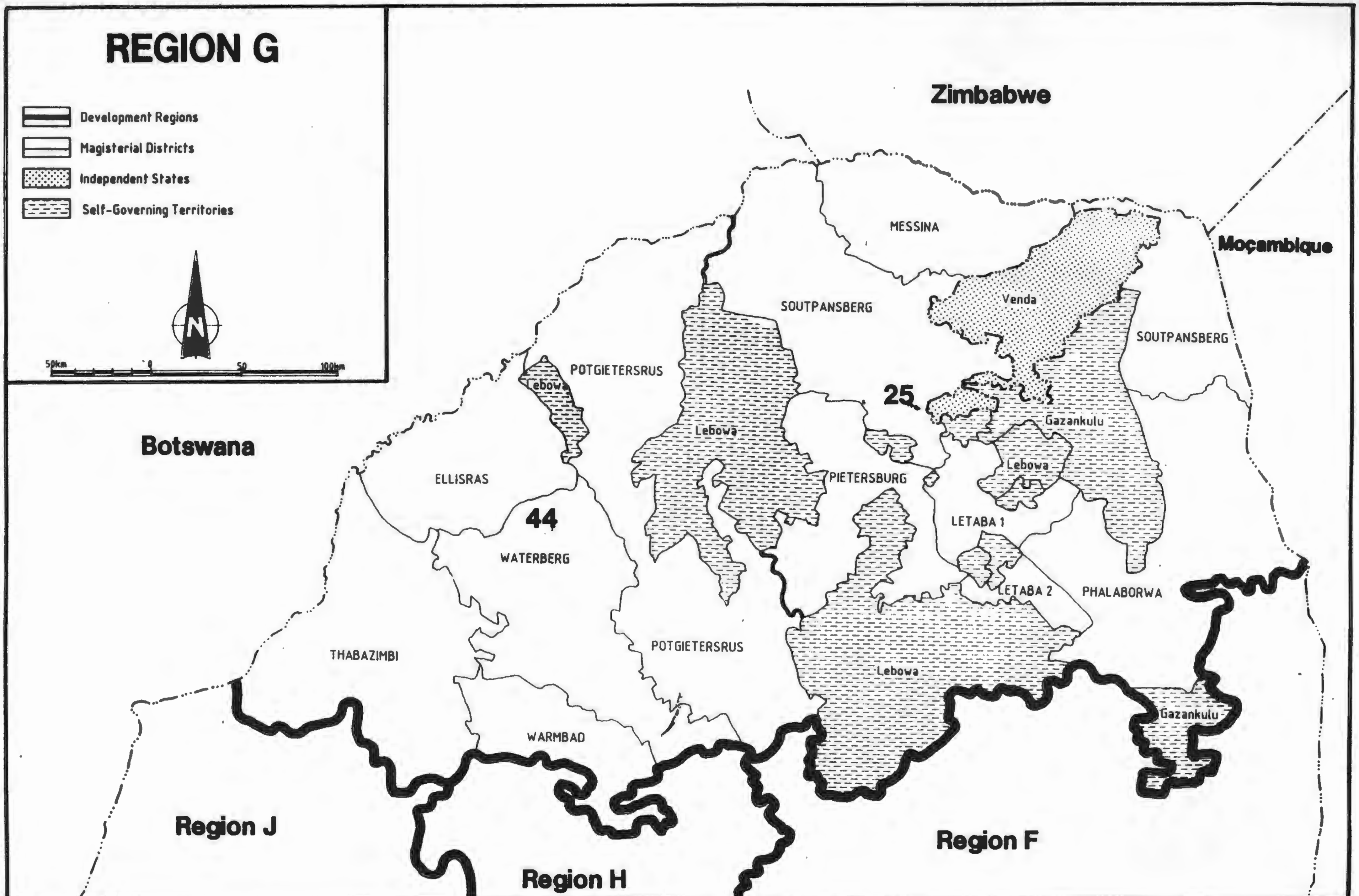

REGION D
Region A
Region B
Region C
Region E
Lesotho
Transkei
Ciskei
INDIAN OCEAN
VENTERSTAD
11
ALBERT
ALIWAL NORTH
LADY GREY
BARKLY EAST
MACLEAR
20
ELLIOT
INDWE
WODEHOUSE
STEYNSBURG
MOLTENO
STERKSTROOM
MIDDELBURG
HOFMEYR
12
CRADOCK
TARKASTAD
QUEENSTOWN
21
CATHCART
STUTTERHEIM
KOMGA
KING WILLIAMS TOWN
MDANTSANE 4
MDANTSANE 3
MDANTSANE 2
EAST LONDON
GRAAFF-REINET
ABERDEEN
9
PEARSTON
SOMERSET EAST
BEDFORD
ADELAIDE
FORT BEAUFORT
VICTORIA EAST
10
ALBANY
BATHURST
ALEXANDRIA
JANSENVILLE
WILLOWMORE
STEYTLERVILLE
KIRKWOOD
UITENHAGE
40
JOUBERTINA
HANKEY
8
HUMANSDORP
PORT ELIZABETH
Development Regions
Magisterial Districts
Independent States
Self-Governing Territories
N
50km
0
50
100

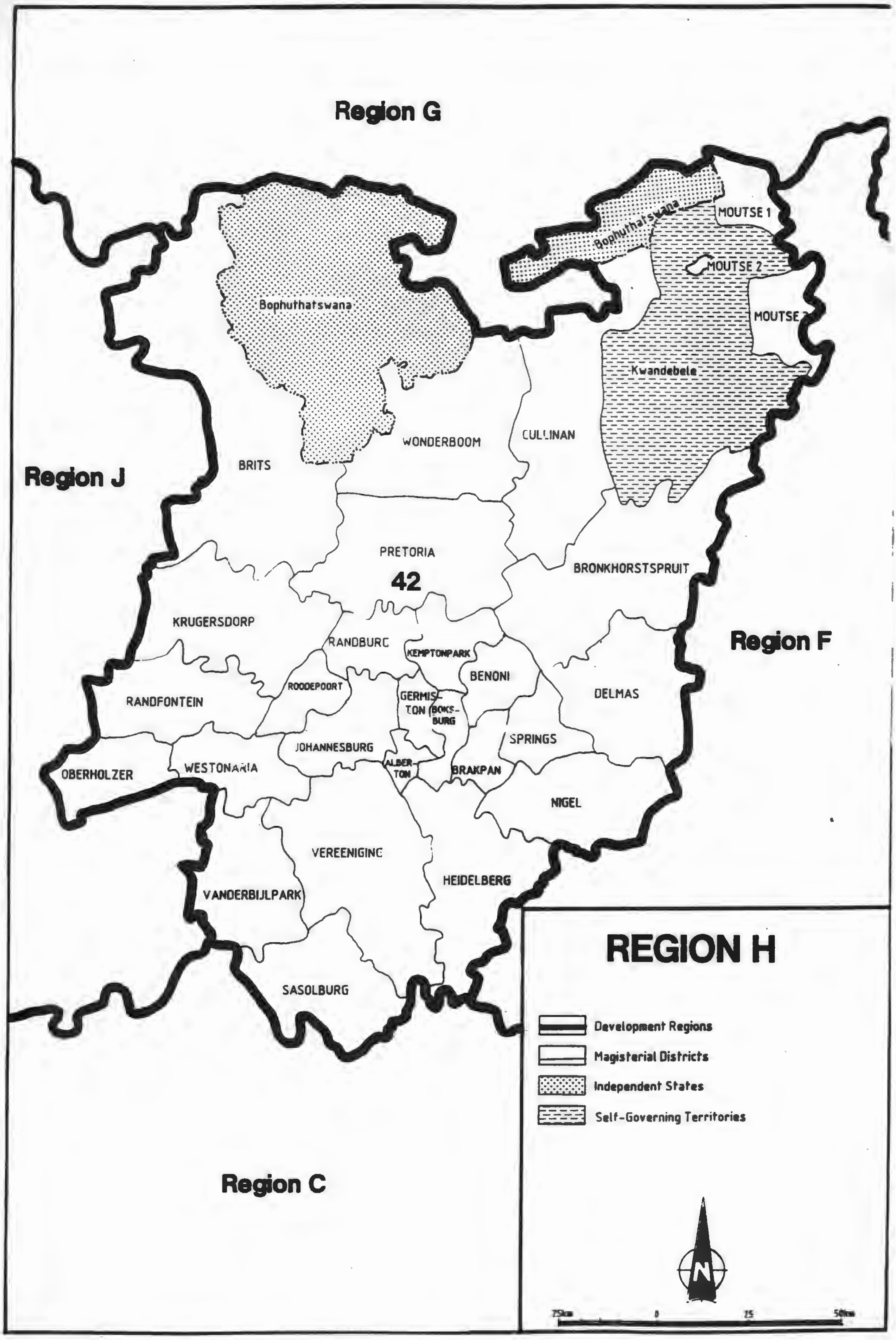


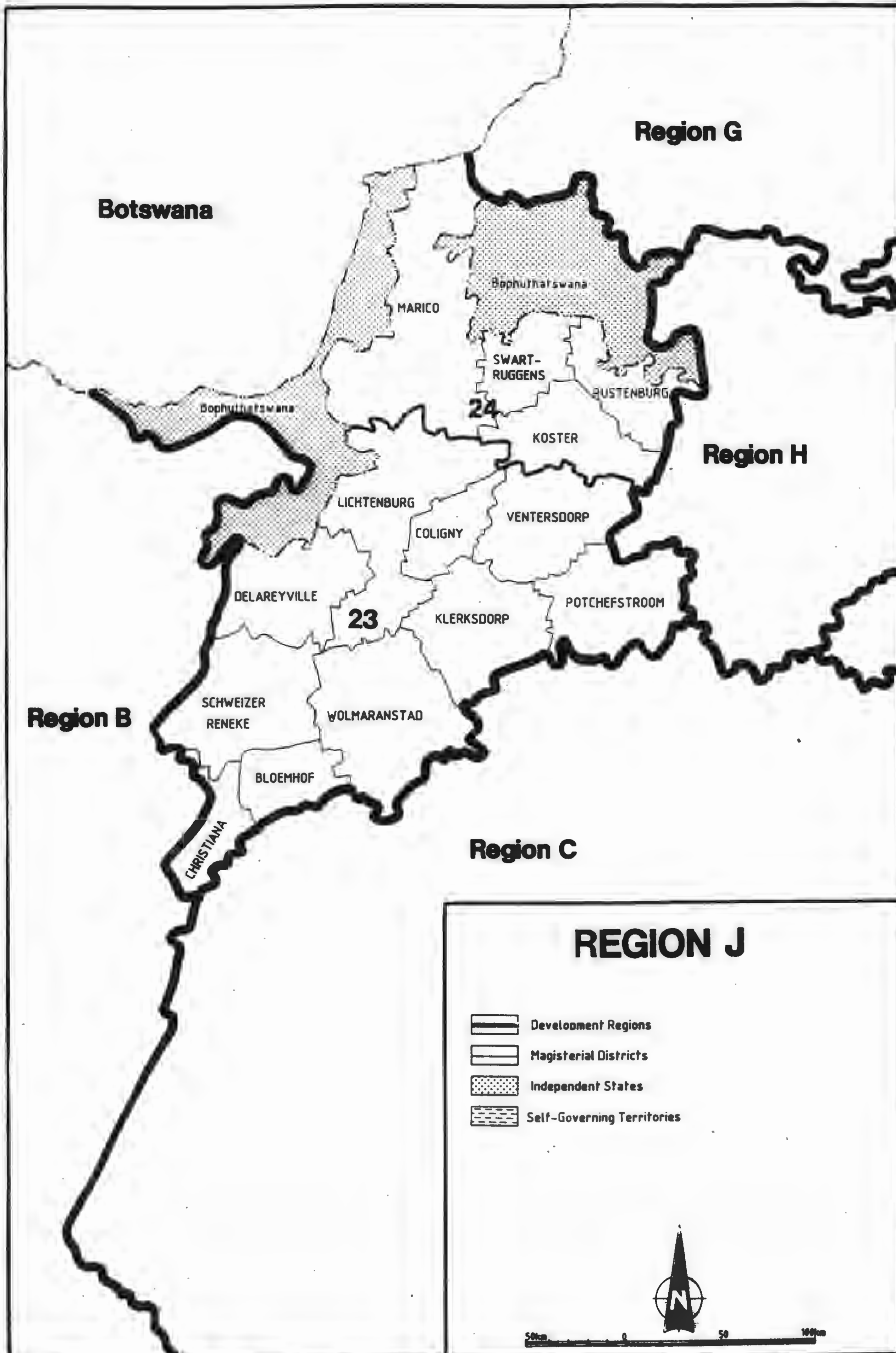
Moçambique
Swaziland
Region F
Region C
Lesotho
Region D
Kwazulu
PAUL-PIETERSBURG
UTRECHT
NEW-CASTLE
32
NGOTSHE
33
VRYHEID
UBOMBO
34
HLABISA
DANNHAUSER
GLENCOE
DUNDEE
KLIPRIVIER
BABANANGO
MJONJARENI
LOWER UMFOLOZI
37
ESCOURT
WEENEN
ESHOWE
KRANS-KOP
MTUNZINI
UMVOTI
35
MOOIRIVIER
NEW HANOVER
LIONS RIVER
LOWER TUGELA
MPENDLE
PIETER-MARITZ-BURG
UNDERBERG
CAMPER-DOWN
41
INANDA
RICHMOND
PINETOWN
INDIAN OCEAN
38
IXOPO
Transkei
MOUNT CURRIE
UMZINTO
ALFRED
PORT SHEP-STONE
36
REGION E
Development Regions
Magisterial Districts
Independent States
Self-Governing Territories
N
50KM
0
50
100



Region G
PILGRIM'S REST 1
PELGRIMS
REST 2
LYDENBURG
26
WITRIVIER
GROBLERSDAL
NELSPRUIT
BARBERTON
27
BELFAST
WATERVAL
BOVEN
Kangwane
Moçambique
MIDDELBURG
WITBANK
Region H
CAROLINA
Kangwane
BETHAL
28
HIGHVELD
RIDGE
ERMELO
Swaziland
BALFOUR
STANDERTON
AMERSFOORT
PIET RETIEF
WAKKERSTROOM
VOLKSRUST
Kwazulu
Region C
Region E
REGION F
Development Regions
Magisterial Districts
Independent States
Self-Governing Territories
Lesotho
N
50km
0
50
100km


REGION G
Development Regions
Magisterial Districts
Independent States
Self-Governing Territories
N
50km
0
50
100km
Zimbabwe
Moçambique
Botswana
MESSINA
SOUTPANSBERG
Venda
SOUTPANSBERG
POTGIETERSRUS
Lebowa
Lebowa
25
Gazankulu
Lebowa
ELLISRAS
PIETERSBURG
44
LETABA 1
WATERBERG
LETABA 2
PHALABORWA
THABAZIMBI
POTGIETERSRUS
Lebowa
Gazankulu
WARMBAD
Region J
Region H
Region F


Region G
Region J
Region F
Region C
Bophuthatswana
Bophuthatswana
MOUTSE 1
MOUTSE 2
MOUTSE 3
Kwandebele
WONDERBOOM
CULLINAN
BRITS
PRETORIA
42
BRONKHORSTSPRUIT
KRUGERSDORP
RANDBURG
KEMPTONPARK
BENONI
ROODEPOORT
RANDFONTEIN
GERMISTON
BOKSBURG
DELMAS
SPRINGS
JOHANNESBURG
OBERHOLZER
WESTONARIA
ALBERTON
BRAKPAN
NIGEL
VEREENIGING
HEIDELBERG
VANDERBIJLPARK
SASOLBURG
REGION H
Development Regions
Magisterial Districts
Independent States
Self-Governing Territories
N
25
50km



Region G
Botswana
Bophuthatswana
MARICO
SWART-
RUGGENS
RUSTENBURG
Bophuthatswana
24
KOSTER
Region H
LICHTENBURG
VENTERSDORP
COLIGNY
DELAREYVILLE
23
KLERKSDORP
POTCHEFSTROOM
SCHWEIZER
RENEKE
WOLMARANSTAD
Region B
BLOEMHOF
CHRISTIANA
Region C
REGION J
Development Regions
Magisterial Districts
Independent States
Self-Governing Territories
N
50km
0
50
100km