Chapter

3

Methodology for measuring the impact of changes in the economy on poverty

The micro-analysis model; the input-output model; poverty impact model

3.1   Introduction

A combination of three models is used for measuring the impact of development projects (positive) or negative factors on the extent and depth of poverty in Emfuleni. In the first part of this chapter, the model of measuring poverty on a micro-level at different periods of time is discussed. In the second part of this chapter, the compilation of an input-output table of the local economy is discussed. This model is then used to measure the impact of any positive or negative factor on the level of employment and household income in Emfuleni. In the third part of the third chapter, the model for measuring the impact of a change in the level of household income on the level and depth of poverty in Emfuleni is discussed.

3.2   A micro-analysis of poverty

A micro-analysis of poverty needs to describe the measuring of poverty at a household level by using different income-related criteria. Poverty is defined in absolute terms. However, the aim is not only to calculate the number of the poor, in other words, the extent of poverty, but also to determine how the poor are distributed below the minimum subsistence level, in other words, the magnitude of poverty.

The method of measuring poverty used in this chapter is similar to methods used by the World Bank and other institutions with research credibility. In Chapter 2, it was pointed out that a great deal of poverty research in the past

focused on criticising the different methods of measurement and describing their inadequacies at length. At the same time, little was done to trace the underlying causes of poverty and to design strategies to alleviate it. Although fact-finding, with the collection of basic information being fundamental to an analysis of the causes of poverty and for attempts to formulate solutions and to measure changes over time, it serves no purpose to carry on the debate on the different tools for measuring poverty *ad infinitum*. More emphasis should rather be placed on tracing the underlying causes of poverty and designing means and strategies to alleviate it (Wilson 1996a:20).

In this chapter, household incomes as well as a poverty line are defined. Income indicators of poverty such as the headcount index, poverty gap index, dependency ratio and the concept of dominance in conjunction with the distribution of household income are defined and adapted for the purpose of a micro-analysis of poverty.

3.2.1   A definition of poverty at household level

Conventional literature on poverty divides the foundations of the definitions of poverty into two approaches, namely, the relative approach and the absolute approach.

The <u>relative approach to poverty</u> is based on the idea that people are poor in relation to the community or society in which they live. This means that their income is consistently below the level that would allow them to attain a specific average standard of living. This is judged against the standard of living of the society they are part of. This approach is normally followed in the North where poverty is less problematic and generally a minority problem (Wratten 1995:12). Alcock (1993:59) sees the relative approach as a more subjective (normative) approach than the absolute approach. He explains that the relative definition of poverty is based upon a comparison between the standard of living of the poor and the standard of living of other members of society who are not poor. This usually involves some measure of the average living standard of the society in which poverty is being studied.

The absolute approach to poverty looks at it from the viewpoint of deprivation or the lack of sufficient income to satisfy basic needs. Unsatisfied needs, especially of a physiological nature, are seen as absolute poverty. Holman (1978:2) refers to such poverty as subsistence poverty or poverty below the subsistence level. He refers to the poor as those who have regular, though sparse income. The very poor are those whose income, for whatever reason, falls far below the subsistence level. The operative word in this approach is *income*. Income that consistently falls short of supporting the bare basic necessities of life is viewed as causing poverty.

The unconventional *human scale development (HSD) approach* defines poverty in far broader, holistic terms (Max-Neef *et al*. 1989:17-46). This approach makes a clear distinction between *needs* and *satisfiers* of those needs. Human needs are viewed as interrelated and interactive, and are classified into two categories: existential and axiological. By classifying needs into these categories, the interaction of the needs of being, having, doing, and interacting on the one hand, and the needs of subsistence, protection, affection, understanding, participation, idleness, creation, identity and freedom on the other hand, is demonstrated.

Food and shelter are not seen as needs, but as *satisfiers* of the need for subsistence. Education, either formal or informal, study, investigation and meditation are viewed as *satisfiers* of the need for understanding. The curative systems, preventative systems and health schemes in general are satisfiers of the need for protection.

A satisfier may contribute simultaneously to the satisfaction of different needs, or conversely, a need may require various satisfiers in order to be met. For example, a mother breast-feeding her baby is simultaneously satisfying the infant's need for subsistence and protection, affection and identity.

By drawing a distinction between the concepts of needs and satisfiers, Max-Neef *et al*. (1989:20) argue that fundamental human needs are finite, few and classifiable. Furthermore, fundamental human needs are the same in all cultures and in all historical periods. What changes is the way or the means to

satisfy these needs. Every social or political system adopts different methods to satisfy similar fundamental needs. In every system, fundamental human needs are satisfied (or not satisfied) through the generation (or non-generation) of different types of satisfiers.

Max-Neef *et al*. (1989:21) further argue that the traditional concept of poverty is limited and restricted, since it refers exclusively to the predicaments of people who may be classified below a certain income threshold. According to them, *any* fundamental human need that is not adequately satisfied reveals a human poverty. For example, the poverty of subsistence could be due to insufficient income, food, and shelter; the poverty of protection to bad health systems and violence; the poverty of affection to authoritarianism and oppression; the poverty of understanding to poor quality education; the poverty of participation to the marginalisation and discrimination of women, children and minorities; and the poverty of identity to the imposition of alien values upon local and regional cultures, forced migration and political exile.

Defining poverty in this context, Max-Neef *et al*. (1989:21) suggest that one should speak of *poverties* instead of *poverty*. Poverties, however, are not only just that, but much more in that each poverty generates pathologies. For example, extended unemployment generates pathologies that will totally upset a person's fundamental need system. Owing to subsistence problems, the person will feel increasingly unprotected; crises in the family and guilt feelings may destroy affections; lack of participation will give way to feelings of isolation and marginalisation; and, declining self-esteem may generate an identity crisis. In the same way, violence directly upsets the need for protection, thus inducing intense anxiety. Max-Neef *et al*. (1989:21) argue that pathologies may no longer be thought of as affecting individuals. The existence of collective pathologies of frustration, for which traditional treatments are simply inefficient, must be recognised.

In Africa, the majority of people actually fail to achieve a minimum acceptable material standard of living because of a lack of income (Wratten 1995:12). They actually fail in all *poverties*. This also applies to Southern Africa. The highest poverty rate is found in sub-Saharan Africa (Todaro 1994:145). For

this reason, the absolute approach, which focuses on subsistence concepts, plays a significant role in poverty investigations in Africa (Novak 1996:51).

It is for this reason that, at least as a start, this study follows the absolute approach in studying the poverty of subsistence in Emfuleni. By following this approach, people living in severe poverty can be identified. The extent of absolute poverty is then defined as the number of people living below a specified minimum level of income (Todaro 1994:145). This minimum level of income is normally expressed in terms of the amount of money needed to attain a certain minimum level of material subsistence. The minimum subsistence level in this argument is not viewed as a cut-off point to divide poor and non-poor households, but rather as a yardstick to measure different degrees of poverty. This, in addition, includes different degrees of urgency of the matter.

For the purpose of this study, poverty is defined as *the inability to attain a minimal material standard of living* (World Bank 1990a:26). To make this definition useful, three questions must be answered, namely:

- How do we measure the standard of living?

- What do we mean by a minimal standard of living?

- Having identified the poor, how do we express the overall severity of poverty in a single measure or index? (World Bank 1990a:26.)

The standard of living is usually expressed in terms of household income and expenditure which is an adequate yardstick. Because this measure does not capture dimensions of welfare such as health, life expectancy, literacy and access to public goods or common property resources, consumption-based poverty measures are usually supplemented with other non-income measures such as unemployment, education, urbanisation, housing, services, health, etc. These measures, however, are beyond the scope of this study.

The minimal standard of living is normally referred to as a poverty line. It is determined by the income necessary to buy a minimum standard of nutrition

and other basic necessities (World Bank 1990a:26). The cost of minimum adequate caloric intake and other necessities can be calculated by looking at prices of the food that make up the diet of the poor. A poverty line can therefore be calculated for a specific geographical area.

By comparing the total income or expenditure of a household with the calculated cost of the minimum adequate caloric intake and other necessities of the household, poor households can be distinguished from non-poor households. The simplest way to measure poverty is to express the number of poor as a proportion of the population. This is called the *headcount index* (World Bank 1990a:27).

Following the guidelines of the World Bank, a poor household can be defined *as a household of which the combined income of all its members is less than the calculated cost of the minimum adequate caloric intake and other necessities of the household.* In order to measure poverty at household level in Emfuleni according to this definition, household income and the poverty line is defined in the next two sections.

3.2.2   A definition of household income

Most of the quantitative measurements of poverty are based on income levels. This is evident in most works on the subject (Ringen 1985:99-111; Lewis & Ulph in Mokoena 1994:18). Beeghley (1984:325) argues that the value of "in-kind or cash benefits" should also be included in what is regarded as income. Omission of this would understate income and may have adverse effects on the measurements of poverty based on income.

The Central Economic Advisory Services (1986:16) included the following in its definition of income: Firstly, salaries, wages, overtime and commissions prior to the deduction of pensions and taxes; secondly, net profit from business, farming or professional practice; thirdly, estimated cash value of fringe benefits such as a company car and housing subsidy, food, clothing and accommodation provided by employers; and fourthly, any other regular income (pensions, interest, dividends, rent from boarders/lodgers).

Following roughly the same approach in this study, <u>income for the purpose of measuring poverty in Emfuleni</u> is defined as:

- *Salaries, wages, overtime and commissions after the deduction of pensions and taxes, in other words "take home pay";*

- *Net income from business, professional and informal activities;*

- *Estimated value of fringe benefits such as housing subsidy, food, clothing and accommodation provided by the employer;*

- *Any other regular income (pensions, interest, dividends, rent from boarders/lodgers, remittances etc).*

3.2.3   A definition of a poverty line

The poverty line shows the income level needed to provide a minimum subsistence level. Until 1973, the term Poverty Datum Line (PDL) was generally used to describe a theoretical minimum cost of living in South Africa. It was based on a calculation of the lowest possible cost of maintaining a person (household) in good health and decency by Western standards, but in the short run only (Potgieter 1980:11). Since 1973, in addition to the PDL, several other poverty lines were developed by different institutions. They are the Minimum Living Level (MLL) and the Minimum Humane Standard of Living (MHSL), by the Bureau of Market Research (Nel *et al*. 1973), the Household Subsistence Level (HSL) and the Household Effective Level (HEL) by Potgieter of the University of Port Elizabeth (Potgieter 1980).

 The PDL is used widely by sociologists, as well as by labour unions and employers in the determination of minimum wage levels. Lowest-cost, calorie-adequate and nutritionally-balanced food as well as such necessities as shelter, transport, clothing, fuel and lighting and cleaning materials are commonly used in such measures. The PDL is used mainly to measure absolute poverty, based on the ability of a person to afford basic needs with available income. The PDL was first introduced to South Africa during the Second World War to measure the extent of poverty in the growing townships and slums of the Western Cape (Wilson & Ramphele 1991:16). The PDL in

South Africa today encompasses different measurements, depending on different researchers and circumstances.

The Minimum Living Level (MLL) and the Minimum Humane Standard of Living (MHSL) are used by the Bureau of Market Research (Nel *et al*. 1973). The MLL is the minimum level at which "a Non-White family would be able to maintain the health of its members and conform with Western standards of decency". It includes the cost of items such as tax, medical expenses, education and household equipment in addition to the items included in the PDL (Wilson & Ramphele 1991:17). The MHS is a modest low-level standard of living index.

The Household Subsistence Level (HSL) and the Household Effective Level (HEL) were developed by Potgieter (1980). Potgieter (1980:4) defines the HSL as an estimate of the theoretical income needed by an individual household to maintain a defined minimum level of health and decency in the short term. The HSL is calculated at the lowest retail cost of a basket of necessities of adequate quality. This comprises the total food, clothing, fuel, lighting, and washing and cleaning materials required for each person, together with fuel, lighting and cleaning materials needed by the household as a whole, and the cost of rent and transport. A comparable calculation can thus be made for any household of any given size and composition.

The two most widely used poverty lines in South Africa today are the HSL and the MLL. The first reason for selecting the HSL as a poverty line for this study is because it is the only measure available for all the major centers in South Africa. Unlike the HSL, the MLL does not specify separate poverty lines for the urban and rural populations (May *et al*. 1995:7). The HSL is therefore the only poverty line with specific data regarding households of Emfuleni. (This data is also available for several years.)

The second reason is that the HSL has been the most frequently used measure in recent years (Whiteford *et al*. 1995:2; World Bank 1995:7; May *et al*. 1995; Carter & Posel 1995:7). This allows for meaningful comparisons.

The third reason is that the method of calculating the HSL as employed by Potgieter (1994:63), and the publication of the details, makes it possible to calculate a unique HSL for individual households. Potgieter gives a breakdown of the subsistence cost for different age groups of the different genders, as well as certain costs for a household as a whole (see Table 3.1). By calculating the HSL for an individual household, and comparing this figure with the combined income of the different members of the same household, the degree of poverty can be measured at micro-level or household level.

Table 3.1 below lists Potgieter's (2003:69) HSL calculations for households in Emfuleni for August 2003.

TABLE 3.1   CALCULATION OF THE MONTHLY HOUSEHOLD SUBSISTENCE LEVEL (HSL) FOR HOUSEHOLDS IN EMFULENI: AUGUST 2003

Household Subsistence Level (Rand)			
	Food	Clothing	Fuel, Light, Washing & Cleansing	Total
Children				
1-3 years	122.72	13.81	6.28	142.81
4-7 years	145.73	27.62	6.28	179.63
8-10 years	175.62	27.62	6.28	209.52
Boys & men				
11-14 years	206.16	41.42	6.28	253.86
15-18 years	232.49	55.82	6.28	294.59
19 + years	232.49	55.82	6.28	294.59
Girls & women				
11-14 years	199.43	41.42	6.28	247.13
15-18 years	199.43	55.23	6.28	260.94
19 + years	199.43	55.23	6.28	260.94
Housing			126.54	126.54
Household Fuel, Light, Washing & Cleaning materials:			295.74	295.74
Transport:			173.20	173.20

- SOURCE: Potgieter 2003:69.

The components of the HSL are limited to the short-term satisfaction of basic needs and make no provision for such essential requirements for decent living such as medical expenses, education, savings, hire purchases, holidays, reading materials, entertainment, recreation, insurance, purchases and replacements of household equipment, and incidental transport. This implies that there are other poverties as well - not only the "**material poverty of subsistence**" as argued by Max-Neef *et al*. (1989:21). The Max-Neef approach may be very helpful here in identifying and categorising the "other" poverties.

Potgieter (1980:7) maintains that although the HSL indicates the cost of a theoretical budget of necessities, it does not suggest an adequate income. In practice, one third of a total income equivalent to an HSL budget will be diverted from the specified items to other immediate essentials. In the case of the HSL, the income is not effective in enabling the household to maintain the standards of long-term health and decency. Potgieter (1980:7) therefore defines the Household Effective Level (HEL) of income, which is 150 per cent of the HSL.

3.2.4   The measurement of poverty

With the income of households and the poverty line (HSL) for households defined, the definition of a poor household (see Section 3.2.1) can now be adapted to read as follows: *A poor household is one in which the combined income of all its members is less than the HSL as determined for the specific household.* With a poor household defined, the number of poor households in Emfuleni can be calculated.

The candidate conducted several household surveys in Emfuleni, the last one being in July 2003. The questionnaire used in these surveys (see Annexure A) was constructed in a manner that income and expenditure information for both the household and the individual members of the household could be obtained.

The survey data gives the combined income of each individual household, as well as the age and gender of all household members. By allocating the

amounts suggested by the HSL to the different members, the HSL for each individual household can be determined. Comparing the combined income of a specific household with the HSL of the household, it can be determined whether the household is poor or not. Once the number of poor households has been determined, the different income indicators of poverty can be applied to analyse poverty in Emfuleni. The income indicators used in this study are the headcount index in conjunction with the poverty gap index, the dependency ratio and the concept of dominance in conjunction with the distribution of household income. All of these are adapted for the purpose of a micro-analysis in Emfuleni.

3.2.5   The headcount index and the poverty gap

The headcount index is defined as the *fraction of the population below the poverty line* (Deaton 1994:122). The purpose of the headcount index is therefore to quantify the number of those individuals or households that fall below the poverty line. If the distribution of incomes is represented by *y* and the poverty line by *z,* a poverty measure may be expressed by the function *P(y;z)*.

Suppose that in a population of *N* income units with incomes y_i *(i=1...N)* ranked in ascending order by subscript, *M* units have incomes equal to or less than *z,* then the headcount ratio (*H*) may be defined as follows (Borooah & McGregor 1991:359):

Headcount index:

$$H(y;z) = M / N$$

The headcount index, however, is a limited measure of poverty. It does not take into account the degree of poverty. In order to capture the degree (or magnitude) of poverty, the poverty gap measure is used in conjunction with the headcount index. The poverty gap measures the average shortfall of the income of the poor from the poverty line. Both the headcount index and the poverty gap measures were introduced by Sen (1981:24-34).

The headcount index is concerned with the number of the poor people or households whose incomes fall below a given poverty line as a ratio of the whole population. The poverty gap index is concerned with the depth of poverty (its magnitude) and therefore measures the extent of the shortfall of incomes below the poverty line.

The poverty gap ratio (*R*) can be described by the following equation from Borooah and McGregor (1991:359):

$$R(y;z) = \sum_{i=1}^{M} (z - y_i)/z$$

Where:

R = the mean income shortfall of the poor expressed as a proportion of the poverty line;

z = the poverty line;

y = the income of a household; and

M = the number of households with incomes below or equal to the poverty line (z).

However, measuring poverty amongst households where not all members are earning an income and where all members have to live from the combined income, makes the adaptation of this measure compulsory.

The size and composition of different households are totally different. This means that the income of households cannot be compared to an average poverty line. To overcome this to some extent, the total household income is divided by the number of household members to arrive at a household per capita income. The shortcoming of this method is that it does not take into account that children cost less to feed and clothe than adults. A poverty line for each household should be determined, based on the size and composition of the household. Some researchers, therefore, make use of Adult equivalent scales, as suggested by Deaton (in Whiteford & McGrath 1995:4). With this method the number of adult equivalents in each household

can be calculated. Total household income divided by the number of adult equivalents gives the household per adult equivalent income. Adult equivalent scales are calculated by the formula:

$$E = (A + \alpha K)^{\beta}$$

Where:

E =   number of adult equivalents;

A =   the number of adults;

α =   the "child fraction of adults";

K =   the number of children; and

β =   the economies of scale coefficient.

Whiteford and McGrath (1995:4), in their explanation of adult equivalents for households, use a generalised scale for developing countries as suggested by Deaton, where the value of 0.5 is attributed to α and 0.9 to β.

Although this method is an improvement when compared to *household per capita income*, a more accurate and simpler method can be applied by allocating the calculated amounts for different kinds of members of a household as determined by Potgieter (1994:63), as listed in Table 3.1.

Instead of only making a distinction between adults and children by using adult equivalent scales, Potgieter's method allocates appropriate amounts for men and women and boys and girls of different ages. The requirements for a child between 1 and 3 years are quite different from those for a child between 8 and 10 years (R142.81 versus R209.52 in Table 3.1). There are also differences between the different genders and ages. The HSL for an individual household can thus be calculated by allocating amounts for the different members of the household.

For example, a household consists of four members: A father, 34 years of age and working; a mother 30 years of age at home; a son aged 16 at school; a daughter aged 11 at school. The HSL calculated for the household from the information in Table 3.1 is as follows: R294.59 (father) + R260.94 (mother) +

R294.59 (boy) + 247.13 (girl) + R295.74 (fuel, light, washing & cleaning materials) + R126.59 (housing) + R173.2 (transport for working member) = R1,692.73.

The HSL for a household can be calculated and compared with its own total income with the information regarding the total income of a household, as well as the age and gender of its members available. The HSL not only determines whether the household is below the poverty line or not, but also how far below (or above) the household is with regard to its own poverty line. In this way, the poverty gap of an individual household is calculated. By calculating the same for all households of the survey sample, the total number of households below and above the poverty line and their distribution below and above the poverty line is determined.

3.2.6   The measurement of the poverty gap

Normally the poverty gap measures the average shortfall of the incomes of the poor from the poverty line. The poverty gap index measures the extent of the shortfall of incomes below the poverty line, that is, the difference between the poverty line and the mean income of the poor, expressed as a ratio of the poverty line (World Bank 1993a:15). The larger the value, the larger the gap between the poverty line and the mean income of the poor, indicating a larger depth in poverty. Instead of taking the difference between the poverty line and the mean income of the poor, a more accurate measure would be to calculate the poverty gap for each household individually. This is done by measuring the difference between a household's income and its own poverty line. To calculate the poverty gap ratio, the difference between the income and the poverty line of each household is expressed as a ratio of its own poverty line. The formula for calculating the poverty gap index for a specific household will then be:

$$R_i(y;z) = (z_i - y_i)/z_i$$

Where:

R_i = The income shortfall of a household expressed as a proportion of the households' poverty line;

y_i = the income of a specific household; and

z_i = the poverty line of a specific household.

The mean of all households' poverty gaps can be taken as the mean poverty gap for the population concerned. The mean poverty gap ratio of all households then gives the poverty gap ratio for the population concerned, expressed by the equation:

$$R_{i..n}(y;z) = \sum_{i=1}^{M}(z_{i..n} - y_{i..n})/z_{i..n}$$

Where:

$R_{i..n}$ = the mean of the poverty gap ratios of individual households;

$z_{i..n}$ = the individual poverty lines of households;

$y_{i..n}$ = the incomes of individual households; and

$M_{i..n}$ = the number of households with incomes below or equal to their poverty lines.

The mean of all individual poverty gap indexes will be the poverty gap index for the population concerned.

3.3   The input-output model

The model discussed in this section will be implemented to measure the impact of positive (e.g. the establishment of new industries) and negative (e.g. disinvestment) changes in the Emfuleni economy on employment and household income. Input-output modelling is based on internationally recognised econometric techniques. The result of an input-output modelling exercise is presented in the format of input-output tables. These tables are based on the national accounting system of a country. In South Africa, the main source for providing this information is Statistics South Africa (Stats SA).

3.3.1   Description of an input-output model

The input-output framework of analysis was developed by Leontief in the late 1920s and early 1930s. In the beginning, it was designed for application at a national level; subsequent developments have extended it to the regional level (Miller 1998:42). The first official input-output table in South Africa was compiled in 1956-1957 to serve as a basis for the Economic Development Plan (CSS 1978:18).

The input-output model depicts economic linkages that exist within and between different components of an economy. This approach identifies monetary flows (expenditures and receipts) between various units (Khun & Jansen 1997), and focuses on the interdependence of different sectors of economic activities.

The fundamental notion of an input-output table is that the production of any output requires inputs. These inputs may take the form of raw materials or semi-manufactured goods, or inputs of services supplied by households or the government (Armstrong & Taylor 2000).

There are four quadrants in an input-output table, shown in Table 3.2.

TABLE 3.2   FEATURES OF AN INPUT-OUTPUT TABLE

QUADRANT 1 Intermediate Inputs	QUADRANT 2 Final Demand
QUADRANT 3 Primary inputs	QUADRANT 4 Primary Inputs directly to Final Demand

- Source: CSS 1978:15 (simplified).

The contents of each quadrant, as discussed in Central Statistical Services (CSS 1978:12, 13) is explained below.

Quadrant 1 is referred to as the transactions table, which contains the transfer of goods and services between different sectors for production purposes. They are referred to as "intermediate inputs".

Quadrant 2 shows the different "final demand" components: private consumption expenditure, government consumption expenditure, gross domestic fixed investment, change in inventories and total exports.

Quadrant 3 represents the demand for "primary inputs" by the productive sector: imports, remuneration (salaries and wages which can also be divided into categories or social classes depending on the analyst's objectives on income distribution analysis), gross operating surplus (savings and depreciation), as well as net indirect taxes (subsidies are subtracted).

Quadrant 4 shows the portion of "receipts by primary inputs", which is part of final demand. For example, part of income can be dispatched as dividend and interest, salaries to households for private consumption, investment expenditure, government transfer (e.g. pension) and transfer to the rest of the world.

Input-output tables show the production function of a specific geographic area in terms of the value of transactions that have taken place between different sectors and sub-sectors in the economy. It also takes into account imports and exports to and from the specific geographic area. The classical input-output model therefore provides a framework that illustrates inter-industrial linkages and economic interdependencies (Urban Econ 1998:117).

The input-output technique provides a snapshot of economic production at a given point in time and, as such, has numerous application possibilities. An application of this technique includes determining the impact of changing production functions on the general economic equilibrium. It is imperative that the results of the model be interpreted in the correct context and that cognisance be taken of its constraints, as is the case with almost any

modelling exercise. The most important constraints and assumptions of this technique are briefly outlined below (Urban Econ 1998:77,78).

- Classical input-output modelling provides a view of the economy in equilibrium at a specific instant in time and it therefore assumes fixed output production and pricing.

- Calculations are linear in two respects, firstly in terms of pricing and secondly in terms of production. Therefore, input-output modelling assumes that the output price will be directly proportional to demand, allowing for no economics of scale and other externalities. Similarly, production functions (the mix of inputs relative to outputs) are fixed for all output ranges.

- Input-output tables are sophisticated, costly and have extensive data requirements. The results are therefore dependent on data availability and quality.

- The model does not anticipate structural economic changes such as, for example, the impact of substitute products and technological innovation.

In spite of the limitations of input-output modelling, it is an empirical, internationally recognised econometric technique that has been widely applied in South Africa (Urban Econ 1998:117). The construction of an input-output transactions table for a regional economy is not confined to describing the input-output flows only. Once the interdependencies between sectors have been quantified, it is possible to estimate the effect of any change in the final demand on the entire system (Miller 1998:42). In this thesis, it will primarily be used to describe different economic transactions (intra-industry or inter-industry) which take place within the region; between Emfuleni and other regions (in and outside the RSA); and to provide a model to measure the (direct and indirect) impact of any change in the final demand for Emfuleni's outputs on the level of household income and employment in Emfuleni.

3.3.2   Methodology

An input-output table of a region is a very useful instrument to indicate the degree of interdependence of local industries, the dependence of the local economy on imports and the role played by exports. It depicts the flow of goods within, out of and into the economy and it has the potential to do so on a highly aggregated basis, by type of industry (Slabbert & Slabbert 1983:5).

As discussed in Slabbert and Slabbert (1983:5), the input-output table divides the economy into production sectors. For each of these sectors, the table lists the inputs by their source and the outputs by their destination. Each sector appears twice, as a column with its input pattern (purchases from other sectors) and as a row with its output pattern (sales to other sectors). More precisely, a row in the regional input-output table shows the distribution of the output (in Rand value at producer prices) of a particular local industrial sector listed at the left side of the row, in relation to:

- Every other sector in the same region or to local intermediate demand (part of the inter-sectoral matrix);

- Exports of the region;

- Direct domestic consumption and investment demand, i.e. to final demand.

Reading down a column in a regional input-output table yields the material inputs (in Rand values at producer prices) into the local industrial sector listed at the head of the column:

- For every sector in the same region (part of the inter-sectoral matrix);

- From outside the region as imports, as well as the labour, capital and other value-added inputs.

An input-output table identifies in Quadrant 1 the inter-sectoral matrix which is indicative of the degree of local industrial interdependence; in Quadrant 2 the consumption pattern of the locally-produced goods and services as well as

the export pattern of the region; and in Quadrant 3, the income accruing to the local factors of production (e.g. the households for their labour) for their participation in the local productive activity, as well as the import pattern of the region (Slabbert & Slabbert 1983:5).

It is clear that the input-output table is an excellent device for describing the flow of goods in the regional economy. However, in addition to its descriptive function, it also offers analytical qualities and can serve as an economic model for the region. The cornerstone for such a model is the technological relationship that the sales of any sector to any other sector depend, via an assumed linear and constant production function, on the level of output of the purchasing sector. A skeletal input-output table (Table 3.3) will illustrate this technical relationship (Slabbert & Slabbert 1983:5).

TABLE 3.3   A SKELETAL INPUT-OUTPUT TABLE

Input \ Output	1	2	3	Final Demand minus export	Export	Gross output
1	X_{11}	X_{12}	X_{13}	Y_1	E_1	X_1
2	X_{21}	X_{22}	X_{23}	Y_2	E_2	X_2
3	X_{31}	X_{32}	X_{33}	Y_3	E_3	X_3
Value added	V_1	V_2	V_3			
Import	I_1	I_2	I_3			
Gross outlay	X_1	X_2	X_3			

- Source: Slabbert & Slabbert 1983:6.

Where:

X_i = the gross output or outlay of sector i;

X_{ij} = the intermediate sales of sector i to sector j from sector i;

Y_i = the sales of sector i to final demand (direct consumption and investment);

E_i = the sales of sector i to export;

V_i = value added in sector i by the local factors of production which in this

context stands mainly for household income;

I_i = purchases of sector i from import.

The following equations can be drawn up from the skeletal input-output table:

$$X_1 = \boxed{X_{11} + X_{12} + X_{13}} + Y_1 + E_1$$
$$X_2 = \boxed{X_{21} + X_{22} + X_{23}} + Y_2 + E_2$$
$$X_3 = \boxed{X_{31} + X_{32} + X_{33}} + Y_3 + E_3$$

Intermediate sales or inter-industry

What sector 1 sells to sectors 1,2, and 3 depends on the level of output of the purchasing sectors 1,2 and 3 (Slabbert & Slabbert 1983:7):

$$X_{11} = a_{11} x_1$$
$$X_{12} = a_{12} x_2$$
$$X_{13} = a_{13} x_3$$

Where: $a_{11} = \dfrac{x_{11}}{x_1}$; $a_{12} = \dfrac{x_{12}}{x_2}$; $a_{13} = \dfrac{x_{13}}{x_3}$

In the above equation a_{11}, a_{12} and a_{13} or more generally a_{ij} are called the direct input coefficients. In a *n* sector model of a region they represent the direct requirements of the product of any local sector i per unit of output of any other local purchasing sector j and they form the direct input coefficient matrix or technical matrix, as illustrated in Table 3.4 below (Slabbert & Slabbert 1983:7).

TABLE 3.4   DIRECT INPUT COEFFICIENT MATRIX

Output / Input	1	2	3
1	a_{11}	a_{12}	a_{13}
2	a_{21}	a_{22}	a_{23}
3	a_{31}	a_{32}	a_{33}

- Source: Slabbert & Slabbert 1983:7.

One of the important analytical uses of a regional input-output table is to measure the effect or impact of a change in the final demand for a locally produced good, or a change in the output of a local sector on the total output of the region (Miller 1998:42). The direct input coefficients enable measurement of the direct or first effect: how much additional output is

needed from all the local sectors as a result of an increase of R1.00 in the output of a particular sector. The direct input coefficients measure the effect on the industries delivering direct inputs to the expanding sector.

Referring to the skeleton input-output table and its technical coefficients matrix (Table 3.3 and Table 3.4): If the output of sector 2 increases by R1.00, then a_{12} indicates the direct input needed by sector 2 from sector 1, a_{22} the direct input needed from sector 2 and a_{32} the direct input needed from sector 3. An increase of R1.00 in the output of a local sector also produces an indirect effect: the industries delivering direct inputs to the expanding sector experience in turn an increase in their output and thus require additional inputs.

Measuring the direct and indirect effect of a change in the final demand for a locally-produced good or a change in the output of a local sector on the total output of a region can be done by calculating the Leontief-inverse of the matrix of direct input coefficients a_{ij} (Richardson 1972:26-30). Each direct and indirect input coefficient b_{ij} of the Leontief-inverse matrix measures the direct and indirect requirements of products from each local sector listed at the left hand side per Rand additional output of the local sector at the top.

TABLE 3.5   LEONTIEF INVERSE MATRIX

Output�ळ Input	1	2	3
1 2 3	b_{11} b_{21} b_{31}	b_{12} b_{22} b_{32}	b_{13} b_{23} b_{33}
Sectoral Output Multiplier	$\sum_{j=1}^{3} bj1$	$\sum_{j=1}^{3} bj2$	$\sum_{j=1}^{3} bj3$

- Source: Slabbert & Slabbert 1983:8.

By summing all entries in the Leontief-inverse, in the column of a particular sector, the <u>output multiplier</u> of this particular sector can be derived. It measures the direct and indirect input requirements needed from all the sectors in the local economy by a particular local sector due to an increase of R1.00 in the output of that local sector.

From the input-output table and its technical matrices also employment, remuneration, GGP income, etc. multipliers can be derived, which indicate the effect of a change in final demand on the level of employment, remuneration (household income), GGP income, etc.

3.3.3   The Vaal Triangle input-output table

As outlined in Section 3.3.1, the input-output model is considered as a suitable technique to conduct a sectoral analysis of the economy and identify the key economic sectors. Money-values that were given to economic variables are based on the information available up to the time of publication. The utmost care has been taken to use the most relevant up-to-date information. A regional input-output table (1993 figures) was constructed for the Vaal region by VAALMET Consortium (1995). In 2002 this table was updated to 2000 figures (Slabbert 2002a:104-109).

Different sources of information have been consulted to estimate and update the information. These sources include VAALMET estimates, Vaal Research Group reports, as well as Gross Geographic Product figures for the Vaal Triangle. These sources have some limitations, which may impact on the accuracy of the figures. One of the main shortcomings is the lack of reconciliation of data between different sources for the same variable or economic activity. As the economies of Emfuleni and Metsimaholo, which together form the Vaal region or Vaal Triangle, are interwoven, it is not possible, nor desirable, to construct an input-output table for Emfuleni alone. Apart from that, no data is available to construct a separate input-output table for Emfuleni. From this updated input-output table for the Vaal region, the different multipliers are derived, which indicate the effect of a change in local final demand on the local level of employment, remuneration (household income), GGP income, etc. (see Table 7.8).

3.4   The poverty impact model

The poverty impact model described in this section was developed by the candidate. It is based on the assumption that a change in final demand for the

output of a region will, via the multiplier process, have an impact on the level of income of all households in the region. An increase in the demand for steel will, for example, increase the number of inputs required to produce the steel. Depending on the forward and backward linkages to the different sectors of the economy, other sectors of the economy will be influenced in such a way that employment and household income will increase until the multiplier is worked out. An increase in the final demand for steel will thus increase the household income in the economy by a certain percentage.

The increase of household income in a region by a certain percentage will impact both on the magnitude and extent of poverty. Some households, of which their respective incomes were less than their respective poverty lines, will, by the increase of their household income, now receive an income above their poverty line. These households will no longer be reckoned as poor, and this will effect the headcount index. Other households' income will still be less than their respective poverty lines, but the increase of their income will have the effect that their respective poverty gaps are decreased, and this will affect the poverty gap measure.

The model

Following the guidelines of the World Bank (as described in section 3.2.1), a poor household is defined as a household of which the combined income of all its members is less than the HSL as determined for the specific household. If the combined income of a household is described by y_i and the poverty line (HSL) of the same household is described by z_i, the extent of poverty, P_i, of this household is described by $P_i(y_i; z_i)$.

The headcount index is defined as the fraction of the population below the poverty line (Section 3.2.5). In this thesis, the headcount index was adapted to indicate the fraction of households that fall below their individual poverty lines, and is described by means of the equation:

$$H(y; z) = M / N$$

Where: $H =$ the fraction of households below the poverty line;

y = household income;

z = the poverty line of households;

M = the number of households with incomes less than z;

N = the total number of households.

It was previously mentioned that the poverty gap measures the average shortfall of the incomes of the poor from the poverty line while the poverty gap index measures the extent of the shortfall of incomes below the poverty line. In Section 3.2.6 the poverty gap index was adapted to be a measure of a specific household, described by the equation:

$$R_i(y; z) = (z_i - y_i)/z_i$$

Where: R_i = the income shortfall of a household expressed as a proportion of the household's poverty line;

y_i = the income of a specific household; and

z_i = the poverty line of a specific household.

The poverty gap of an individual household (in monetary terms) can therefore be expressed by the equation:

$$G_i(y; z) = z_i - y_i$$

Where: G_i = the income shortfall of a specific household;

y_i = the income of a specific household; and

z_i = the poverty line of a specific household.

From the three equations above, it is clear that the poverty gap will be influenced by an increase or decrease in household income.

An increase or decrease in the final demand for a region's output will influence the level of household income in a region by a certain percentage (or fraction) via the multiplier process. Projects initiated in the region will thus affect the level of employment and household income, which in turn will supplement the existing income of households to such an extent that the

headcount index for the population is decreased. On the other hand, disinvestments or closures of firms will increase the headcount index as well as the poverty gap.

If the income of a household is described by y_i and the poverty line (HSL) of a household by z_i and the fraction by which the average household income level is increased or decreased (e.g. 10% = 1.1 or -20% = 0.8) by f, then the poverty gap of the household will be influenced by a change in the final demand for a region's output as follows:

$$G_i(y;z) = z_i - (y_i.f)$$

Where: $G_i =$ the poverty gap of a single household;

$z_i =$ the poverty line of the household;

$y_i =$ the income of the household; and

$f =$ the factor by which household income is increased or decreased

The condition for reducing the headcount index is that the poverty gap of a household or households becomes zero or negative. This condition is described by the following equation:

$$G_i(y;z) = z_i - (y_i.f) \leq 0$$

Where: $G_i =$ the poverty gap of a single household;

$z_i =$ the poverty line of the household;

$y_i =$ the income of the household; and

$f =$ the factor by which household income is increased or decreased

The larger the number of households satisfying this condition because of the change in final demand, the smaller the headcount index becomes.

Projects implemented in the region (or disinvestment / closure of firms) resulting in an increase (or decrease) in the final demand for the region's

output will affect the extent of poverty, because it will increase (or decrease) the poverty gap. However, for sustainable development, the summation of all effects should reduce the headcount index as well as the poverty gap. The extent to which the headcount index is reduced, as well as the extent to which the poverty gap is reduced, will determine the degree of sustainability of the economy, taking into account all positive and negative factors.

3.5   Summary and conclusion

Three different models were developed and employed to finally measure the impact of change in the Emfuleni economy on its sustainability as defined above.

The first model measured both the extent and depth of poverty. Poverty is measured at a household level by calculating an individual poverty line (Household Subsistence Level) for each household. The amounts allocated for each member of the household depend on the age and gender of a household member. Once the poverty line for a household has been determined, the total household income for a household can be calculated and compared to the poverty line for the household. The headcount index, which was defined as the *fraction of the population below the poverty line,* is then calculated. The purpose of the headcount index is to quantify the number of those individuals or households that fall below the poverty line.

The depth of poverty is measured by the poverty gap measure, in conjunction with the headcount index. The poverty gap measures the average shortfall of the income of the poor from the poverty line. Whereas the headcount index is concerned with the number of the poor people or households whose incomes fall below a given poverty line as a ratio of the whole population, the poverty gap measures the average shortfall of the incomes of the poor from the poverty line.

The poverty gap index measures the extent of the shortfall of incomes below the poverty line, that is, the difference between the poverty line and the mean income of the poor, expressed as a ratio of the poverty line. The larger the va-

lue, the larger the gap between the poverty line and the mean income of the poor, indicating a larger depth in poverty.

Instead of taking the difference between the poverty line and the mean income of the poor, a more accurate measure is followed by calculating the poverty gap for each household individually. This is done by measuring the difference between a household's income and its own poverty line. To calculate the poverty gap ratio, the difference between the income and the poverty line of each household is expressed as a ratio of its own poverty line. The mean of all households' poverty gaps can be taken as the mean poverty gap for the population concerned.

The second model, an input-output model of the Vaal economy, measures the effect of endogenous and exogenous changes in the economy on the level of household income and employment. The input-output model depicts economic linkages that exist within and between different components of the economy. This approach identifies monetary flows (expenditures and receipts) between various units and focuses on the interdependence of different sectors of economic activities.

Input-output tables show the production function of a specific geographic area in terms of the value of transactions that have taken place between different sectors and sub-sectors in the economy. It also takes into account imports and exports to and from the specific geographic area. The classical input-output model therefore provides a framework that illustrates inter-industrial linkages and economic interdependencies.

The input-output technique provides a snapshot of economic production at a given point in time and, as such, has numerous application possibilities. An application of this technique includes determining the impact of changing production functions on the general economic equilibrium. In order to do this, sectoral linkages and sectoral multipliers for the Vaal economy were calculated, which are used to identify the key economic sectors. These are sectors which, if stimulated, have the greatest impact on the level of

household income and employment in the region – and consequently also on poverty.

The last model measures the impact of a change in household income on the extent and depth of poverty. The degree in which proposed local economic development projects decrease the magnitude and extent of poverty determines the degree of sustainability of the economy.

The impact of employment creation or an increase in household income on poverty levels can be measured with the aid of a model that incorporates the headcount index method and the poverty gap methods. Employment creation may, for example, supplement the existing income of households to such an extent that the headcount index for the population is decreased significantly.

An employment creation scheme aimed at the unemployed poor will have an immediate effect on the extent of poverty, because it reduces the poverty gap. However, to have a significant effect, it should also reduce the headcount index. The extent to which the headcount index is reduced will indicate the success of an employment creation programme. The condition for reducing the headcount index is that the poverty gap of a household or households becomes zero or negative. The larger the number of households satisfying this condition, the smaller the headcount index becomes.

.