DETERMINING A METHOD TO MEASURE THE CAPITAL INTENSITY FOR ENTERPRISES LISTED IN THE INDUSTRIAL SECTOR OF THE JOHANNESBURG STOCK EXCHANGE FOR THE PERIOD 1989 TO 1996

By

Petrus Daniël Erasmus

Assignment presented in partial fulfilment of the requirements for the degree of Master of Commerce at the University of Stellenbosch.

Study Leaders: Prof. I.J. Lambrechts
Prof. N.J. le Roux

Stellenbosch
March 2001

DECLARATION

I, the undersigned, hereby declare that the work contained in this assignment is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

P.D. Erasmus

ABSTRACT

A definite need exists for a measure which can be used to determine the degree of capital intensity of an enterprise. One of the main reasons why it is important to determine if an enterprise is capital or labour intensive is that the two types of enterprises react to changes in the economic environment in different ways. Some changes in the economic factors will have a totally different effect on a capital intensive enterprise than they would have on a labour intensive one. The degree of capital intensity of an enterprise can therefore be used to predict how it will react to economic changes, and it is therefore a valuable source of information for financial decision-making.

The measurement of capital intensity, however, presents a major problem. A large number of different measures have been developed and used in the literature. These measures include the measures of total assets to revenue; property, plant and equipment to revenue; property, plant and equipment to total assets; depreciation as a percentage of revenue; as well as property, plant and equipment per employee. A number of measures are also based on value added figures, and these include salaries to revenue; value added per employee; property, plant and equipment to value added; and salaries to value added. In the literature most researchers provide no or little justification for their preferred measure of capital intensity.

The main objective of the study is to determine an appropriate method to measure capital intensity. For this purpose the above-mentioned measures, which are generally used to determine capital intensity, are considered critically and evaluated by classifying enterprises listed in the Industrial Sector of the Johannesburg Stock Exchange during the period 1989 to 1996. During this period the South African economy experienced a decline, followed by an upswing in the economic cycle.

Principal component analyses (PCA) are used to analyse the data. These analyses are carried out for each year separately as well as for the period as a whole. Biplots are used to provide a multidimensional graphic representation of the results.

The results indicate that the five traditional measures of capital intensity which are not based on value added figures are all suitable to use as measures of capital intensity. Only one of the measures based on value added figures, however, are able to indicate capital intensity. The five traditional measures of capital intensity which are not based on value added figures, as well as the measure property, plant and equipment to value added, are therefore included in the principal component analyses. The principal component scores obtained from the first principal component are proposed as a composite measure of capital intensity. These principal component scores represent a linear combination of the six measures of capital intensity. The relative contributions of the various measures to this composite measure are also investigated, and it is found that all six the measures provide an important contribution. The results indicate that a number of enterprises listed in the Stores and Food sectors are relatively less capital intensive, while enterprises listed in the Building and Construction, Engineering, Steel and Allied, and Electronics sectors are relatively capital intensive. A visual evaluation of the results indicates that the proposed method is able to distinguish between capital and less capital intensive enterprises.

The results of the study provide researchers with a more efficient way of measuring capital intensity, and can be used to provide more information about the effect of changes in the economic cycle on the expected financial performance of enterprises.

SAMEVATTING

'n Duidelike behoefte bestaan vir 'n maatstaf wat gebruik kan word om die kapitaalintensiteit van 'n onderneming te bepaal. Een van die vernaamste redes waarom dit belangrik is om te bepaal of 'n onderneming kapitaal- of arbeidsintensief is, is die verskillende wyses waarop die twee tipes ondernemings gedurende 'n verandering in die ekonomiese siklus reageer. Sommige veranderinge in die ekonomiese faktore sal die teenoorgestelde effek op 'n kapitaalintensiewe onderneming hê as wat dit op 'n arbeidsintensiewe onderneming mag hê. 'n Onderneming se graad van kapitaalintensiteit kan dus gebruik word om te voorspel hoe die onderneming op ekonomiese veranderinge sal reageer, en is dus 'n belangrike bron van inligting by finansiële besluitneming.

Die meting van kapitaalintensiteit is egter 'n belangrike probleem. 'n Groot aantal verskillende maatstawwe van kapitaalintensiteit is ontwikkel en word algemeen in die literatuur gebruik. Hierdie maatstawwe sluit totale bates tot inkomste; eiendom, aanleg en toerusting tot inkomste; eiendom, aanleg en toerusting tot totale bates; depresiasie as 'n persentasie van inkomste; asook eiendom, aanleg en toerusting tot aantal werknemers in. 'n Aantal maatstawwe wat op waarde toegevoeg gebaseer is, is ook ontwikkel, en sluit die maatstawwe salarisse tot inkomste; waarde toegevoeg per werknemer; eiendom, aanleg en toerusting tot waarde toegevoeg; asook salarisse tot waarde toegevoeg in. In die literatuur verskaf die meeste navorsers min of geen motivering vir die spesifieke maatstaf wat hul voorkeur geniet nie.

Die primêre doelstelling van die studie is om 'n geskikte metode te vind om kapitaalintensiteit te meet. Ten einde hierdie doelstelling te bereik, word die bogenoemde maatstawwe, wat algemeen gebruik word as maatstawwe van kapitaalintensiteit, krities ondersoek en geëvalueer deur ondernemings wat genoteer is in die Industriële Sektor van die Johannesburgse Aandelebeurs gedurende die periode 1989 tot 1996 te klassifiseer. Gedurende hierdie periode het die Suid-Afrikaanse ekonomie 'n afname, gevolg deur 'n opswaai in die ekonomiese siklus beleef.

Hoofkomponent analises word gebruik om die verskillende maatstawwe te evalueer. Die analises word individueel uitgevoer vir elke jaar, sowel as vir die periode as 'n geheel. Bi-stippings word gebruik om 'n meerdimensionele grafiese voorstelling van die resultate te verskaf.

Die resultate toon dat die vyf tradisionele maatstawwe van kapitaalintensiteit wat nie op waarde toegevoeg gebaseer is nie almal geskik is om as maatstawwe van kapitaalintensiteit gebruik te word. Slegs een van die maatstawwe wat op waarde toegevoeg gebaseer is, is egter in staat om kapitaalintensiteit aan te toon. Die vyf tradisionele maatstawwe van kapitaalintensiteit, sowel as die maatstaf eiendom, aanleg en toerusting tot waarde toegevoeg, word derhalwe ingesluit in die hoofkomponent analises, en die hoofkomponenttellings wat verkry word uit die eerste hoofkomponent word as 'n saamgestelde maatstaf van kapitaalintensiteit voorgestel. Hierdie hoofkomponenttellings verteenwoordig 'n liniëre kombinasie van die ses maatstawwe van kapitaalintensiteit. Die relatiewe bydraes van die verskillende maatstawwe tot die saamgestelde maatstaf word ook ondersoek. Die resultate dui aan dat 'n aantal ondernemings wat in die Winkels en Voedsel sektore genoteer is relatief minder kapitaalintensief is, terwyl ondernemings wat in die Boubedryf, Ingenieurswese, Staal en Bedrywe, asook die Elektronika sektore genoteer is, relatief kapitaalintensief is. 'n Visuele evaluasie van die resultate toon aan dat die voorgestelde maatstaf in staat is om tussen kapitaalintensiewe en minder kapitaalintensiewe ondernemings te onderskei.

Die resultate van die studie stel navorsers in staat om 'n meer effektiewe meting van kapitaalintensiteit te verkry, en kan ook meer inligting verskaf oor die invloed van veranderinge in die ekonomiese siklus op die verwagte finansiële prestasie van ondernemings.

DEDICATION

This assignment is dedicated to my parents

Klaas and Lizette Erasmus

ACKNOWLEDGEMENTS

Prof. I.J. Lambrechts, my study leader, for his continued support and guidance throughout the completion of the study.

Prof. N.J. le Roux, my study leader, for his assistance with the statistical analysis and his willingness to assist me at all times.

Miss Sugnet Gardner, for assisting with the statistical analysis.

Prof. W.D. Hamman of the University of Stellenbosch Graduate School of Business, for providing the value added data.

My Heavenly Father, for His grace, and the power to complete the study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Background to the study

The ability to predict its future financial performance is indispensable for any enterprise. External financial analysts, the financial managers of an enterprise, and the potential and existing shareholders of an enterprise would all benefit from being able to determine in advance how an enterprise is expected to react to changes in its economic environment. It is therefore logical that most of the research conducted in the field of financial management endeavours to develop measures to explain the effect of a changing environment on enterprises and to improve the quality of financial decision-making and management of the enterprise.

Traditionally an enterprise's degree of capital intensity has not been considered to be an important indicator of the enterprise's expected future financial performance. Other financial measures for instance, the enterprise's earnings per share, the price-earnings ratio, or the dividend and earnings yield were normally used as indicators of an enterprise's expected financial performance. However, in a study by Bloom, Lambrechts and Le Roux (1998) it was found that the ability to differentiate between capital and labour intensive enterprises has specific consequences for predicting the expected financial performance of the two types of enterprises. It was found that capital intensive enterprises reacted differently than labour intensive enterprises during changes in the economic cycle. While some changes in the economic environment may negatively influence a capital intensive enterprise, the same changes may have no or much less of an adverse effect on a labour intensive enterprise.

If it is therefore possible to distinguish between capital and labour intensive enterprises the distinction may be used to anticipate how, and to some extent when, the enterprises will react to changes in their environment. This in turn could lead to an improvement in the quality of financial decision-making. It was furthermore found that in some cases the two types of enterprises were able to provide indications of a change in the economic cycle before the change actually occurred. In other cases certain enterprises would outperform the market even after the change had already occurred (Bloom, Lambrechts and Le Roux, 2001).

To be able to distinguish between capital and labour intensive enterprises, however, some measure of an enterprise's degree of capital intensity is needed. A large number of different measures of capital intensity have been developed and used in the literature. The measurement of capital intensity, however, presents a major problem. In the literature most researchers provide little or no motivation and justification of their preferred measure of capital intensity at all. Furthermore, relatively little research has been conducted to determine which measure or combination of measures provides the most accurate indication of an enterprise's degree of capital intensity. In most cases researchers also tend to use only one or two measures of capital intensity when classifying an enterprise according to its degree of capital intensity. Most of the measures of capital intensity which were developed focus only on one aspect of the enterprise being investigated. Capital intensity, however, is not a one-dimensional aspect. A large number of different factors influence the degree of capital intensity of an enterprise. By focusing on only one specific measure of capital intensity, it is therefore possible to obtain an inaccurate indication of an enterprise's true degree of capital intensity. Furthermore, there is no objective external classification of the degree of capital intensity of enterprises in South Africa. It is therefore not possible to determine exactly how efficient a specific measure is in determining capital intensity by comparing it to another classification.

The differences in the behaviour of the two types of enterprises during changes in the economic cycle can partly be explained by the differences in their physical and financial

structures. In the case of a capital intensive enterprise large amounts of capital are normally invested in property, plant and equipment (PPE), and relatively little labour is required. This large investment in PPE exposes the enterprise to a number of risks. Certain changes in the economic cycle could have a negative effect on the financial performance of this type of enterprise. Changes in the interest rate, rate of inflation and the availability of capital could all have a greater negative effect on capital intensive enterprises than on labour intensive enterprises. An increase in interest rates usually results in an increase in an enterprise's cost of capital. This may have a negative effect on profitability in the case of a capital intensive enterprise, where the largest percentage of the capital is invested in PPE. However, in the case of labour intensive enterprises, large amounts of capital are usually invested in current assets, and labour intensive enterprises would therefore also be adversely affected by increases in interest rates. During periods where high inflation rates are experienced, a capital intensive enterprise needs to ensure that provision is made for the increased replacement value of its assets. Capital intensive enterprises are usually very dependent on production processes which require a relatively large amount of PPE. It is therefore necessary to invest large amounts of capital in PPE to ensure that the enterprise can continue its operations. If only a limited amount of capital is available for investment purposes, capital intensive enterprises may find it difficult to obtain sufficient capital to meet their capital requirements. A shortage of capital available usually means that the enterprise may have to pay substantially more to get the limited amount of capital which is available, or that in extreme circumstances it may not be able to obtain the capital that it needs at all.

Labour intensive enterprises, on the other hand, are usually less dependent on PPE and use relatively more labour in their production processes. These types of enterprises are therefore not affected to the same extent as capital intensive enterprises by the changes mentioned in the previous paragraph. However, changes in some other factors may negatively influence these types of enterprises to a larger extent than capital intensive enterprises. If a shortage of skilled workers occurs, labour intensive enterprises may not be able to obtain the desired type of employees which they require. It is also possible that they may have to pay substantially more to ensure that they can still obtain the required

employees for their specific needs. Labour unrest, a common phenomenon in South Africa, also has a negative effect on labour intensive enterprises. In the case of capital intensive enterprises it is normally possible to continue with production during periods of labour unrest, but labour intensive enterprises are usually brought to a standstill. In South Africa the high levels of labour unrest were one of the main contributing factors to the increase in the degree of capital intensity of enterprises in the manufacturing sector (Kaplinsky, 1995). Enterprises usually protect themselves against the risk of labour unrest by relying on more capital intensive production techniques at the expense of using more employees. Increases in the relative cost of labour could also have a negative effect on labour intensive enterprises. In the case of a capital intensive enterprise increases in the cost of labour can partly be solved by investing more capital in PPE and capital intensive production processes, and using less labour (Dornbusch and Fischer, 1992). A labour intensive enterprise, however, will usually not be able to do this in order to solve the effect of increases in the cost of labour. Low levels of labour productivity could also influence labour intensive enterprises to a greater extent than capital intensive enterprises.

The cost structures of capital and labour intensive enterprises also differ substantially. In the case of a capital intensive enterprise, the cost structure tends to include more fixed costs (e.g. depreciation) as a result of the large amount of PPE which is used. In the case of a labour intensive enterprise variable costs (which include the salaries and wages paid) usually form the most important part of the total costs (Garrison and Noreen, 1997).

It can therefore be expected that capital and labour intensive enterprises will react differently during periods of economic changes. The ability to differentiate between capital and labour intensive enterprises can provide valuable information about the expected future financial performance of the two types of enterprises. To be able to classify an enterprise as capital or labour intensive, however, it is necessary to develop a measure(s) which can be used to determine its degree of capital intensity.

1.2 Objectives of the study

A need exists to be able to differentiate between capital and labour intensive enterprises. However, in order to be able to differentiate between these two types of enterprises, it is necessary to have a measure which can be used to determine an enterprise's degree of capital intensity. A large number of different measures of capital intensity have been developed and are used to classify enterprises according to their degree of capital intensity. However, little attention is given to which one of these different measures provides the best indication of an enterprise's degree of capital intensity. Most researchers provide little or no motivation for their preferred measure of capital intensity.

The main objective of this study is to develop a method(s) which can be used to determine an enterprise's degree of capital intensity. The different indicators which are generally used as measures of capital intensity are identified and evaluated critically to investigate their ability to indicate capital intensity. An appropriate method which can be used to measure capital intensity is then developed from these measures.

1.3 Definitions of capital intensity

It is important to develop a clear definition of exactly what capital intensity refers to. There are a number of different definitions. These definitions were developed in different fields of study and could all be used to define the concept of capital intensity. However, the different definitions focus on different aspects of an enterprise. In some instances it may therefore be possible that one definition is more applicable to one specific enterprise than another. Some of these definitions are discussed below.

Capital intensive enterprises are usually defined as those enterprises which require or use a very large amount of capital relative to their need for using labour. A labour intensive enterprise, on the other hand, requires a large supply of labour relative to capital. Capital intensity therefore refers to the dependence of an enterprise on capital. A capital

intensive enterprise uses relatively more capital than labour. Normally capital intensive enterprises use production processes in which a large amount of capital is invested in PPE and only a few employees are needed for operational purposes.

In a micro-economic context capital intensity refers to the relationship between the capital employed in an enterprise and the labour used. To calculate the degree of capital intensity, the capital-labour ratio is calculated. In this ratio the amount of capital used is compared to the labour used. Capital is measured as the total amount of PPE which is used in the production processes of the enterprise. Labour is measured by determining the number of employees of the enterprise. The ratio provides an indication of the value of the PPE which is being used per employee. Capital intensive enterprises have a large value for the ratio, since a large amount of PPE is used per employee in their production processes. Conversely, labour intensive enterprises have a lower value for the ratio, since less PPE per employee is normally required.

In the field of financial management an enterprise is defined as being capital intensive if a large percentage of its total assets consists of PPE, or if a large amount of capital is needed to generate a certain level of revenue. In a capital intensive enterprise the largest percentage of the total assets is usually in the form of PPE. The production processes usually depend on the use of a large number of expensive machines and equipment. The number of employees is usually relatively low when compared with the amount of capital required. Conversely, a labour intensive enterprise is defined as an enterprise where PPE does not form such a large percentage of the total assets, and where less capital is needed to generate a certain level of revenue. The production processes of these types of enterprises are less capital intensive and most activities are heavily dependent on the use of employees. The number of employees is relatively high compared to the amount of capital used. An enterprise's degree of capital intensity is therefore an indication of the importance of capital in the enterprise, and usually measures how much capital needs to be invested in the form of PPE to ensure that the enterprise will be able to continue its activities.

It is important to note, however, that an enterprise with a low degree of capital intensity is not necessarily labour intensive, and that an enterprise with a low degree of labour intensity is not necessarily capital intensive. It is possible for an enterprise to be classified as being capital intensive and still employ a large labour force (Bloom *et al.*, 1998). In the case of a capital intensive enterprise, the level of skills expected from the employees is usually higher than in the case of a labour intensive enterprise (Goldin and Katz, 1998). Even if a capital intensive enterprise is using fewer employees in its production process, it may be paying them substantially more than in the case of a labour intensive enterprise. This could result in the total amount of salaries paid equalling or even exceeding that of a labour intensive enterprise. When attempting to classify an enterprise as capital or labour intensive, it is important to take into account that these two classifications are not always mutually exclusive, and that an enterprise may be classified as both capital and labour intensive. This possibility further complicates the measurement of an enterprise's degree of capital intensity.

It is important to note that the different measures of capital intensity focus on different aspects of an enterprise. Depending on the type of enterprise that is being investigated, it is therefore possible that specific measures may be providing a better indication of a specific type of enterprise's degree of capital intensity than other measures. Some of the indicators which are used to measure capital intensity are measures which usually focus on indicating low levels of capital intensity and are normally used to measure labour intensity. By assuming that a low degree of labour intensity is an indication of capital intensity, it is in some cases possible to use these measures to determine capital intensity. However, extreme care should be taken when these measures are used to quantify capital intensity for enterprises with a high degree of capital intensity, since the measures are not always able to accurately measure high degrees of capital intensity. In the next chapter a detailed discussion of the different measures is provided.

1.4 Basic structure of the study

In this chapter a brief background to the study is provided. The importance of determining the degree of capital intensity for an enterprise is discussed and the need for a method which can be used to measure capital intensity is identified. The objective of the study is also outlined. Finally a number of definitions of capital intensity are highlighted.

In Chapter 2 provides a survey of the available literature and research conducted on capital intensity. The focus of the chapter is on identifying the different measures which are generally used to determine an enterprise's degree of capital intensity. These measures are defined and their methods of calculation are discussed.

Chapter 3 outlines the methodology of the research. Specific attention is given to the design of the sample, the calculation of the measures of capital intensity as well as the statistical measures which are used in the study.

In Chapter 4 five of the traditional measures of capital intensity, which are not based on value added figures, are investigated. Principal component analyses are conducted on the five measures and a composite measure of capital intensity is developed by calculating the principal component scores for the different enterprises.

All nine the different measures of capital intensity which were identified in the study are investigated in Chapter 5. These measures include four measures based on value added figures as well as the five measures not based on value added figures, which are discussed in Chapter 4.

Chapter 6 contains a summary of the results of the study, as well as the conclusions and recommendations for further research.

1.5 Summary

Traditionally the ability to differentiate between capital and labour intensive enterprises was not seen as an important indicator of the expected financial performance of the two types of enterprises. However, it seems as if the quality of financial decision-making could be improved if a distinction is made between the two types of enterprises. To be able to classify an enterprise as a capital or labour intensive enterprise, however, some measure of its degree of capital intensity is needed.

Although a large number of different measures have been developed and used, relatively little research has been conducted to investigate the ability of these measures to indicate capital intensity. These measures therefore need to be investigated critically in order to determine their ability to indicate capital intensity and to determine an appropriate method which can be used to measure capital intensity.

CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

Most of the research on capital intensity is conducted in the field of microeconomics. The main objective in most of these studies is an attempt to determine the optimal combination of the two resources, capital and labour. The measure which is normally used to determine the degree of capital intensity in this context is the capital-labour ratio. A capital intensive enterprise has a high value for this ratio, while a lower value indicates that an enterprise is labour intensive.

In financial management the measure of total assets to revenue is normally used to determine an enterprise's degree of capital intensity. The degree of capital intensity is defined as the amount of total assets required per dollar of revenue generated (Brigham and Capenski, 1991). A capital intensive enterprise has a high value for this ratio, since a large amount of total assets is required to generate a certain level of revenue.

The previous chapter provided an introduction to the study. Specific attention was given to the background of the study as well as the main objectives. A definition of capital intensity was also provided. This chapter gives an overview of the literature available on capital intensity. The emphasis of the literature survey is placed on identifying the various measures of capital intensity (nine in total) which are referred to in the literature. The calculation of the measures is discussed as well as the interpretation of the calculated values.

2.2 Traditional measures of capital intensity

This section discusses five traditional measures of capital intensity, while the remaining four measures (based on value added figures) are discussed in the following section.

2.2.1 Total assets to revenue (TOT:REV)

This measure considers the relationship between the amount of capital invested in total assets and the revenue generated. The total assets of an enterprise consist of non-current assets (property, plant and equipment; goodwill; investments in associates; and other financial assets) and current assets (inventories; trade and other receivables; prepayments; and cash and cash equivalents). According to this measure an enterprise's degree of capital intensity is defined as the amount of total assets required to generate one dollar of revenue (Brigham and Capenski, 1991). In the case of a capital intensive enterprise a high value will usually be calculated for this measure, since a substantial amount of total assets is normally required to generate a certain level of revenue. In the case of a capital intensive enterprise an increase in revenue usually requires an increase in the investment in total assets.

In the case of a labour intensive enterprise less capital is invested in total assets and the measure will therefore have a lower value. Labour intensive enterprises are usually able to increase their revenue without a substantial increase in their investment in total assets.

Harris (1994) investigated the degree of capital intensity of an enterprise as part of a model to test optimal capital structure theories. Capital intensity is measured by using the measure of total assets to total sales revenue. A positive relationship between capital intensity and industry capital requirements is found. Furthermore, the study determined that an increase in an enterprise's cost of capital leads to a decrease in the degree of capital intensity. The study also indicates that an enterprise's degree of capital intensity is a function of a number of factors, including the weighted average

cost of capital, the gross price-cost margin, the enterprise's capital requirement and the ratio interest expenses to revenue.

2.2.2 Property, plant and equipment to revenue (PPE:REV)

Another measure which is closely related to the total assets to revenue measure is the measure PPE to revenue (Burger and Hamman, 1999). This measure excludes the investments in associates, goodwill and other financial assets as well as the current assets, and only considers the amount of capital invested in PPE. It is therefore an indication of the amount of PPE required to generate a certain level of revenue. In capital intensive enterprises a large amount of capital is usually invested in PPE. A high value for this measure is therefore an indication of a high degree of capital intensity, while a lower value indicates labour intensity.

2.2.3 Property, plant and equipment to total assets (PPE:TOT)

The measure of PPE to total assets considers the relationship between the amount of capital invested in PPE and in total assets. The value of the measure is therefore an indication of the percentage of the total assets which consists of PPE. In the case of a capital intensive enterprise, a large percentage of the total assets usually consists of PPE. A high value for this measure is therefore an indication of a high degree of capital intensity (Bloom *et al.*, 1998). A labour intensive enterprise normally uses relatively less PPE and the measure will therefore have a lower value.

Bloom (2001) uses two measures to determine the degree of capital intensity of enterprises in his study. The measures which are used are PPE to total assets and PPE to number of employees. Both these measures are used to measure the degree of capital intensity. The measures are used to classify enterprises listed in the Industrial Sector of the JSE for the period 1986 to 1992.

The enterprises are firstly classified using the two measures individually. The correlation between the two measures is very high (0,72) and indicates a strong relationship between them. On the other hand, the correlation of 0,72 means that

48,2% of the variation in one of the measures is not explained by the variation in the other. This is an indication that, although related, the two measures measure different aspects (dimensions) of capital intensity. Therefore the enterprises are then also classified by using both the measures simultaneously. Scatterplots of the two measures are constructed for the different enterprises in the study. Depending on the location of a specific enterprise on the scatterplot, it is classified as a capital or labour intensive enterprise. The degree of capital or labour intensity is determined by calculating the Euclidian distance from the mean vector for an enterprise on the scatterplots of the two measures. A scale of capital intensity based on these Euclidian distances is constructed. Large positive values on this scale indicate capital intensity and large negative values labour intensity. The larger the value on this scale, the higher the enterprise's degree of capital intensity. The study concludes that this combination of the two measures provides a better indication of an enterprise's degree of capital intensity than the two individual measures used separately.

2.2.4 Depreciation as a percentage of revenue (DEP:REV)

To measure the degree of capital intensity of an enterprise, depreciation as a percentage of revenue can also be calculated (Ismail and Choi, 1996). The amount of depreciation which an enterprise makes provision for is influenced by the amount of capital invested in PPE. It can therefore be expected that a capital intensive enterprise will be providing for a larger amount of depreciation than in the case of a labour intensive enterprise since a larger amount of capital is normally invested in PPE. A high percentage of depreciation to revenue is therefore seen as an indication of a high degree of capital intensity, while a lower value indicates labour intensity.

When this measure is calculated, it is important to take into account that it is possible for different enterprises to calculate depreciation according to different methods. Comparisons between the values of the measure calculated for different enterprises should therefore be made very carefully.

In those cases where an enterprise has been using the same PPE for a relatively long period of time, it may occur that the items have been depreciated completely and that

no further depreciation is calculated. Extreme care should be taken when the measure of depreciation as a percentage of revenue is used to measure capital intensity in such instances. Capital intensive enterprises which use a large amount of PPE could have a low value for the measure and could therefore be incorrectly classified as labour intensive enterprises.

2.2.5 Property, plant and equipment per employee (PPE:EMP)

Most of the research on capital intensity has been conducted in the field of microeconomics. The measure which is normally used to determine capital intensity in this context is the capital-labour ratio. This measure focuses on the relationship between the amount of capital invested in PPE, and the number of employees of an enterprise. The value of the ratio is therefore an indication of the value of the PPE which is being used per employee.

In the case of a capital intensive enterprise, a large amount of capital is usually invested in PPE. However, capital intensive enterprises usually tend to use relatively fewer employees in their production processes than labour intensive enterprises. A large value for this measure indicates that an enterprise is using a large amount of PPE per employee, and it is classified as a capital intensive enterprise. However, if a lower value for the measure is calculated, an enterprise is classified as a labour intensive enterprise.

There are a number of shortcomings in the traditional measure of PPE to total number of employees. The first shortcoming is that the emphasis should be placed on the actual amount of capital equipment which an employee is using while at work (Lim, 1976). If another employee on another production shift is using the same equipment, this should be taken into account when the capital intensity is calculated.

A number of adjustments could be made to the traditional capital-labour ratio to overcome this shortcoming. The first of these adjustments is to use only the number of employees on the largest production shift and not the total number of employees of the enterprise, when calculating the measure. This ensures that the value of the measure provides a true

indication of the value of the PPE which is being used per employee. The reason for this adjustment is that the value of the measure will be lower if the total number of employees is included in the calculation instead of the number of employees on a specific shift. A lower value for the capital-labour ratio indicates a lower degree of capital intensity. This, however, will not be a true indication of the enterprise's capital intensity. The lower value could be the result of more than one production shift per day and not necessarily a decrease in the degree of capital intensity. By incorporating only the number of employees during the largest production shift, the adjusted value of the measure will provide a more accurate indication of an enterprise's degree of capital intensity.

The second problem is to include the actual utilisation of capital, which means that the actual amount of time per year that the PPE is utilised should be used. The value of the measure will then provide an indication of the true value of the capital which is used in the production process. It is important to include the utilisation figures, since some enterprises may have a large amount of capital invested in PPE, but they may only be using a small percentage of it in the production process. Using the total amount invested in PPE when calculating the measure will result in an inaccurate indication of the true capital intensity of the enterprise's production process.

An adjustment to include the intensity of use of the equipment during the largest production shift is also suggested, where the speed at which the equipment is working is also taken into account. Some enterprises operate in industries which are exposed to large seasonal fluctuations. These fluctuations result in production levels which change substantially during the different seasons.

Lim (1976) concludes that the capital-labour ratio, modified to include these adjustments for the utilisation of capital and the number of employees on the largest production shift, is theoretically the best method to measure capital intensity. It can therefore be very useful when used to distinguish between capital and labour intensive enterprises in most less developed countries and would provide a more accurate indication of the degree of capital intensity than the unadjusted measure.

Kaplinsky (1995) measured the capital intensity of enterprises in the South African manufacturing sector by calculating the measure PPE to number of employees. The study

concludes that the poor performance of enterprises in the manufacturing sector can be attributed to the static labour force in the formal sector. If the different sectors of the manufacturing sector are considered, it is found that the capital intensive sectors maintained high levels of investment and output growth, while labour intensive sectors experienced a decline in capital stock and low growth rates. The informal sector is also poorly developed.

The high levels of capital intensity are the result of an under-investment in the labour intensive sectors, rather than an over-expansion of the capital intensive sectors. The reason for the under-investment is claimed to be the unstable political situation during the period of the study, which caused investors to be extremely careful about investing in the labour intensive sectors and rather investing in the capital intensive sectors of the economy.

Kaplinsky also calculated an incremental capital-output ratio to use as a measure of an enterprise's overall level of capital intensity. The capital-output ratio is calculated by using the enterprise's fixed capital to the incremental value added.

Osborn and Lings (1993) calculate the capital-labour ratio to determine the degree of capital intensity of the South African manufacturing sector. The measure is calculated for the total manufacturing sector, as well as for the different sub-industry groups. It is found that at the aggregate level the capital intensity (as measured by the measure PPE to number of employees) increased at an average compound rate of 3,5%. However, if the period of the study is split up into different sub-periods, it is found that the increases are different for certain of these periods. During some periods relatively high increases occurred, while other periods experienced smaller increases.

Where different sub-industry groups are considered, it is found that some industry groups (for instance Steel and Iron, Chemicals, and Paper and Printing) experience substantial changes in their degree of capital intensity over the different periods of the study. If these groups are excluded from the calculations, the average increase in the degree of capital intensity of the manufacturing sector is only 0,5%. Claims that the South African manufacturing industry became more capital intensive should therefore be treated very carefully, since it seems as if the high overall degree of capital intensity of the

manufacturing sector is the result of the high increases in the degree of capital intensity of certain industry groups.

An adjusted value is also calculated where capacity utilisation figures, which represent the actual amount of PPE which is utilised in the manufacturing process, are used instead of the total amount of capital invested in PPE. In this case the overall average rate of increase in the degree of capital intensity is also lower than in the case where the total amount of capital invested in PPE is used.

In a study to determine the relationship between an increase in the degree of capital intensity and rising unemployment levels, Bell (1978) uses the capital-labour ratio as a measure of the manufacturing sectors' degree of capital intensity. The study concludes that there is not enough evidence to support the argument that there is a tendency in the South African economy towards an increase in the levels of unemployment due to increases in the levels of capital intensity.

2.3 Value added measures of capital intensity

A number of measures which are based on value added figures have also been developed. These measures include value added per employee; PPE to value added; and salaries to value added. During the period of the study enterprises were not required to publish the amount of salaries paid as part of the traditional annual financial statements. However, the amount of salaries paid is included in the calculation of the value added and can therefore be obtained from the value added statement. The measure of salaries to revenue is therefore also included with the other measures which are based on value added figures.

Value added is defined as "the wealth accrued to those who participate in the entity: the employees, the providers of loan capital and risk capital, together with the government" (Riahi-Belkaoui, 1992). The value added by an enterprise is calculated by subtracting all bought-in costs and services from the revenue or, alternatively, by adding salaries and wages, interest payments, dividends, taxes, depreciation and retained earnings together. A

positive correlation exists between an enterprise's degree of capital intensity and the amount of value added (Banerji, 1978).

2.3.1 Salaries to revenue (SAL:REV)

A capital intensive enterprise can be defined as an enterprise which requires a large amount of capital relative to its need for using labour. With an increase in the degree of capital intensity, the contribution of labour normally decreases. A capital intensive enterprise will therefore have a high level of capital investment and a low level of labour intensity. The use of the measure salaries to revenue when measuring capital intensity is based on this inverse relationship between the level of capital investment and labour intensity.

The measure determines the relationship between the salaries paid and the revenue which is generated. It therefore measures the amount of salaries needed to generate a certain level of revenue. In the case of a labour intensive enterprise the amount of salaries paid is usually higher than for an enterprise which is less dependent on labour. A high value for this measure indicates that the enterprise is labour intensive and, conversely, a lower value could be seen as an indication of capital intensity. Usually this measure is more accurate in indicating low degrees of capital intensity and it is often used as a measure of labour intensity. However, by assuming that a low degree of labour intensity indicates capital intensity, it is also possible to use the measure to indicate high levels of capital intensity.

It is important, however, to consider whether a low value for this measure always indicates a high degree of capital intensity. An enterprise with a low degree of capital intensity is not necessarily a labour intensive enterprise and, conversely, an enterprise with a low degree of labour intensity is not necessarily capital intensive. A low value for this measure could in some instances be an indication of a capital intensive enterprise (Burger and Hamman, 1999). However, it is possible for an enterprise to be classified as being capital intensive and yet it still employs a large labour force (Bloom *et al.*, 1998). In the case of a capital intensive enterprise, the level of skills required from the employees is usually higher than in the case of a labour intensive enterprise (Goldin and Katz, 1998). Even if a capital intensive enterprise is therefore using fewer employees in its production process, it may be paying them substantially more than in the case of a labour intensive enterprise.

This could result in the total amount of salaries paid by a capital intensive enterprise equalling or even exceeding that of a labour intensive enterprise which employs a substantially larger number of employees. This measure, however, does not take into account the amount of capital which the enterprise is using in its production process, and it only considers the amount of salaries paid. When this measure is used to calculate the degree of capital intensity of an enterprise, this should therefore be done very carefully.

2.3.2 Value added per employee (VA:EMP)

A further measure of capital intensity which is based on value added figures is the measure value added per employee. If this measure is used to calculate an enterprise's degree of capital intensity, the value added by the enterprise is compared with the number of employees which is used. If an enterprise is capital intensive, relatively less labour is needed to generate a certain amount of value added. On the other hand, if an enterprise is labour intensive, more labour is needed. A large value for this measure indicates that relatively little labour is used and that the enterprise is capital intensive. A lower value may be an indication that more labour is used and that the enterprise is labour intensive.

In a study to investigate the relationship between the average size of production plants and the capital intensity of different countries, Banerji (1978) experienced a number of problems in calculating the traditional capital-labour ratio (PPE to number of employees) as a measure of capital intensity. As a proxy the measure of non-wage value added per employee is used, since it was determined that this measure is positively correlated with an enterprise's degree of capital intensity. The study concludes that a positive relationship exists between the average size of production plants and the capital intensity of the country.

Value added per employee as a measure of capital intensity is also used in a study to investigate the differences in the degree of capital intensity of foreign, private local, and government-owned enterprises in less developed countries (Ahiakpor, 1986). The study was conducted in Ghana and the results indicate that the capital intensity of enterprises within the country are to a greater extent influenced by cost and profit considerations than by the nationality of the owners of the enterprises. Foreign and government-owned

enterprises do enjoy certain tax and financial preferences above local enterprises and this in part explains the higher levels of capital intensity of these types of enterprises.

Certain problems may, however, occur when the measure value added per employee is calculated. The measure could be adjusted to differentiate between the different shifts in those cases where a factory operates more than one production shift per day (Lim, 1976). It was found that the value added per employee is usually lower in the case of a night shift than in the case of a day shift. In enterprises where more than one shift is operated, this may result in a lower overall amount of value added per employee than in the case where only one production shift is operated. It is important to take this factor into account, since a lower value for the measure could be the result of different shifts and not a decrease in the capital intensity of the enterprise.

2.3.3 Property, plant and equipment to value added (PPE:VA)

This measure considers the relationship between an enterprise's investment in PPE and the value added (Burger and Hamman, 1999; Miller, 1986). The value of the measure indicates the amount of capital that needs to be invested in PPE in order to generate R1 of value added.

A large value for the measure indicates that a large amount of PPE is used to generate a certain amount of value added. The enterprise under consideration is then classified as being capital intensive and, conversely, if a lower value is obtained, as being labour intensive.

2.3.4 Salaries to value added (SAL:VA)

This measure investigates the relationship between salaries paid and value added (Kay and Davis, 1990; Riahi-Belkaoui, 1992; Burger and Hamman, 1999). The value of the measure provides an indication of the importance of labour in an enterprise when the value added is calculated. In the case of a labour intensive enterprise where labour forms one of the most important components, the measure will have a high value. If a lower value is obtained, labour is less important and the enterprise will be less labour intensive. However, when

this measure is used as an indicator of capital intensity, the same care should be taken as in the case when the measure salaries to revenue is used. Furthermore, since salaries are included when calculating the value added by an enterprise, salaries and value added are not independent of each other. This may have an effect on the results of the study.

2.4 Summary

This chapter gives an overview of the different measures used to calculate capital intensity. A large number of different measures have been developed and used in the literature. These measures include the measure total assets to revenue; PPE to revenue; PPE to total assets; depreciation as a percentage of revenue; and PPE per employee. A number of measures which are based on value added figures are also used; they include the measures PPE to value added; salaries to value added; value added per employee; and salaries to revenue. However, in the literature little or no attention is given to which one of these different measures provides the best indication of an enterprise's degree of capital intensity.

A number of adjustments to the measures which are suggested in the literature are also discussed. However, due to the unavailability of the necessary financial data to do these adjustments in this study, they are not included in the remainder of this study.

The next chapter describes the research methodology of the study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter provided an overview of the research conducted to develop measures of capital intensity. Specific attention was given to the different measures of capital intensity which are referred to in the literature. The different measures used to determine an enterprise's degree of capital intensity were defined and their methods of calculation described. Problems which may occur when calculating the different measures and possible adjustments to solve these problems were identified. However, due to the unavailability of the necessary data to complete these adjustments, they are not carried out in this study. Nine measures of capital intensity were identified, consisting of five traditional measures of capital intensity and four measures which are based on value added figures.

This chapter outlines the research methodology of the study. The description of the research methodology consists of three sections. The first section describes the sample of enterprises which is used in the study. The second section outlines the methods of calculation of the different measures of capital intensity. The last section introduces the statistical procedures for analysing the data.

The main objective of this study is to develop an appropriate method which can be used to determine the degree of capital intensity of an enterprise. The study is conducted for enterprises listed in the Industrial sector of the Johannesburg Stock Exchange. The research covers the period 1989 to 1996. This period consists of a decline phase in the economic cycle (1989 to 1992), where negative economic growth occurs, and an upswing phase (1993 to 1996), where positive economic growth is experienced (as measured by

the Gross Domestic Product) (South African Reserve Bank Quarterly Bulletin, December 1999). The intention is not to determine how capital intensive and labour intensive enterprises react to an upswing and decline of the economic cycle, but rather to investigate if the different measures behave differently during the two phases. If the measures behave differently for the two economic phases, it may be necessary to use a specific measure(s) during each of the different phases.

3.2 Selection of the sample

All the enterprises listed in the Industrial Sector of the JSE during 1996 were considered initially. Since the study was conducted for the period 1989 to 1996, the sector classifications which were applied during this period are used in this study instead of the current sector classifications. Enterprises listed in the Industrial Holdings Sector are mainly holding enterprises and are excluded from the research, since they are generally not directly involved in business operations. A number of enterprises not included in the Industrial Holdings Sector are also holding enterprises and pyramids which do not participate actively and directly in business activities. These enterprises are therefore also excluded from the sample. Enterprises listed in the Development and Venture Capital Sectors are also excluded from the sample. The reason for their exclusion lies in the unpredictability and instability of enterprises listed in these sectors. To ensure that the study would not be influenced by these unpredictable fluctuations in the performance of the enterprises, it was decided not to include them in the sample.

To be included in the sample an enterprise had to be listed for the entire period of the study, i.e. from 1989 to 1996. Enterprises which were listed for the entire period were then subjected to a number of different criteria to determine if they should be included in the sample. The first criterion was to consider the financial performance of the enterprises during the period under review. Those enterprises which were declared insolvent or placed under provisional liquidation during the period under review are

excluded from the sample. Enterprises which were delisted during the period of the study are also excluded from the sample.

A total of 300 enterprises were listed by the end of the period, if all the enterprises listed in the Industrial Holdings Sector are excluded. A total of 182 enterprises were declared insolvent, placed under provisional liquidation, or not listed for the entire period of the research, and are therefore excluded from the sample. The remaining 118 enterprises are all included in the main sample (See Table 3.1). Unfortunately, complete financial information to calculate all five the measures for the entire period of the study is only available for 48 of the enterprises (Table 3.2).

In South Africa, the publication of value added statements is not required by the Companies Act. Value added statements are therefore not available for all the enterprises included in the sample. Some of the measures which are investigated in the study, however, are based on value added figures. To evaluate these measures, it is only possible to calculate the measures for those enterprises which published value added statements. To be able to evaluate these measures, a sub-sample is therefore obtained from the main sample. All the enterprises which published value added statements during the period of the study are selected from the main sample. A total of 60 enterprises are included in this sub-sample (Table 3.3). Complete financial information to calculate all nine the measures over the entire period of the study, however, is only available for 34 of the enterprises (Table 3.4).

3.3 Calculation of the measures

A total of nine measures of capital intensity were identified in Chapter 2. Four of these measures are based on value added figures, while the remaining five measures are not based on value added figures.

Traditional measures of capital intensity not based on value added figures:

- Total assets to revenue (TOT:REV)
- Property, plant and equipment to revenue (PPE:REV)
- Property, plant and equipment to total assets (PPE:TOT)
- Depreciation as percentage of revenue (DEP:REV)
- Property, plant and equipment per employee (PPE:EMP)

Measures of capital intensity based on value added figures:

- Salaries to revenue (SAL:REV)
- Value added per employee (VA:EMP)
- Property, plant and equipment to value added (PPE:VA)
- Salaries to value added (SAL:VA)

The various measures of capital intensity highlighted in the literature survey are quantified for each year in the period 1989 to 1996. The mean and median values of the different measures over the period are also calculated. The two samples which were obtained are investigated individually. The results of the five measures calculated for the main sample are discussed in Chapter 4, while the measures calculated for the sub-sample of enterprises providing value added figures are evaluated in Chapter 5.

In the case of the main sample value added statements are not available for all the enterprises. It is therefore only possible to calculate the five traditional measures of capital intensity: total assets to revenue; PPE to revenue; PPE to total assets; depreciation as a percentage of revenue; and PPE per employee. These measures are not based on value added figures. The financial data and employment figures which are required to

calculate these measures were obtained from the McGregor BFA Database and the Johannesburg Stock Exchange handbook.

All nine the measures of capital intensity identified in Chapter 2 are calculated for the sub-sample consisting of the 60 enterprises which published value added statements. The measures which are evaluated include the five traditional measures calculated for the main sample as well as the measures PPE to value added; salaries to value added; value added per employee; as well as salaries to revenue. The value added figures were obtained from the University of Stellenbosch Graduate School of Business Value Added Database, and the financial data and employment figures from the McGregor BFA database and the Johannesburg Stock Exchange handbook.

3.4 Statistical procedures

3.4.1 Principal component analyses

Principal component analysis (PCA) was originally defined by Pearson, but most of the development of the technique was conducted by Hotelling (Dunteman, 1989). The main objective of the technique is usually to reduce the number of dimensions of a large number of variables into fewer dimensions. This is achieved by linearly transforming the set of variables into a smaller set of uncorrelated variables which still represents as much as possible of the original data set's information. The linear transformation results in a number of principal components which are uncorrelated. The principal components are ranked according to the portion of the total variance which is explained by them. The portion of the total variance of the original data set which is explained by the first principal component is maximised. The other principal components each explain the maximum portion of the remaining variance (Joliffe, 1986). This results in the first few principal components explaining most of the variance of the original data set and the last few principal components explaining only a relatively small portion of the total variance. In some instances it may therefore be possible to exclude the last few principal

components, while still explaining a relatively large portion of the total variance with the remaining principal components.

Instead of using all the variables in the original data set, it is therefore possible to focus on a smaller number of variables by considering only the resulting principal components. The resulting set of uncorrelated principal components is usually much easier to understand than a large set of correlated variables. Furthermore, it is usually easier to use this set of variables in further analyses.

If the variables which are investigated are all positively correlated, it is possible to use the first principal component which is obtained as a so-called size variable. In those cases where all the correlations between the original variables are positive, the resulting first principal component will be such that its elements are all positive or all negative. Using the first principal component as a size vector, it is possible to calculate a principal component score. These principal component scores represent a linear combination of the original variables, weighted according to the coefficients of the first principal component. The variance of the principal component scores calculated in this way is maximised (Cureton and D'Agostino, 1983). In this study the principal component scores which are calculated for the enterprises are basically a linear combination of the different measures of capital intensity included in the PCA. The value of the principal component score calculated for an enterprise can then be used as a composite measure of capital intensity.

If the coefficients of the first principal component are investigated, they can be used to determine the contribution of the different variables to the principal component score. If a specific variable has a relatively small coefficient when compared to the other variables, this is an indication that the specific variable is not making an important contribution to the principal component score. It could therefore be possible to exclude the variable from the principal component analysis. However, if all the coefficients are relatively large, this indicates that all the variables provide an important contribution to

the principal component score. All the variables should therefore be included in the analysis.

It is known that PCA is not scale-invariant (Flury, 1997). If the variables which are investigated are not measured in the same units, the different units of measurement may influence the result of the analysis. Furthermore, if the units which are used to measure the different variables are changed, this may change the results of the analysis. Since the main objective of PCA is to maximise the variation which is explained by a few principal components, a variable with a larger variance than the other variables which are being investigated will usually dominate the results of the analysis. It is therefore important to ensure that the variables which are investigated are all measured using comparable units. The different measures which are investigated in this study are measured using different units of measurement. To ensure that this does not influence the results of the study, the data matrix was centred as well as standardised. The standardisation was conducted by dividing the variables by their standard deviation.

3.4.2 Biplots

It is relatively easy to obtain a visual representation of a two-dimensional data set. However, since the data which are investigated in this study consists of more than two variables, it is relatively complicated to obtain a visual representation. One method which could be used to solve this problem is to use biplots. Biplots can be used to represent multivariate data in fewer dimensions. Usually the data are represented in two dimensions. Biplots can therefore be considered as the multivariate analogues of scatterplots. The term biplot is derived from the fact that both the sample which is being investigated as well as the variables are indicated on the figure, and not the fact that the data are usually represented in two dimensions.

Gabriel (1971) originally introduced the biplot. Gabriel's biplot represents the data by using two sets of vectors. The first set of vectors represents the sample points, while the other set represents the variables being investigated. The different variables are usually

plotted as arrows from the origin of the figure. In this study the biplot would therefore indicate each enterprise as a point on the figure and the different measures being investigated by an arrow from the origin. Distances in the traditional biplots devised by Gabriel are interpreted in terms of inner products, which are relatively complex to interpret. As a result of this, Gower and Hand (1996) developed a different perspective on biplots.

The main concern of the new approach followed by Gower and Hand (1996) is to represent the information of a sample as well as the variables in one single figure. The interpretation of the resulting figure should be relatively easy and it should be possible to use the diagram to determine the relationships between the different variables which are being investigated. In the case of a two-dimensional scatterplot it is usually relatively easy to use the scatterplot. The sample points are indicated as points on the scatterplot, while the axes of the figure indicate the two variables. However, if more than two variables are being investigated, it becomes more difficult to interpret the data in the same way. The biplots developed by Gower and Hand can be used to provide an approximation of the distribution of the multivariate data set in two dimensions as well as an approximation of the different variables by representing them as curves (axes) in the two-dimensional figure.

The biplots developed by Gower and Hand (1996) represent the different variables as axes on the figure and the variables themselves are therefore not plotted on the figure. Only the sample points are plotted. The biplot axes indicated on the figure are not orthogonal, since they are drawn for a number of variables in only two dimensions. It is possible, however, to use these axes in much the same way as normal scatterplot axes by applying orthogonal projections onto them. The first two principal components are used as the scaffolding for the plotting of the data. The first principal component is used for the horizontal scaffolding, and the second principal component for the vertical scaffolding. Since the first principal component is used as a size vector in this study, enterprises will be arranged along the horizontal axis according to their degree of capital intensity.

If the values of the different variables are provided, it is possible to find the position of a sample point on the figure by using the process of interpolation. On the other hand, if a specific sample point on the figure is identified, prediction can be used to infer the values of the variables for this sample point.

In order to ensure that the biplots can be used as an accurate visual representation of the data, the quality of the representation needs to be evaluated. The main aim of the biplots is to display the different sample points in a two-dimensional diagram in such a way that the relationships between the points are indicated clearly and accurately. To measure the quality of the representation, the quality of fit for the biplot is calculated. This can be defined as the portion of the total variance explained by the first two principal components, since the first two principal components are used as scaffolding for the figure. A relatively large portion of the total variance is usually displayed by the first two principal components, and the quality of fit should therefore be relatively high. However, since the first two principal components do not explain all the variance of the data, there will be some loss of information when the biplot is constructed. All of the different variables will therefore not be represented equally well. To determine how well the different variables are represented by the biplot, the adequacy of the display of the variables can be calculated.

3.5 Summary

This chapter provided an overview of the research methodology. Attention was firstly given to the selection of the sample. Two samples were compiled. A main sample consisting of 118 enterprises was first obtained. However, complete financial data to calculate the five traditional measures of capital intensity are only provided by 48 of these enterprises for the entire period of the study. A number of measures which are based on value added figures have also been identified. To be able to evaluate these measures, a sub-sample consisting of the 60 enterprises which published value added

figures during the period under review was compiled from the main sample. Only 34 of these enterprises provided the necessary financial information to calculate all nine of the measures of capital intensity for the entire period of the study.

Next, the nine measures of capital intensity which were identified in the literature survey were highlighted and the financial data used to calculate the measures were described. Finally, the statistical procedures used to evaluate the data were discussed. These include principal component analyses (PCA), which are used to determine a composite measure of capital intensity. Related biplots are used to provide a visual representation of the data.

Chapter 4 provides the results of the analysis carried out for the five measures of capital intensity which are not based on value added figures, calculated for the main sample of enterprises. Chapter 5 contains the results for all nine of the measures of capital intensity (including the four measures which are based on value added figures) calculated for the sub-main sample of enterprises which published value added statements.

Table 3.1: Main sample of 118 enterprises per JSE classified sector

ENTERPRISE	JSE SECTOR	ENTERPRISE	JSE SECTOR
Amalgated Beverage Industries	Bev, Hotels & Ls	JD Group	Furn & Household
Adcock Ingram	Pharm & Medical	Karos Hotels	Bev, Hotels & Ls
Adonis Knitwear Holdings	Cloth & Footwar	Laser Transport Holdings	Transportation
Advanced Technical Systems	Electronics	LTA	Bldg & Construc
Assosiated Furniture Companies	Furn & Household	Macadams Bakery Supplies Holdings	Food
African Oxygen	Engineering	Masonite (Africa)	Bldg & Construc
Fraser Alexander	Engineering	Medi-Clinic Corporation	Pharm & Medical
Alex White Holdings	Paper & Pack	Metair Investments	Motor
Alpha	Bldg & Construc	Metro Cash and Carry	Stores
Amalgated Retail	Furn & Household	Midas	Stores
Aries Packaging	Paper & Pack	Namibian Fishing Industries	Food
Autopage Holdings	Electronics	Nampak	Paper & Pack
Basil Read Holdings	Bldg & Construc	Namibian Sea Products	Food
Bolton Footwear	Cloth & Footwar	Nothern Engineering Industries Africa	Engineering
Boumat	Bldg & Construc	Ninian and Lester Holdings	Cloth & Footwar
Bowler Metcalf	Paper & Pack	Nu-World Holdings	Electronics
Cadbury Schweppes (SA)	Food	Oakfields Thoroughbreds and Leisure Ind.	Bev, Hotels & Ls
Cargo Carriers	Transportation	Oceana Fishing Group	Food
Cashbuild	Stores	Omnia Holdings	Chemical & Oil
Caxton	Print & Publish	Pals Holdings	Cloth & Footwar
Cementation Company (Africa)	Engineering	PEP	Stores
Chemical Services	Chemical & Oil	Pick 'n Pay Stores	Stores
Chubb Holdings	Engineering	Portland Holdings	Bldg & Construc
Clinic Holdings	Pharm & Medical	Brian Porter Holdings	Motor
Clyde Industrial Corporation	Engineering	Power Technologies	Electronics
Combined Motor Holdings	Motor	Pretoria Portland Cement Company	Bldg & Construc
Coates Brothers (SA)	Paper & Pack	Protea Furnishers	Furn & Household
Concor	Bldg & Construc	Putco	Transportation
Conshu Holdings	Cloth & Footwar	Rainbow Chicken	Food
Consol	Paper & Pack	Reunert	Electronics
Control Instruments Group	Electronics	Rex Trueform Clothing Company	Cloth & Footwar
Canadian Overseas Packaging Ind.	Paper & Pack	Romatex	Cloth & Footwar
Crookes Brothers	Food	Stocks & Stocks Holdings	Bldg & Construc
Delta Electrical Industries	Electronics	SA Bias Industries	Cloth & Footwar
Dimension Data Holdings	Electronics	South African Druggist	Pharm & Medical
Distillers Corporation	Bev, Hotels & Ls	Sappi	Pharm & Medical
Edgars Stores	Stores	Sasol	Chemical & Oil
Edward L Bateman	Engineering	Scharrighuisen Holdings	Engineering
Ellerine Holdings	Furn. & Household	Seardel Consolidated Holdings	Cloth & Footwar
Engen	Chemical & Oil	Sentrachem	Chemical & Oil
Fintech	Electronics	Stellenbosch Farmers' Winery Group	Bev, Hotels & Ls
Foschini	Stores	Shoprite Holdings	Stores
Fralex	Engineering	Shoredits Holdings	Bldg & Construc
Frame Group Holdings	Cloth & Footwar	Siltek	Electronics
General Optical Company	Pharm & Medical	Sondor Industries	Engineering
Gentyre Industries	Motor	Spescom Electronics	Electronics
Glodina Holdings	Cloth. & Footwear	Suncrush	Bev, Hotels & Ls
Grinaker Holdings	Bldg & Construc	Towles, Edgar Jacobs	Cloth & Footwar
Group Five	Bldg & Construc	Tongaat Hulett Group Limited	Food
Gubb and Inggs	Cloth & Footwar	Toyota South Africa	Motor
Haggie	Engineering	Trencor	Transportation
Harwill Investments	Paper & Pack	Unihold	Engineering
Highveld Steel and Vanadium Corp.	Steel & Allied	Unispin Holdings	Cloth & Footwar
Hudaco Industries	Food	Unitrans	Transportation
Irvin & Johnson	Food	Vaaltrucar	Motor
Inmins	Engineering	Voltex Holdings	Electronics
Interleisure	Bev, Hotels & Ls	WB Holdings	Food
Iscor	Steel & Allied	Wooltru	Stores
Jasco Electronics Holdings	Electronics	The York Timber Organisation	Bldg & Construc

Table 3.2: 48 Enterprises from main sample providing complete financial data per JSE classified sector

ENTERPRISE	JSE SECTOR	ENTERPRISE	JSE SECTOR
Amalgated Beverage Industries	Bev, Hotel & Ls	Metro Cash and Carry	Stores
Adcock Ingram	Pharm & Medical	Midas	Stores
Assosiated Furniture Companies	Furn & Househld	Nampak	Paper & Pack
African Oxygen	Engineering	Oceana Fishing Group	Food
Alpha	Bldg & Construc	Omnia Holdings	Chemical & Oil
Amalgated Retail	Furn & Househld	Pep	Stores
Autopage Holdings	Electronics	Pick 'n Pay Stores	Stores
Cadbury Schweppes (SA)	Food	Power Technologies	Electronics
Cashbuild	Stores	Pretoria Portland Cement	Bldg & Construc
Caxton	Print & Publish	Putco	Transportation
Chemical Services	Chemical & Oil	Rainbow Chicken	Food
Consol	Paper & Pack	Reunert	Electronics
Crookes Brothers	Food	Romatex	Cloth & Footwar
Fintech	Electronics	SA Bias Industries	Cloth & Footwar
Frame Group Holdings	Cloth & Footwar	South African Druggist	Pharm & Medical
Glodina Holdings	Cloth & Footwar	Sappi	Pharm & Medical
Grinaker Holdings	Bldg & Construc	Sasol	Chemical & Oil
Group Five	Bldg & Construc	Sentrachem	Chemical & Oil
Haggie	Engineering	Towles, Edgar Jacobs	Cloth & Footwar
Highveld Steel and Vanadium Corp.	Steel & Allied	Trencor	Transportation
Hudaco Industries	Food	Unihold	Engineering
Iscor	Steel & Allied	Unispin Holdings	Cloth & Footwar
Laser Transport Holdings	Transportation	Wooltru	Stores
Masonite (Africa)	Bldg & Construc	The York Timber Organisation	Bldg & Construc

Table 3.3: Sub-sample of 60 enterprises providing value added figures per JSE classified sector

ENTERPRISE	JSE SECTOR	ENTERPRISE	JSE SECTOR
Amalgated Beverage Industries	Bev, Hotels & Ls	Laser Transport Holdings	Transportation
Adcock Ingram	Pharm & Medical	LTA	Bldg & Construc
Assosiated Furniture Companies	Furn & Househld	Medi-Clinic Corporation	Pharm & Medical
African Oxygen	Engineering	Metro Cash and Carry	Stores
Alpha	Bldg & Construc	Midas	Stores
Amalgated Retail	Furn & Househld	Nampak	Paper & Pack
Boumat	Bldg & Construc	Oceana Fishing Group	Food
Cadbury Schweppes (SA)	Food	Pep	Stores
Cashbuild	Stores	Pick 'n Pay Stores	Stores
Chemical Services	Chemical & Oil	Brian Porter Holdings	Motor
Chubb Holdings	Engineering	Pretoria Portland Cement	Bldg & Construc
Clinic Holdings	Pharm & Medical	Putco	Transportation
Clyde Industrial Corporation	Engineering	Romatex	Cloth & Footwar
Combined Motor Holdings	Motor	SA Bias Industries	Cloth & Footwar
Conshu Holdings	Cloth & Footwar	South African Druggist	Pharm & Medical
Consol	Paper & Pack	Sappi	Pharm & Medical
Crookes Brothers	Food	Sasol	Chemical & Oil
Distillers Corporation	Bev, Hotels & Ls	Seardel Consolidated Holdings	Cloth & Footwar
Edgars Stores	Stores	Sentrachem	Chemical & Oil
Ellerine Holdings	Furn & Househld	Shoprite Holdings	Stores
Engen	Chemical & Oil	Shoredits Holdings	Bldg & Construc
Fintech	Electronics	Suncrush	Bev, Hotels & Ls
Frame Group Holdings	Cloth & Footwar	Towles, Edgar Jacobs	Cloth & Footwar
Gentyre Industries	Motor	Tongaat Hulett Group Limited	Food
Grinaker Holdings	Bldg & Construc	Toyota South Africa	Motor
Haggie	Engineering	Trencor	Transportation
Hudaco Industries	Food	Unispin Holdings	Cloth & Footwar
Irvin & Johnson	Food	Unitrans	Transportation
Interleisure	Bev, Hotels & Ls	Wooltru	Stores
JD Group	Furn & Househld	The York Timber Organisation	Bldg & Construc

Table 3.4: 34 Enterprises from the sub-sample providing complete value added figures per JSE classified sector

ENTERPRISE	JSE SECTOR	ENTERPRISE	JSE SECTOR
Amalgated Beverage Industries	Bev, Hotels & Ls	Nampak	Paper & Pack
Adcock Ingram	Pharm & Medical	Oceana Fishing Group	Food
Assosiated Furniture Companies	Furn & Househld	Pep	Stores
African Oxygen	Engineering	Pick 'n Pay Stores	Stores
Alpha	Bldg & Construc	Pretoria Portland Cement	Bldg & Construc
Amalgated Retail	Furn & Househld	Putco	Transportation
Cadbury Schweppes (SA)	Food	Romatex	Cloth & Footwar
Cashbuild	Stores	SA Bias Industries	Cloth & Footwar
Chemical Services	Chemical & Oil	South African Druggist	Pharm & Medical
Consol	Paper & Pack	Sappi	Pharm & Medical
Crookes Brothers	Food	Sasol	Chemical & Oil
Frame Group Holdings	Cloth & Footwar	Sentrachem	Chemical & Oil
Grinaker Holdings	Bldg & Construc	Towles, Edgar Jacobs	Cloth & Footwar
Haggie	Engineering	Trencor	Transportation
Laser Transport Holdings	Transportation	Unispin Holdings	Cloth & Footwar
Metro Cash and Carry	Stores	Wooltru	Stores
Midas	Stores	The York Timber Organisation	Bldg & Construc

CHAPTER 4

THE MEASUREMENT OF CAPITAL INTENSITY BY MEANS OF TRADITIONAL MEASURES OF CAPITAL INTENSITY

4.1 Introduction

The literature survey identified nine different measures of capital intensity. These measures consist of four which are based on value added figures, and five traditional measures of capital intensity which are not based on value added figures. Although the different measures have been developed in different fields of study, they are all used to provide an indication of an enterprise's degree of capital intensity. When it becomes necessary to determine capital intensity, however, the question arises as to which measure, or combination of measures, provides the most accurate indication of an enterprise's degree of capital intensity.

The previous chapter outlined the research methodology of the study. Specific attention was given to the selection of the sample of enterprises, the calculation of the measures of capital intensity which are investigated as well as the financial data used for their calculation, and the statistical procedures which are used in the study.

In this chapter the five measures of capital intensity which are not based on value added figures are calculated and evaluated empirically. The five measures are quantified for the main sample (Table 3.1) and are calculated for each year of the period 1989 to 1996. The measures which are considered in this chapter are total assets to revenue; PPE to revenue; PPE to total assets; depreciation as a percentage of revenue; and PPE per employee. The ability of the different measures to indicate capital intensity is investigated first. Thereafter the five measures are included in a principal component analysis and a composite measure of capital intensity is constructed by calculating the principal component score based on the first principal component.

The chapter consists of 4 sections. Section two discusses the results of the study. The correlations between the measures are investigated, and the results of the principal component analyses and biplots are presented. Section three provides a summary of the results, while section four contains the conclusion and recommendations.

4.2 Results

4.2.1 Correlation between the measures

The five measures, calculated for the main sample (see Table 3.1), are all positively correlated for each year of the study and they are all relatively large (Table 4.1). These correlations are graphically displayed in Figure 4.1. If a large positive correlation between two measures is calculated, this is usually an indication that, to some extent, the different measures under consideration are measuring the same characteristic. The correlations follow a certain trend. If the correlations are considered separately for the decline and upswing phases in the economic cycle, it is found that the correlations between some measures during the decline phase differ from those during the upswing phase.

Table 4.1: Correlation between the five measures calculated for the main sample (but not the same number of enterprises for every year)

	1989 N=55	1990 N=71	1991 N=74	1992 N=77	1993 N=92	1994 N=110	1995 N=110	1996 N=109
TOT:REV&PPE:REV (r1,2)	0,947	0,926	0,939	0,903	0,937	0,913	0,936	0,978
TOT:REV&PPE:TOT (r1,3)	0,598	0,552	0,644	0,552	0,589	0,532	0,560	0,441
TOT:REV&DEP:REV (r1,4)	0,517	0,465	0,472	0,347	0,695	0,835	0,853	0,736
TOT:REV&PPE:EMP (r1,5)	0,672	0,595	0,606	0,558	0,339	0,382	0,313	0,242
PPE:REV&PPE:TOT (r2,3)	0,770	0,754	0,799	0,780	0,716	0,705	0,695	0,523
PPE:REV&DEP:REV (r2,4)	0,608	0,540	0,526	0,390	0,719	0,868	0,877	0,742
PPE:REV&PPE:EMP (r2,5)	0,750	0,636	0,604	0,563	0,318	0,390	0,320	0,254
PPE:TOT&DEP:REV (r3,4)	0,758	0,694	0,732	0,495	0,682	0,527	0,589	0,646
PPE:TOT&PPE:EMP (r3,5)	0,609	0,525	0,493	0,465	0,450	0,449	0,434	0,439
DEP:REV&PPE:EMP (r4,5)	0,380	0,278	0,289	0,137	0,255	0,325	0,302	0,255

N = Number of enterprises

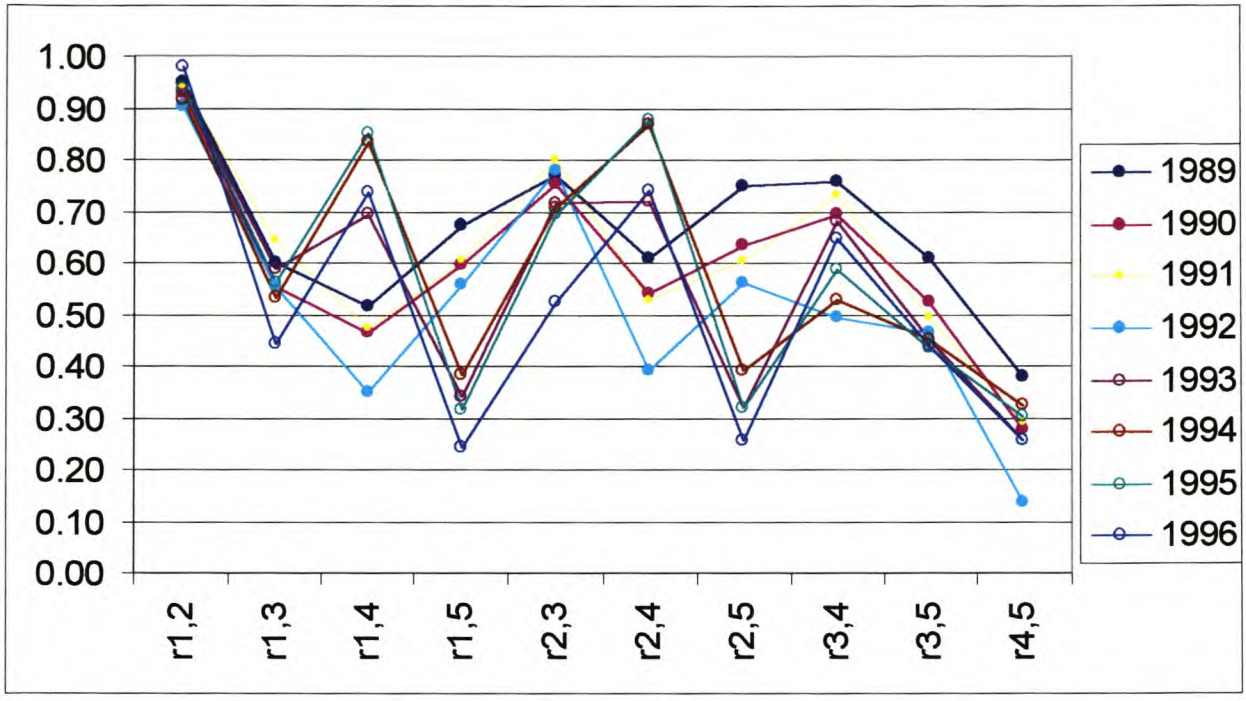


Figure 4.1: Correlation between the five measures calculated for the main sample (but not the same number of enterprises for every year)

If the correlations between the measures TOT:REV and PPE:EMP, and PPE:REV and PPE:EMP are investigated it is found that the correlations during the decline phase are all higher than those calculated for the upswing phase. The correlations between TOT:REV and DEP:REV, and PPE:REV and DEP:REV display the opposite behaviour, with the correlations calculated for the decline phase all lower than those calculated for the upswing phase. In the case of the other measures, however, the correlations do not differ substantially for the different years. The correlations between certain measures therefore remain relatively stable during both the economic phases, while the correlations between some of the other measures behave differently during the two phases. It is important to determine if this difference in the behaviour of the correlations is the result of the changes in the economic cycle or a result of some other factor.

Unfortunately, complete financial information to calculate the five ratios is only available for 48 enterprises over the entire period of the study (see Table 3.2). It could be possible that the difference in the behaviour of the correlations between certain measures during the two economic phases is the result of different enterprises being

included when the correlations were calculated. To investigate this, only those enterprises which published all the required financial information for the entire period are considered.

In this case all the measures are still positively correlated for all the years and the correlations are all relatively large (Table 4.2). These correlations are graphically displayed in Figure 4.2. Furthermore, the differences in the correlations during the upswing and decline phases are less pronounced than in the case where all enterprises were included in the calculation. The differences in the correlations between TOT:REV and PPE:EMP, and PPE:REV and PPE:EMP, as well as those between TOT:REV and DEP:REV, and PPE:REV and DEP:REV are smaller. If the data are investigated, it is found that when the measure PPE:EMP was calculated, a large number of the values needed to calculate the measure were not available. It therefore appears that by only including those enterprises which provided all the required financial information when calculating the correlations, the differences between the correlations for the two economic cycles are less pronounced. This may indicate that the differences in the behaviour of the correlations for the two economic phases are not the result of the change in the economic cycle, but rather the effect of missing values when the measures are calculated.

One exception is 1992, where relatively large differences still exist. A possible explanation may be that the change in the economic cycle occurred during this year. However, if 1992 is considered, it can be seen that the differences are most severe in those cases where the correlations between DEP:REV and the other measures are calculated. The correlations between DEP:REV and the other measures are in most cases the lowest of all the correlations which are calculated. If the problems which were identified when this measure is used to determine capital intensity are taken into account, it could be seen as an indication that in some instances the measure may not be ideally suited for use as a measure of capital intensity.

Table 4.2: Correlation between the five measures calculated for the 48 enterprises providing complete financial information

	1989 N=48	1990 N=48	1991 N=48	1992 N=48	1993 N=48	1994 N=48	1995 N=48	1996 N=48
TOT:REV&PPE:REV (r1,2)	0,949	0,957	0,963	0,941	0,891	0,867	0,818	0,826
TOT:REV&PPE:TOT (r1,3)	0,623	0,620	0,720	0,623	0,554	0,581	0,566	0,516
TOT:REV&DEP:REV (r1,4)	0,533	0,537	0,499	0,311	0,621	0,639	0,671	0,651
TOT:REV&PPE:EMP (r1,5)	0,665	0,671	0,708	0,761	0,669	0,605	0,551	0,496
PPE:REV&PPE:TOT (r2,3)	0,783	0,762	0,823	0,786	0,795	0,831	0,877	0,832
PPE:REV&DEP:REV (r2,4)	0,615	0,589	0,541	0,336	0,633	0,612	0,688	0,715
PPE:REV&PPE:EMP (r2,5)	0,746	0,718	0,705	0,721	0,681	0,592	0,571	0,580
PPE:TOT&DEP:REV (r3,4)	0,772	0,713	0,739	0,456	0,595	0,531	0,609	0,654
PPE:TOT&PPE:EMP (r3,5)	0,630	0,612	0,605	0,543	0,564	0,548	0,532	0,562
DEP:REV&PPE:EMP (r4,5)	0,395	0,440	0,459	0,202	0,447	0,379	0,484	0,486

N = Number of enterprises

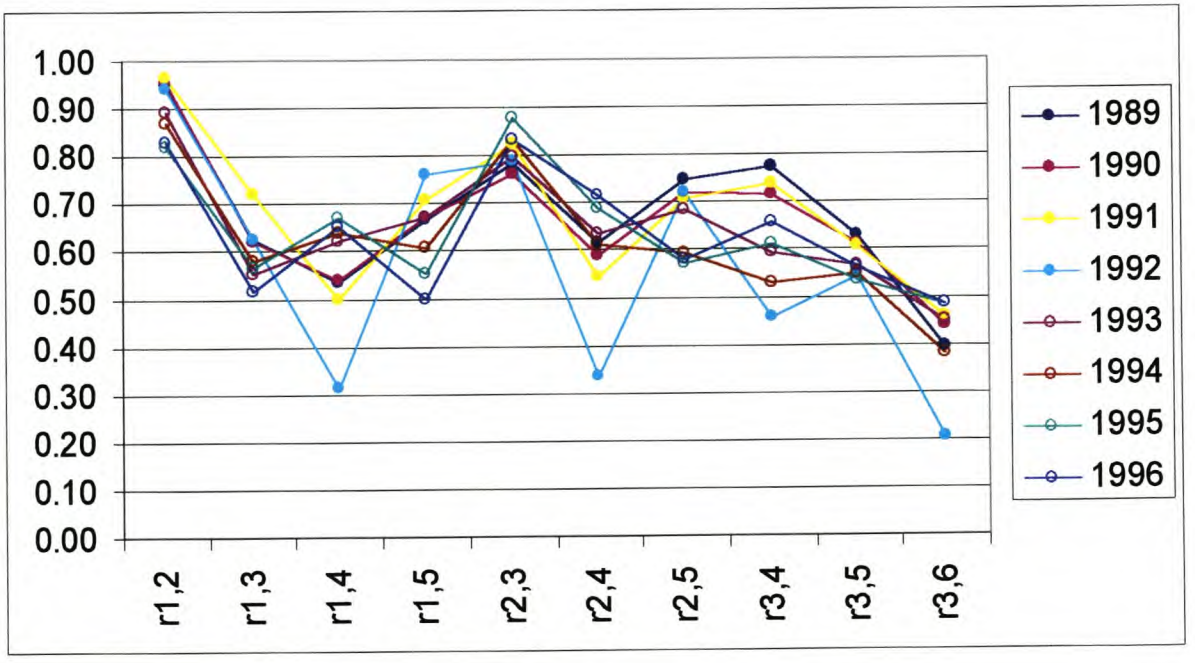


Figure 4.2: Correlations between the five measures calculated for the 48 enterprises providing complete financial information (N=48)

The difference in the behaviour of the correlations may therefore be the result of different enterprises being included in the calculation and not necessarily the result of a change in the economic cycle. Hence, in the remainder of this chapter the focus is on

the five measures calculated for the 48 enterprises which provided complete financial data for the entire period.

4.2.2 Principal component analyses

The five measures which are investigated are all positively correlated. The first principal component therefore forms a size variable, with its coefficients defining a linear combination of the different measures. The principal component scores calculated for each enterprise from this linear combination form a composite measure of the degree of capital intensity. The lower the value of this composite measure is, the higher the degree of capital intensity of the enterprise and, conversely, the higher the value is, the lower the degree of capital intensity.

In Table 4.3 the coefficients of the first principal components are provided for each year of the study, while they are graphically displayed in Figure 4.3. The values of the coefficients provide an indication of the contribution of the five different measures to the composite measure. A measure with a coefficient near zero will contribute little to the principal component score. If 1996 is considered, the measure PPE to revenue has the highest value (0,503) and will therefore provide the largest contribution to the composite measure, while PPE per employee (0,385) will provide a smaller contribution. Perusal of Table 4.3 and Figure 4.3 shows that the coefficients of the first principal component for the decline phase are very similar to those for the upswing phase. An exception occurs during 1992, the year during which the change in the economic cycle occurred. The largest deviation occurs in the case of the measure depreciation as a percentage of revenue.

The mean values for the five measures of capital intensity are calculated for each enterprise over the period 1989 to 1996. The correlations between the mean values of the measures are all positive. Similar calculations were conducted for the median values. Both the correlations and the elements of the first principal component do not differ substantially for the mean and median values. Principal component analyses are conducted on these two correlation matrices, and the coefficients of the first principal components are obtained (see also Table 4.3 and Figure 4.3). The coefficients are all

relatively large (varying between 0,390 and 0,499) and indicate that all five the measures provide an important contribution to the principal component scores. Even though the measure DEP:REV has the lowest value, it is still relatively large and the measure should therefore still be included. All five the measures of capital intensity are therefore included in the composite measure and it is not possible to exclude any of the measures.

Table 4.3: First principal components for the 48 enterprises providing complete financial information

RATIO	1989	1990	1991	1992	1993	1994	1995	1996	MEAN	MEDIAN
TOT:REV	0,460	0,468	0,473	0,502	0,469	0,477	0,455	0,443	0,471	0,475
PPE:REV	0,498	0,496	0,490	0,521	0,502	0,505	0,501	0,503	0,495	0,499
PPE:TOT	0,459	0,452	0,467	0,456	0,436	0,449	0,454	0,453	0,458	0,446
DEP:REV	0,395	0,394	0,380	0,265	0,406	0,400	0,433	0,444	0,400	0,390
PPE:EMP	0,415	0,420	0,416	0,445	0,416	0,394	0,385	0,385	0,405	0,417

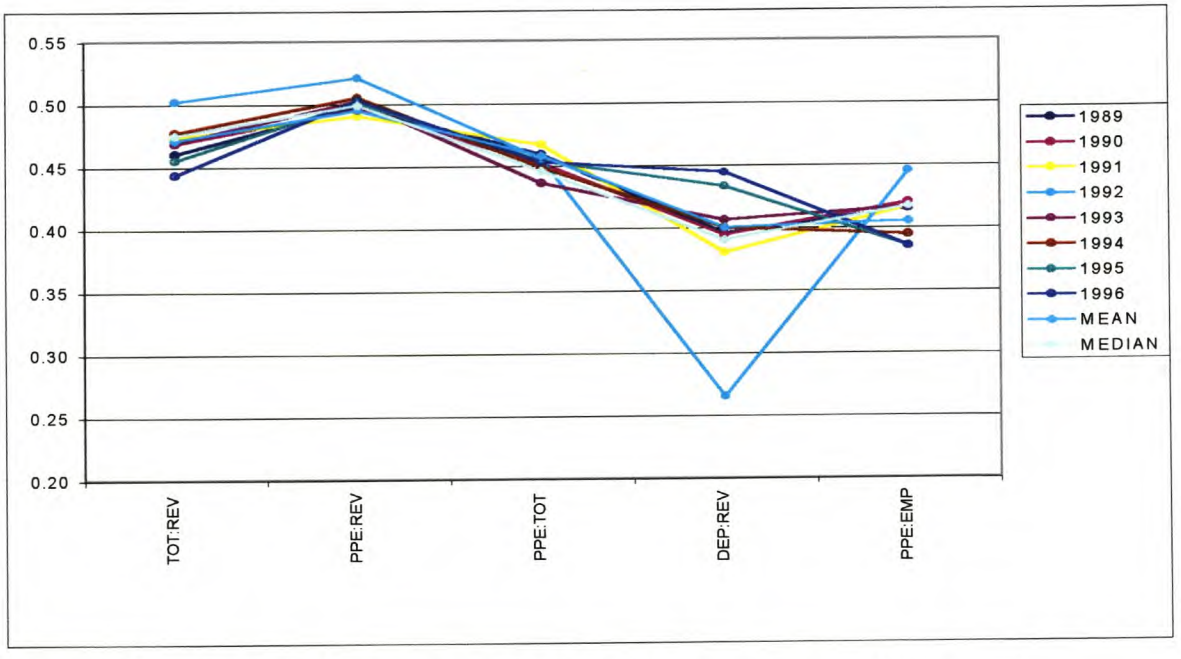


Figure 4.3: First principal components for the 48 enterprises providing complete financial information

The principal component scores are calculated for the 48 enterprises for each year of the study as well as for the mean and median values over the period under review. The lower the value of a principal component score is, the higher the degree of capital

intensity and, conversely, the higher the value is, the lower the degree of capital intensity.

In Figure 4.4 the enterprises are ranked according to increasing capital intensity based on the principal component scores calculated for each year, the mean and median values. If the different rankings are investigated, it can be seen that in most cases very similar rankings are obtained for the different years as well as for the principal component scores based on the mean and median values. Some exceptions, however, do occur. The largest change in the rankings occurs in the case of Autopage, where a decrease of more than 10 positions occurs during 1996. However, if the enterprise's rankings over the different years of the study are considered individually, it appears that they are gradually decreasing. This could be an indication that some factor caused the enterprise's degree of capital intensity to decrease over the period under review. The opposite situation is found in the case of Consol, where the rankings increased substantially during the last two years of the study. The rankings for Group Five increased during 1989 to 1992 and started to decrease again from 1993 to 1996, while the opposite change occurs in the rankings of Trencor. Initially the rankings decreased during the period 1989 to 1991, but then they started to increase from 1992 onwards. The exceptions in the rankings are not investigated in the remainder of this study, but need to be addressed in future studies.

From Figure 4.4 it is clear that the rankings obtained from the principal component scores based on the median is very similar to those based on the mean. The principal component scores calculated for these two values therefore provide very similar rankings. It is therefore not necessary to consider both these values and biplots could be constructed for principal component scores based on the mean only.

Furthermore, if the rankings are investigated, it appears that the principal component scores are able to distinguish between capital and labour intensive enterprises. Enterprises located to the left of the figure are mainly listed in the Stores and Food sectors. These types of enterprises are generally considered to be less capital intensive. The enterprises located to the right of the figure include enterprises listed in the Building and Construction, Engineering, Steel and Allied, and Electronics sectors. These enterprises are usually considered to be relatively capital intensive.

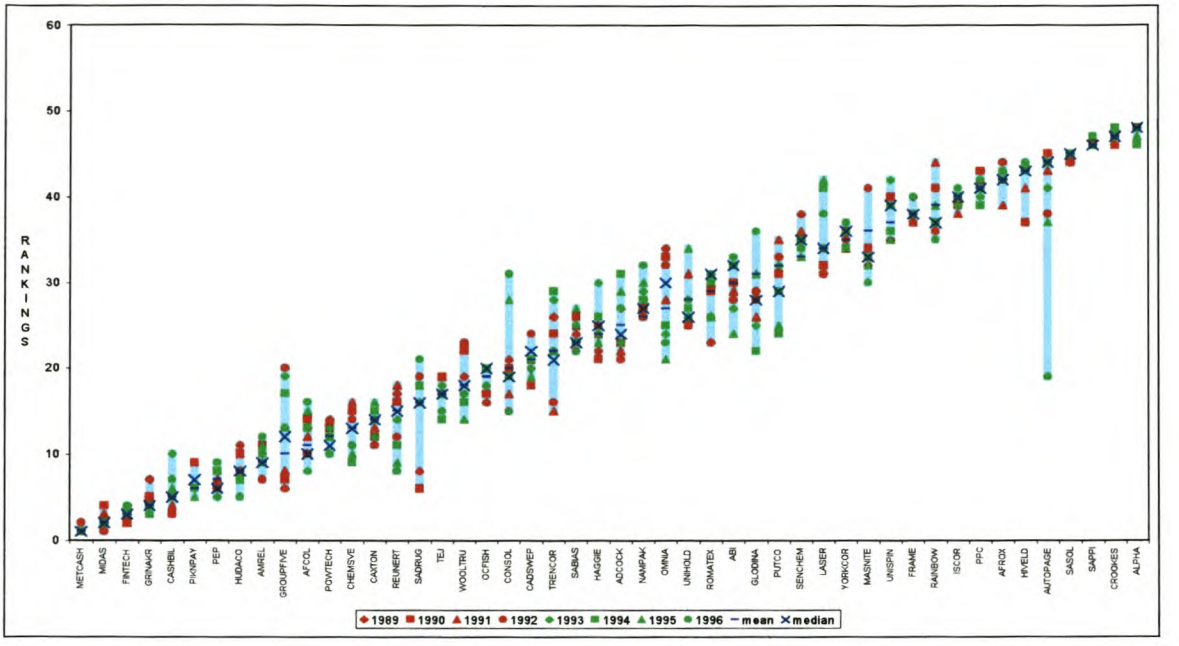


Figure 4.4: 48 enterprises ranked according to principal component scores calculated for each year as well as for the mean and median

It is not only the first principal component which contains information about the measures. The other principal components can also provide valuable information. The coefficients of the second principal component are provided in Table 4.4. It is clear from the table that the coefficients of the second principal component show a remarkably similar pattern during the decline phase (1989-1992). During this period, the second principal component is essentially a contrast between the measures PPE:TOT and DEP:REV, on the one hand, and the three other measures on the other hand. During the first part of the upswing phase (1993-1994), the second principal component is a contrast between DEP:REV and PPE:EMP, while it is dominated by PPE:EMP during the latter part of the upswing phase (1995-1996). If the second principal component is considered, it points to differences in the behaviour of the different measures during the decline and upswing phases.

Table 4.4: Second principal components for the 48 enterprises providing complete financial information

RATIO	1989	1990	1991	1992	1993	1994	1995	1996	MEAN	MEDIAN
TOT:REV	-0,322	-0,349	-0,349	-0,214	-0,199	0,077	0,087	0,412	-0,230	-0,273
PPE:REV	-0,204	-0,236	-0,249	-0,132	-0,065	0,013	0,212	0,166	-0,105	-0,122
PPE:TOT	0,352	0,358	0,298	0,207	0,253	-0,090	0,195	-0,147	0,276	0,278
DEP:REV	0,715	0,730	0,776	0,882	0,694	0,693	0,271	0,278	0,700	0,736
PPE:EMP	-0,469	-0,402	-0,352	-0,341	-0,640	-0,711	-0,914	-0,839	-0,608	-0,542

The coefficients of all five the principal components, calculated for the mean values of the measures over the period under review, are indicated in Table 4.5. If the coefficients of the first principal component displayed in Table 4.5 are considered, it should be noted that the sign of the coefficients differ from those provided in Table 4.3. However, since principal component analysis is unique in respect of multiplication by plus or minus one, both these tables can be investigated and they provide the same information. It is important to note that the coefficients indicated in Table 4.5 are used when the principal component scores provided in Table 4.6 are calculated. This explains the large negative principal component scores in the case of a capital intensive enterprise, and the positive values in the case of labour intensive enterprises. In Figures 4.5 and 4.6 the positive coefficients are used and the enterprises' degrees of capital intensity increase when moving along the horizontal axis of the biplot.

Although the focus in this study is mainly on the first, and to some extent the second, principal component, the other principal components can also provide important information about the behaviour of the different measures. If the third principal component is investigated, it can be seen that it is basically a contrast between the measures PPE:REV and TOT:REV (with coefficients of -0,422 and -0,486 respectively), on the one hand, and the measures DEP:REV and PPE:EMP (with coefficients of 0,345 and 0,680), on the other hand. In the fourth principal component, however, the measure PPE:TOT has the largest value (-0,771) and a contrast is formed with the measures TOT:REV and DEP:REV. In the fifth principal component, there is a contrast between the measure PPE:REV and the measures PPE:TOT and TOT:REV. These principal components therefore point towards differences in the contributions of the different measures. However, although these principal components can provide

more information about the different measures, the focus in this study is on the first principal component, which is used to construct a composite measure of capital intensity, and the others are not evaluated further.

Table 4.5: Principal components based on the mean values of the five measures, calculated for the 48 enterprises providing complete financial information

	PRINCIPAL COMPONENT 1	PRINCIPAL COMPONENT 2	PRINCIPAL COMPONENT 3	PRINCIPAL COMPONENT 4	PRINCIPAL COMPONENT 5
PPE:TOT	-0,471	-0,230	0,054	-0,771	-0,341
PPE:REV	-0,495	-0,105	-0,422	-0,103	0,745
TOT:REV	-0,458	0,276	-0,486	0,413	-0,564
DEP:REV	-0,400	0,700	0,346	0,470	0,094
PPE:EMP	-0,405	-0,608	0,680	0,053	0,038

4.2.3 Biplots

It is possible to interpolate the principal component score of an enterprise not included in the original sample of 48 enterprises in order to plot it on a biplot. However, to be able to do this, at least one year's value for each one of the measures should be available. The principal component scores for the 48 enterprises used for constructing the biplots, together with the interpolated scores for 66 other enterprises from the main sample, are given in Table 4.6. Four enterprises provided no values for certain measures and it is therefore not possible to calculate an interpolated value for these enterprises.

By considering the values of the principal component scores, an indication of an enterprise's degree of capital intensity can be obtained. Comparing the principal component score for Sasol (-3,4877) to that of Midas (2,30514) indicates that Sasol (Chemical & Oil) is relatively capital intensive, while Midas (Stores) is relatively less capital intensive.

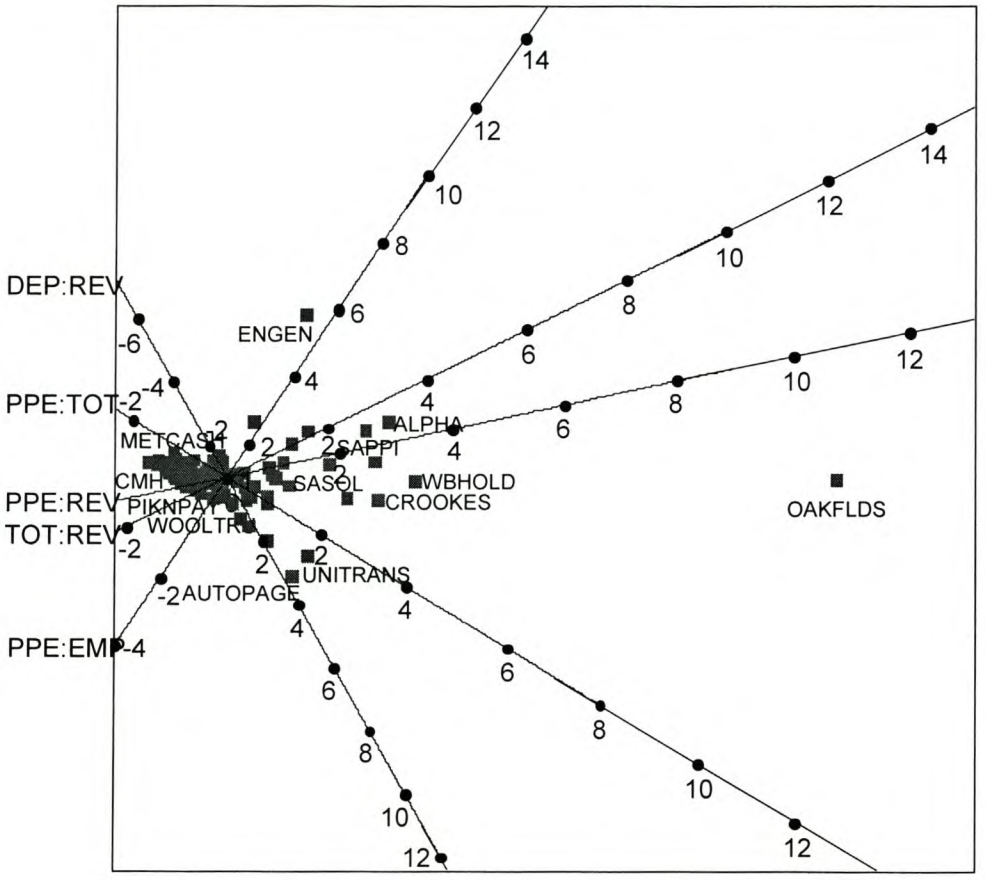
Table 4.6: Principal component scores for the 48 enterprises providing complete financial information, and the interpolated scores for 66 other enterprises from the main sample

ENTERPRISE	SCORE	ENTERPRISE	SCORE	ENTERPRISE	SCORE	ENTERPRISE	SCORE	ENTERPRISE	SCORE
ABI	0.19967	CLINIC	-1.4111	GLODINA	0.19921	NAMPAK	0.27492	SAPPI	-4.7261
ADCOCK	0.47978	CLYDE	1.85108	GRINAKR	2.03481	NAMSEA	-0.7804	SASOL	-3.4877
ADONIS	0.33369	CMH	2.71993	GROUPFIVE	1.44367	NEIAFR	1.48989	SCHARRIG	-4.083
ADVTECH	0.15285	COATES	1.17052	GUBINGS	1.4095	NINIAN	1.44411	SENCHEM	-0.5615
AFCOL	1.41575	CONCOR	2.10486	HAGGIE	0.50342	NUWORLD	1.73404	SFW	0.2906
AFROX	-2.0919	CONSHU	1.5461	HARWILL	0.91395	OAKFLDS	-20.885	SHOPRITE	2.015
ALEXANDR	-0.4019	CONSOL	0.78623	HIVELD	-2.1882	OCFISH	0.91474	SILTEK	2.37691
ALEXWYT	-0.3174	CONTROL	1.29392	HUDACO	1.7454	OMNIA	0.26299	SONDOR	0.56451
ALPHA	-5.5174	COPI	-0.8702	I&J	1.04568	PALS	1.794	SPESCOM	1.3438
AMREL	1.61018	CROOKES	-5.1453	INMINS	2.10703	PEP	1.80737	SUNCRSH	0.18815
ARIES	0.9374	DELTA	1.06189	ISCOR	-1.6163	PIKNPAY	1.8328	TEJ	1.09101
AUTOPAGE	-2.2063	DIDATA	1.64405	JASCO	2.09782	PORTHLD	-2.7362	TONGAAT	-0.1666
BASREAD	1.62757	DISTIL	0.32564	JDGROUP	1.79507	POWTECH	1.39715	TOYOTA	0.48094
BOLWEAR	1.63244	EDGARS	1.61402	KAROS	-5.0356	PPC	-1.9034	TRENCOR	0.69607
BOUMAT	2.29407	EDLBATE	1.99594	LASER	-0.6058	PROFURN	1.85889	UNIHOLD	0.25339
BOWCALF	-1.3396	ELLERINE	1.47901	LTA	1.55752	PUTCO	-0.176	UNISPIN	-1.3342
CADSWEP	0.76939	ENGEN	-2.6738	MACADAM	1.94702	RAINBOW	-1.5067	UNITRANS	-2.7164
CARGO	-1.3661	FINTECH	2.15182	MASNITE	-0.705	REUNERT	1.32739	VAALCAR	1.92551
CASHBIL	1.97784	FOSCHINI	1.45128	MEDICLIN	-0.8833	REXTRUE	1.75168	VOLTEX	0.44946
CAXTON	1.38391	FRALEX	-0.3965	METAIR	0.61737	ROMATEX	0.22896	WBHOLD	-6.4147
CEMENCO	1.0913	FRAME	-1.3378	METCASH	2.42479	S&SHLD	1.81283	WOOLTRU	0.9951
CHEMSVE	1.38857	GENOPT	1.21555	MIDAS	2.30514	SABIAS	0.50584	YORKCOR	-0.6188
CHUBB	1.0507	GENTYRE	-0.156	NAMFISH	-0.0175	SADRUG	1.32111		

Biplots are used to provide a two-dimensional visual representation of the data. Figures 4.5 and 4.6 are biplots constructed for the mean values of each measure in respect of the 48 enterprises providing complete financial information. The interpolated values of the 66 other enterprises from the main sample are also plotted on the biplots. To prevent the figures from becoming too cluttered, the names of only a few enterprises are indicated on the figures. The biplots make it possible to investigate graphically the degree of capital intensity of the different enterprises. By considering the location of an enterprise on the biplots, it is possible to determine its degree of capital intensity. The enterprises are arranged from left to right along the horizontal axis according to increasing capital intensity. From the biplots it can be seen that there is a high concentration of enterprises in one area towards the left of the figure. Enterprises located here include Metcash, Pick and Pay and Wooltru. Enterprises like Alpha, WB Holdings and Sappi, which are generally considered to be capital intensive enterprises, tend to be located to the right of this point, and it is mainly the enterprises which are normally considered to be less capital intensive which are found in the area of concentration. The area of concentration is located relatively near the intercept of the

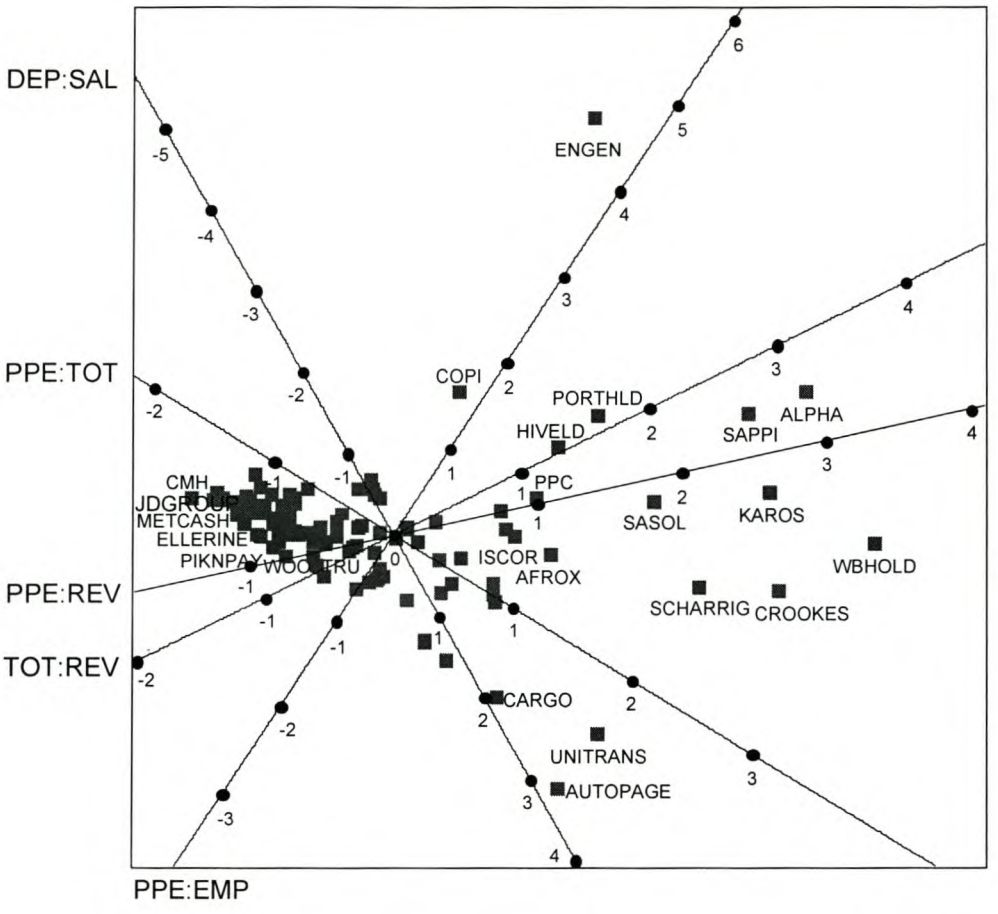
different axes. If orthogonal projections are applied, relatively small values for the different measures are obtained. The other enterprises located away from this point will usually have one or more relatively large value.

Figure 4.5: Biplot constructed for 48 enterprises and interpolated values of 66 other enterprises from the main sample (including Oakfields)



In Figure 4.6 Oakfields is excluded from the biplot. Oakfields is an enterprise mainly involved in breeding thoroughbred horses and farming activities. In most cases the values of the measures calculated for Oakfields are much larger than those calculated for the rest of the enterprises. One of the reasons such a high score is calculated for Oakfields is that, as a result of the nature of its activities, it employs relatively few employees. If the enterprise is excluded from the biplot, a clearer representation of the remaining enterprises is obtained.

Figure 4.6: Biplot constructed for 47 enterprises and interpolated values of 66 other enterprises from the main sample (excluding Oakfields)



The quality of fit of the biplot is high (86,49% of the total variance is accounted for by the first two principal components together) and indicates that the different measures are represented relatively well. The first principal component (horizontal axis) on its own accounts for 74,22% of the total variance, while the second principal component (vertical axis) accounts for 12,27% of the total variance. The adequacy for the different measures is also relatively high, with DEP:REV having the highest value (0,650) and PPE:REV the lowest (0,256).

The biplot can also be used to provide information on the relationship between the five different measures. The angles between the axes of the graph indicate whether there is a strong or a weak relationship between the measures. For instance, if PPE:REV and TOT:REV are considered, the angle between the axis is relatively small. This indicates that there is a strong relationship between the two measures. In the case of DEP:REV

and TOT:REV the angle between the axes is larger, and therefore indicates a weaker relationship between the measures.

It is furthermore also possible to use the biplot to predict the values of the original variables for an enterprise by applying orthogonal projections on the different axes of the biplot. In the case of Alpha, relatively large positive values are obtained from the orthogonal projections onto the axes for the four measures PPE:EMP, PPE:TOT, PPE:REV and TOT:REV, and a relatively small value for the measure DEP:SAL. Relatively small negative values for all the measures, however, are predicted in the case of Combined Motor Holdings.

4.3 Summary

It is necessary to differentiate between capital and labour intensive enterprises because of the different ways that the two types of enterprises react to changes in the economic cycle. If it is possible to determine the degree of capital intensity of an enterprise, this information can be used to improve the quality of financial decision-making. Up until now, no satisfactory methods of differentiating between capital and labour intensive enterprises have been developed. In the literature reference is generally made only to the different measures, but their merits are not discussed in detail.

This chapter investigates five traditional measures of capital intensity. The objective is to find an appropriate method to determine which measure(s) should be used to measure the degree of capital intensity of an enterprise. A sample of enterprises (Table 3.1) listed in the Industrial Sector of the Johannesburg Stock Exchange is selected. However, complete financial data are available only for 48 of these enterprises. In this chapter the focus is on the five measures PPE to revenue, total assets to revenue, PPE to total assets, depreciation as a percentage of revenue and PPE per employee. These measures are calculated for the 48 enterprises providing complete financial data for the entire period of the study.

Statistical procedures which could possibly be used to evaluate the data include principal component analyses (PCA) and related biplots. Principal component analysis explains the variance-covariance structure of a data set through a few uncorrelated linear equations accounting for as much of the variation as possible. The principal component scores obtained with the first principal component are linear combinations of the five measures and can be used as a composite measure of the degree of capital intensity. The coefficients of the first principal component indicate the contribution of the different measures to this composite measure. A large value indicates that the measure provides an important contribution to the overall measure, while a smaller value indicates that the contribution is not so important. Since these coefficients are all relatively large, all five of the measures are included. The principal component scores for the 48 enterprises are calculated and used to arrange the enterprises according to increasing degrees of capital intensity. The principal component scores for 66 other enterprises from the main sample are also interpolated. Unfortunately the interpolated values for the other 4 (118-48-66) enterprises could not be calculated due to the unavailability of the values for some measures. Finally, biplots are constructed to provide a two-dimensional visual representation of the data. The interpolated values are also indicated on the biplot. The results indicate that a number of enterprises listed in the Building and Construction, Engineering, Steel and Allied, and Pharmaceutical Sectors are relatively capital intensive, while enterprises listed in the Stores and Food sectors are in most cases less capital intensive.

4.4 Conclusions and recommendations

The principal component scores obtained from the first principal component are proposed as a composite method to measure the degree of capital intensity. These principal component scores represent a linear combination of five of the traditional measures of capital intensity discussed in the literature. A visual evaluation of the results indicates that the proposed measure is able to distinguish between capital intensive and less capital intensive enterprises. However, some exceptions in the results do occur and need to be considered in future studies.

The correlations between the five different measures are all positive and relatively large. This is an indication that to some extent the five measures are measuring the same characteristics and it is assumed that the five measures are all able to indicate capital intensity relatively well. If the coefficients of the first principal component are considered, it is found that they are all relatively large, and therefore all contribute to the combined measure. It is therefore not sufficient to use only a single measure when measuring the degree of capital intensity, but a combination of the measures should be considered. Since a single measure of capital intensity focuses on only one aspect of an enterprise, this could have been expected. The results of the chapter therefore provide researchers with a more efficient method to measure the degree of capital intensity of an enterprise. Biplots can also be used to graphically evaluate the degree of capital intensity of enterprises.

One of the major shortcomings of this chapter is that the other four measures of capital intensity (based on value added figures) which have been identified in the literature survey are not included in the research. One of the reasons why these measures are not included in this chapter is that value added figures are not available for all the enterprises in the main sample. Furthermore, some doubts have been expressed about the ability of these measures to quantify capital intensity (Burger and Hamman, 1999). It was therefore decided to investigate these measures individually. In the next chapter these measures will be considered together with the measures evaluated in this chapter.

In this chapter the focus is mainly on the first principal component, which was used as a size vector to determine the principal component scores for the enterprises. The other principal components can also provide important information. In particular, if the second principal component is considered, information about the behaviour of the measures during the two economic cycles is obtained. In future studies the contribution of the other principal components should therefore also receive more attention.

CHAPTER 5

THE MEASUREMENT OF CAPITAL INTENSITY BY MEANS OF TRADITIONAL AS WELL AS VALUE ADDED MEASURES

5.1 Introduction

In the previous chapter the five traditional measures of capital intensity, which are not based on value added figures, were investigated to determine their ability to measure capital intensity. The correlations between the five measures are all relatively large and positive. This indicates that to some extent the measures are measuring the same characteristics and it could therefore be assumed that they are all indeed measuring capital intensity. A composite measure of capital intensity was developed by calculating the principal component score of an enterprise obtained from the first principal component (Erasmus, Lambrechts, Le Roux and Gardner, 2000). These principal component scores represent a linear combination of the five traditional measures of capital intensity. Biplots were constructed to provide a two-dimensional visual representation of the data.

In this chapter all nine of the measures of capital intensity which were identified in the literature survey are evaluated to determine which measures provide the most accurate indication of capital intensity. Four of the measures which are investigated are based on value added figures. These measures were excluded from the research conducted in the previous chapter for two reasons. Firstly, since all the enterprises in the main sample did not publish value added figures, it was not possible to calculate the four measures which are based on value added figures for all these enterprises. A sub-sample consisting of the 60 enterprises which provided value added statements was therefore compiled from the main sample (Table 3.3). All nine measures of capital intensity can be calculated for this sub-sample. Secondly, the results of an investigation by Burger

and Hamman (1999) cast a doubt on the role of value added indicators in describing capital intensity. It was therefore decided to investigate these measures separately.

The main objective of this chapter is firstly to investigate the four measures which are based on value added figures and to determine if these measures are suitable to be used as indicators of capital intensity. Secondly, an attempt is made to determine if it is possible to include these measures in the principal component analyses, and if they can therefore be included in the calculation of the principal component score which is proposed as a composite measure of capital intensity, together with the five traditional measures of capital intensity.

This chapter consists of 4 sections. In section two the results are highlighted, while section three provides a summary of the findings. Section four contains the conclusions and recommendations.

5.2 Results

5.2.1 Correlation between the measures

The correlations between the nine different measures of capital intensity, calculated for the 60 enterprises which provided value added figures, are provided in Tables 5.1, 5.2 and 5.3, while they are graphically displayed in Figures 5.1, 5.2 and 5.3. Unlike the correlations between the five traditional measures which were investigated in the previous chapter of the study, no separate trends exist between the correlations calculated for the upswing and decline phases. Furthermore, the correlations remain reasonably stable over the entire period of the study.

In the previous chapter the difference in the behaviour of the correlations during the two economic phases was partly explained by the fact that different enterprises were included in the calculation of the correlations. Of the 118 enterprises included in the main sample, only 48 enterprises provided the required financial information to calculate all five of the traditional measures for each year of the study. When the

correlations were investigated for these 48 enterprises only, it was found that they did not vary substantially over the different years and, furthermore, that the differences between the correlations calculated for the upswing and decline phase did not differ substantially.

In this chapter complete financial information to calculate all nine measures is only provided by 34 of the enterprises over the entire period of the study (see Table 3.4). However, if the correlations between the nine measures are calculated using only these 34 enterprises, they do not differ substantially from those calculated using the different number of enterprises providing the necessary information for specific years. It therefore appears that it is not necessary to consider the correlations between the measures calculated only for the 34 enterprises providing complete financial information, as was the case in the initial part of the study.

The correlations between the measures based on value added figures, those not based on value added figures and between the two sets of measures are investigated individually. The correlations between the five traditional measures which are not based on value added figures are provided in Table 5.1, while Figure 5.1 represents these correlations in the form of a graph. The five measures are all positively correlated and these correlations are furthermore all relatively large. If a large positive correlation between two measures is found, this indicates that to some extent the two measures are measuring the same characteristics. A strong relationship therefore exists between the five measures when they are calculated for the enterprises which also provided value added figures. In the previous chapter large positive correlations were also obtained between the five measures when they were calculated for the 48 enterprises providing complete financial data. It therefore seems as if the five measures which are not based on value added figures could be used to measure capital intensity for both the samples. Furthermore, it appears that these measures are all able to identify capital intensity.

Table 5.1: Correlations between the five measures not based on value added figures, calculated for the sub-sample (but not the same number of enterprises for every year)

	1989 N=39	1990 N=46	1991 N=48	1992 N=52	1993 N=50	1994 N=53	1995 N=55	1996 N=53
TOT:REV&PPE:REV (r1,2)	0,942	0,936	0,953	0,925	0,892	0,855	0,813	0,806
TOT:REV&PPE:TOT (r1,3)	0,585	0,589	0,728	0,622	0,596	0,591	0,551	0,521
TOT:REV&DEP:REV (r1,4)	0,698	0,665	0,683	0,667	0,745	0,800	0,688	0,651
TOT:REV&PPE:EMP (r1,5)	0,532	0,411	0,629	0,545	0,457	0,316	0,244	0,258
PPE:REV&PPE:TOT (r2,3)	0,768	0,768	0,836	0,796	0,806	0,837	0,873	0,844
PPE:REV&DEP:REV (r2,4)	0,747	0,704	0,695	0,680	0,753	0,790	0,726	0,688
PPE:REV&PPE:EMP (r2,5)	0,614	0,438	0,617	0,537	0,445	0,331	0,310	0,339
PPE:TOT&DEP:REV (r3,4)	0,764	0,683	0,798	0,709	0,693	0,674	0,625	0,625
PPE:TOT&PPE:EMP (r3,5)	0,649	0,499	0,518	0,473	0,397	0,386	0,389	0,405
DEP:REV&PPE:EMP (r4,5)	0,542	0,307	0,374	0,305	0,269	0,245	0,213	0,232

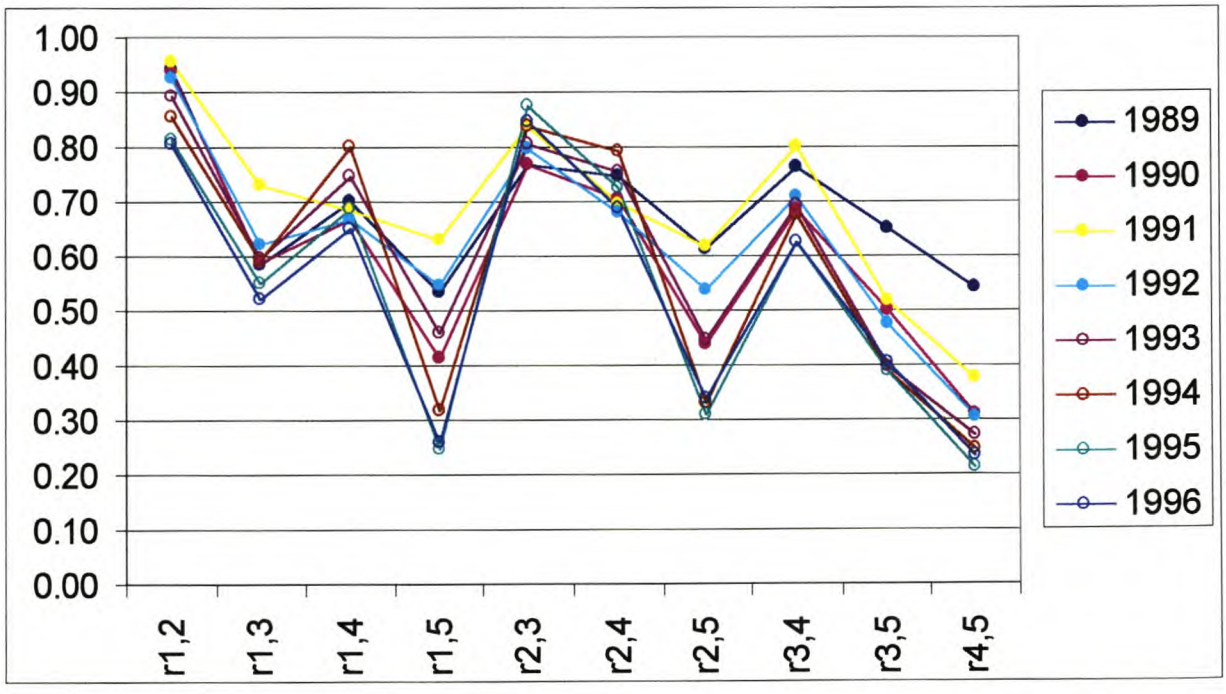


Figure 5.1: Correlations between the five measures not based on value added figures, calculated for the sub-sample (but not the same number of enterprises for every year)

If the correlations displayed in Figure 5.1 are investigated, it can be seen that in most cases they remain relatively stable for the different years of the study. The largest differences between the correlations exist between the measures TOT:REV and

PPE:EMP (varying between 0,244 and 0,629), and PPE:REV and PPE:EMP (varying between 0,310 and 0,617).

The four measures which are based on value added figures are both positively and negatively correlated (Table 5.2 and Figure 5.2). Relatively large negative correlations are found between the measures VA:EMP and SAL:VA, indicating that a negative relationship exists between the two measures. Both positive and negative correlations are found between the measures PPE:VA and SAL:VA. During 1991 a relatively small positive correlation between the measures exists, while relatively small negative correlations are found for the other years. The correlations between the measures SAL:REV and VA:EMP are all negative and relatively small. In the case of SAL:REV and PPE:VA, SAL:REV and SAL:VA, and VA:EMP and PPE:VA relatively small positive correlations are found. A relatively small correlation between two measures usually indicates that the two measures are not measuring the same characteristics.

However, it may be possible that the small correlations are the result of the two measures behaving differently for enterprises in different sectors. If two measures have a high positive correlation when calculated for enterprises in certain sectors and a high negative correlation for enterprises in other sectors, the result would be a low overall correlation between the two measures. To investigate this, scatterplots are compiled of the calculated values for the measures.

Table 5.2: Correlations between the four measures based on value added figures, calculated for the 60 enterprises providing value added figures

	1989 N=39	1990 N=46	1991 N=48	1992 N=52	1993 N=50	1994 N=53	1995 N=55	1996 N=53
SAL:REV&VA:EMP (r6,7)	-0,323	-0,401	-0,428	-0,353	-0,311	-0,356	-0,369	-0,353
SAL:REV&PPE:VA (r6,8)	0,202	0,210	0,295	0,169	0,098	0,125	0,063	0,137
SAL:REV&SAL:VA (r6,9)	0,358	0,365	0,414	0,346	0,151	0,314	0,194	0,417
VA:EMP&PPE:VA (r7,8)	0,124	0,157	0,138	0,344	0,303	0,382	0,418	0,486
VA:EMP&SAL:VA (r7,9)	-0,600	-0,634	-0,498	-0,616	-0,649	-0,727	-0,631	-0,607
PPE:VA&SAL:VA (r8,9)	-0,263	-0,258	0,296	-0,227	-0,337	-0,428	-0,162	-0,229

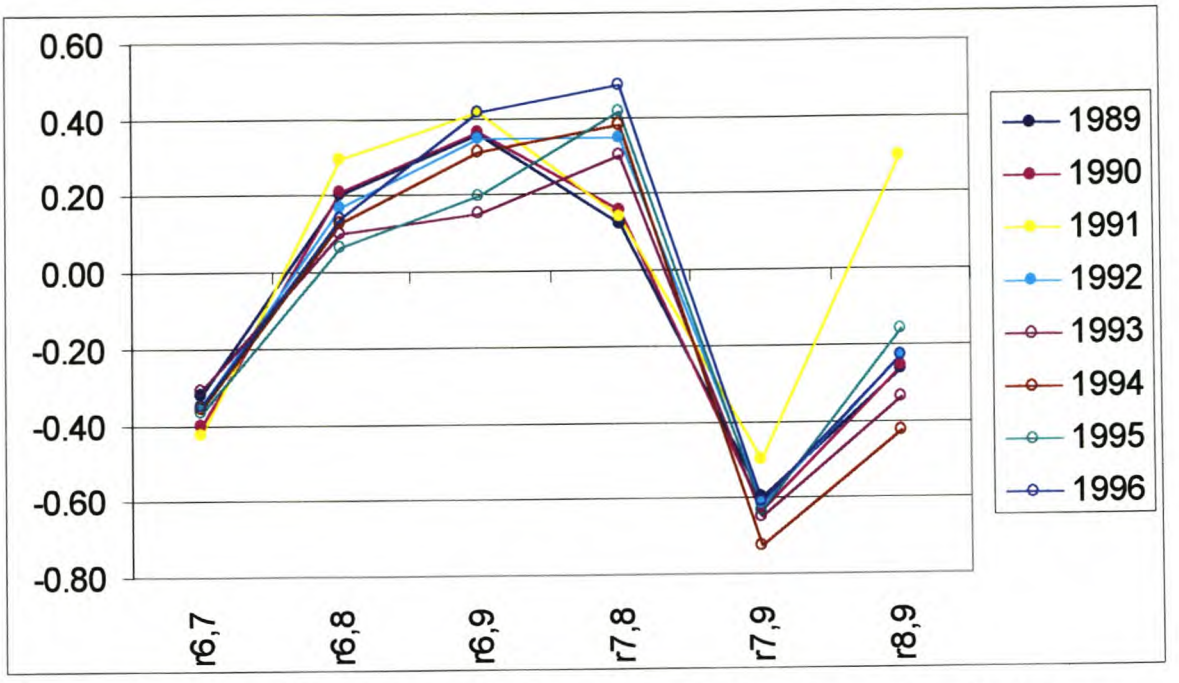


Figure 5.2: Correlations between the four measures based on value added figures, calculated for the 60 enterprises providing value added figures

By investigating the scatterplots, it is possible to obtain more information about the nature of the relationship between two measures. Relatively large positive correlations exist between the measures TOT:REV and PPE:REV. If the scatterplots for these measures are investigated, it can be seen that a very strong positive linear relationship exists between the values of the two measures (Figure 5.3). Similarly, in the case of VA:EMP and SAL:VA, relatively large negative correlations exist. On the scatterplots this is indicated by a relatively strong negative relationship between the measures (Figure 5.4). The values of the correlations, however, are not as large as those between TOT:REV and PPE:REV, and the scatterplot indicates that the relationship between the measures is non-linear. The correlations between certain enterprises are relatively large; this is indicated by the enterprises located in the upper left corner of the figure, while the correlations between the enterprises located to the extreme right of the figure are smaller. In the case of the measures DEP:REV and SAL:VA, a relatively small negative correlation is found. If the scatterplot (Figure 5.5) is investigated, it can be seen that a relatively weak negative relationship exists between the measures. The relationships between the measures are also non-linear, as in Figure 5.4. However, a few enterprises where a relatively large positive correlation exists between the measures are located in the upper left corner of the figure. As a result of these enterprises, the overall correlation calculated between the measures may be slightly larger than in the

case where they are not included in the calculation of the correlations. By investigating the scatterplots, a better understanding of the relationship between the measures is therefore obtained than by simply relying on the values of the correlations between the measures.

If the correlation between the measures SAL:REV and VA:EMP is considered, it is found that the two measures also have a small negative correlation. If the scatterplot (Figure 5.6) is investigated, however, it seems that a relatively strong positive correlation exists between the two measures for certain enterprises and a relatively strong negative correlation for the others. If the individual points on the figure are identified, it is found that the enterprises where positive correlations exist are mostly from the Stores and Food sectors, which are normally considered to be relatively labour intensive. The negative correlations exist for enterprises from the Building and Construction, Engineering, Steel and Allied, and Pharmaceutical sectors, which are generally considered to be relatively capital intensive. From this scatterplot it can be seen that, in some instances, the small correlations are the result of differences in the behaviour of enterprises from different sectors. This may be an indication that some of the measures which are investigated are more suitable to be used as measures of capital intensity for enterprises from specific sectors and not necessarily for all enterprises.

Figure 5.3: Scatterplot compiled for the measures TOT:REV and PPE:REV

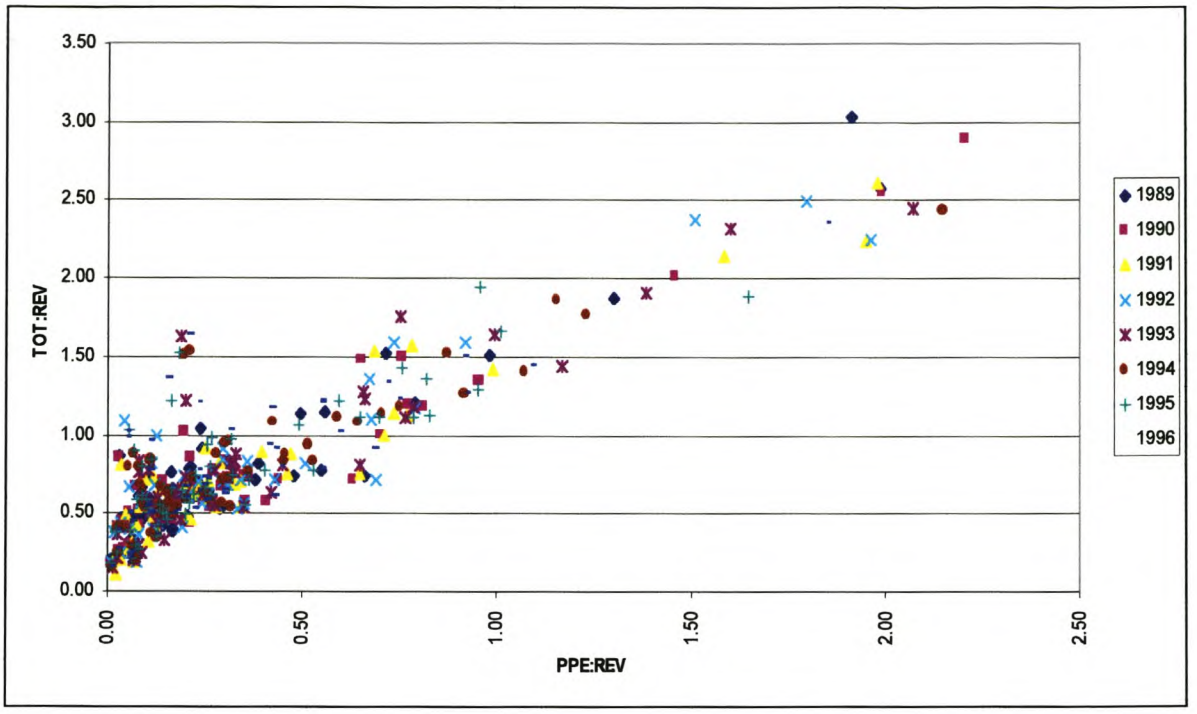


Figure 5.4: Scatterplot compiled for the measures VA:EMP and SAL:VA

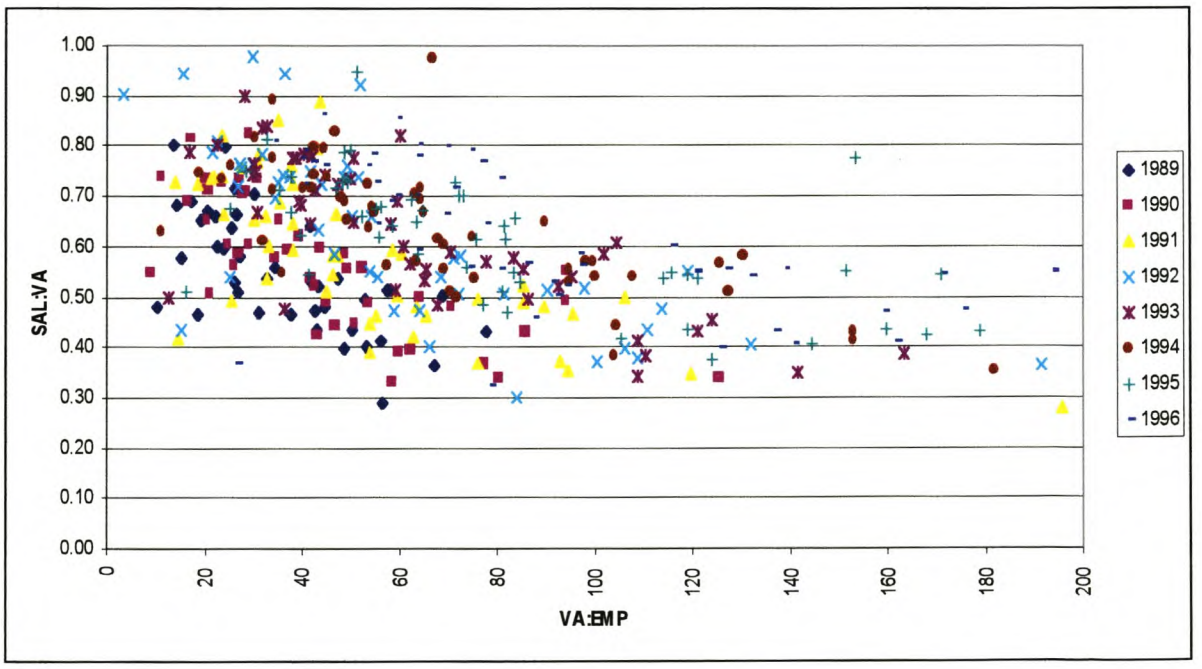


Figure 5.5: Scatterplot compiled for the measures DEP:REV and SAL:VA

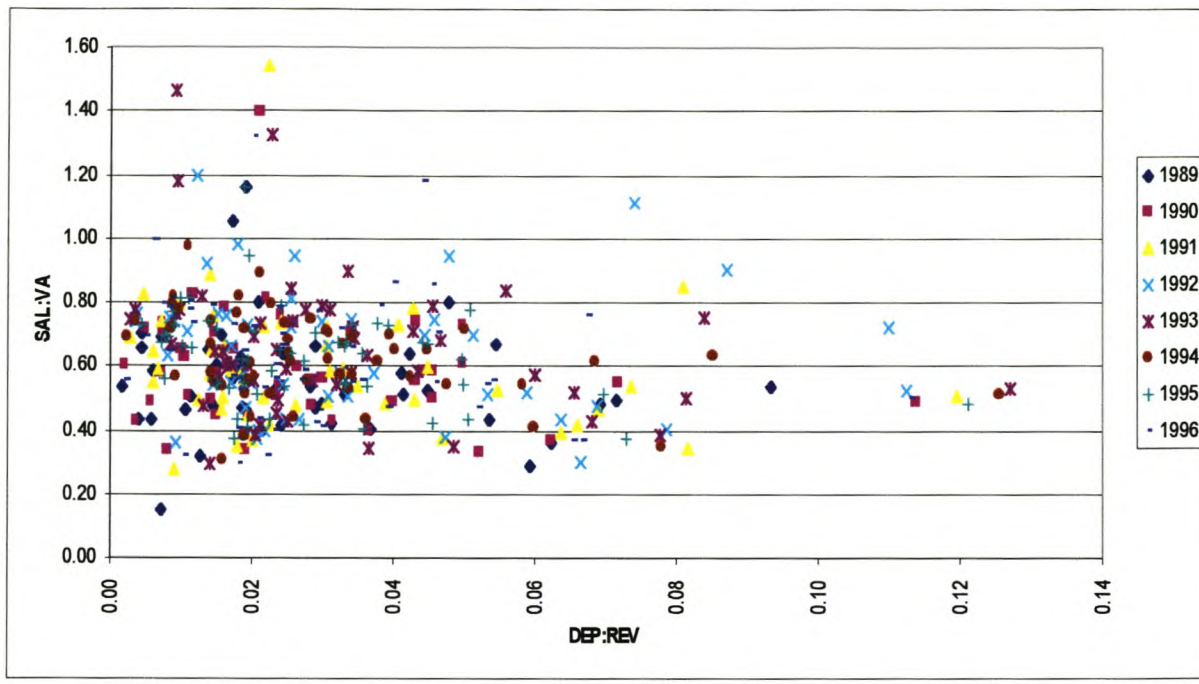
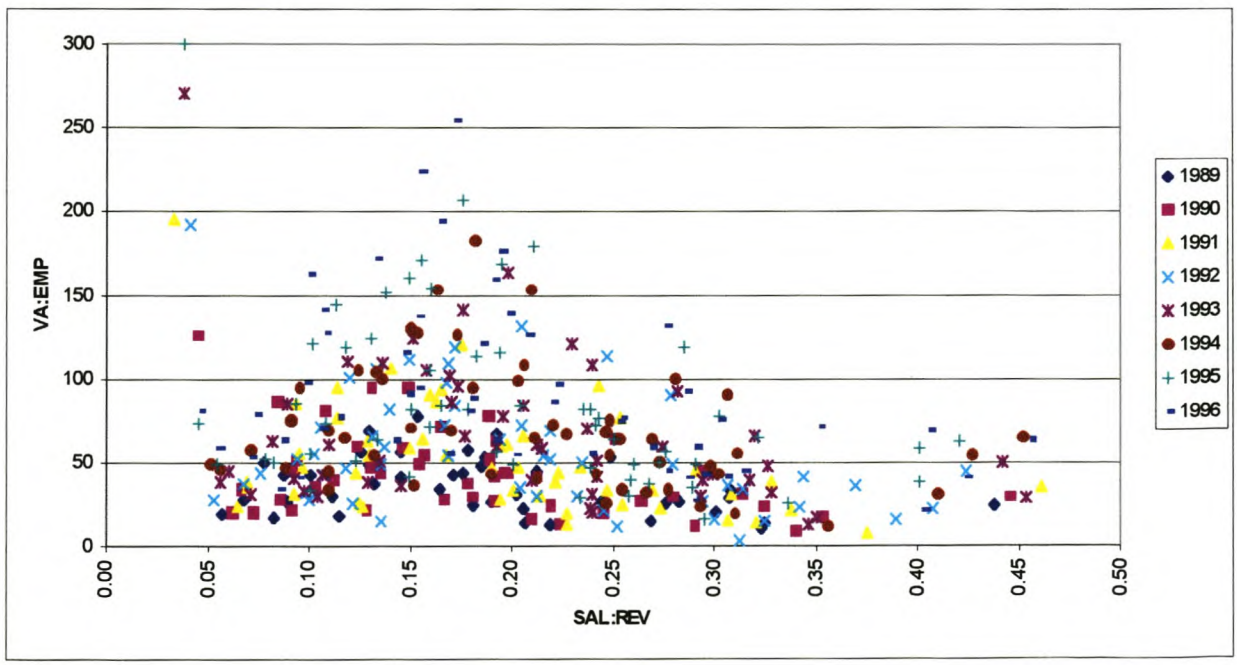
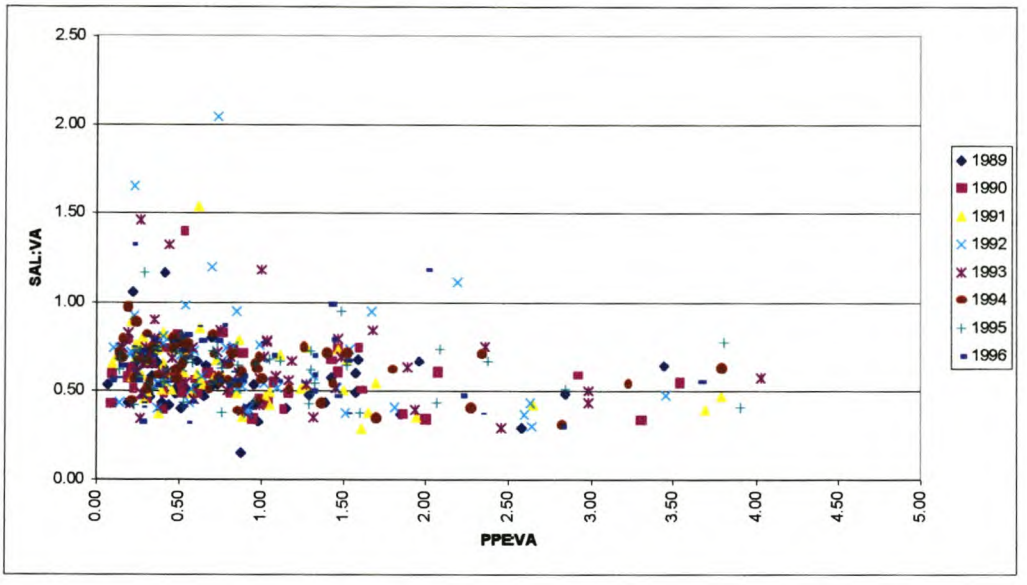


Figure 5.6: Scatterplot compiled for the measures SAL:REV and VA:EMP



The measures PPE:VA and SAL:VA are both positively and negatively correlated, depending on the particular year considered. During 1991 they are negatively correlated, while they are positively correlated for the other years of the study. In Figure 5.7 the scatterplot compiled for these two measures is provided.

Figure 5.7: Scatterplot compiled for the measures PPE:VA and SAL:VA



The correlations between the five measures not based on value added figure, and the four measures which are based on value added figures are provided in Table 5.3 and Figure 5.8 . Both positive and negative correlations exist. The measures DEP:REV and SAL:VA, and PPE:REV and VA:EMP are both positively and negatively correlated depending on the year considered. For certain years they are positively correlated, while they are negatively correlated for the others. Furthermore, these correlations are all relatively small.

Relatively large positive correlations are found between the measure PPE:VA and the five measures which are not based on value added figures. This could be an indication that the measure is also able to indicate capital intensity. The three other measures based on value added figures have relatively small correlations with the five measures. This could be an indication that these measures are not suitable to be used as measures of capital intensity.

Table 5.3: Correlations between the measures based on value added figures, and those not based on value added figures, calculated for the 60 enterprises providing value added figures

		1989 N=39	1990 N=46	1991 N=48	1992 N=52	1993 N=50	1994 N=53	1995 N=55	1996 N=53
TOT:REV&SAL:REV	(r1,6)	0,421	0,404	0,355	0,332	0,352	0,402	0,439	0,432
TOT:REV&VA:EMP	(r1,7)	0,079	0,020	0,147	0,225	0,264	0,194	0,204	0,182
TOT:REV&PPE:VA	(r1,8)	0,790	0,836	0,858	0,818	0,783	0,746	0,573	0,586
TOT:REV&SAL:VA	(r1,9)	-0,281	-0,258	-0,022	-0,203	-0,379	-0,371	-0,302	-0,276
PPE:REV&SAL:REV	(r2,6)	0,388	0,425	0,347	0,334	0,363	0,382	0,449	0,415
PPE:REV&VA:EMP	(r2,7)	0,051	-0,026	0,107	0,197	0,136	0,119	0,104	0,131
PPE:REV&PPE:VA	(r2,8)	0,885	0,907	0,826	0,874	0,871	0,900	0,758	0,802
PPE:REV&SAL:VA	(r2,9)	-0,309	-0,211	-0,103	-0,276	-0,323	-0,286	-0,234	-0,221
PPE:TOT&SAL:REV	(r3,6)	0,412	0,498	0,462	0,427	0,436	0,409	0,467	0,464
PPE:TOT&VA:EMP	(r3,7)	0,126	0,111	0,139	0,242	0,14	0,196	0,145	0,203
PPE:TOT&PPE:VA	(r3,8)	0,794	0,774	0,696	0,777	0,756	0,828	0,766	0,801
PPE:TOT&SAL:VA	(r3,9)	-0,309	-0,193	-0,144	-0,316	-0,357	-0,318	-0,173	-0,136
DEP:REV&SAL:REV	(r4,6)	0,586	0,481	0,599	0,595	0,510	0,415	0,390	0,394
DEP:REV&VA:EMP	(r4,7)	0,200	0,059	0,036	0,094	0,093	0,142	0,177	0,152
DEP:REV&PPE:VA	(r4,8)	0,621	0,593	0,655	0,603	0,608	0,659	0,484	0,552
DEP:REV&SAL:VA	(r4,9)	-0,248	-0,185	0,118	-0,129	-0,253	-0,351	-0,317	-0,155
PPE:EMP&SAL:REV	(r5,6)	-0,057	-0,195	-0,138	-0,152	-0,197	-0,229	-0,220	-0,204
PPE:EMP&VA:EMP	(r5,7)	0,598	0,724	0,751	0,776	0,829	0,887	0,774	0,861
PPE:EMP&PPE:VA	(r5,8)	0,792	0,686	0,620	0,758	0,682	0,630	0,776	0,757
PPE:EMP&SAL:VA	(r5,9)	-0,422	-0,496	-0,308	-0,398	-0,489	-0,606	-0,304	-0,400

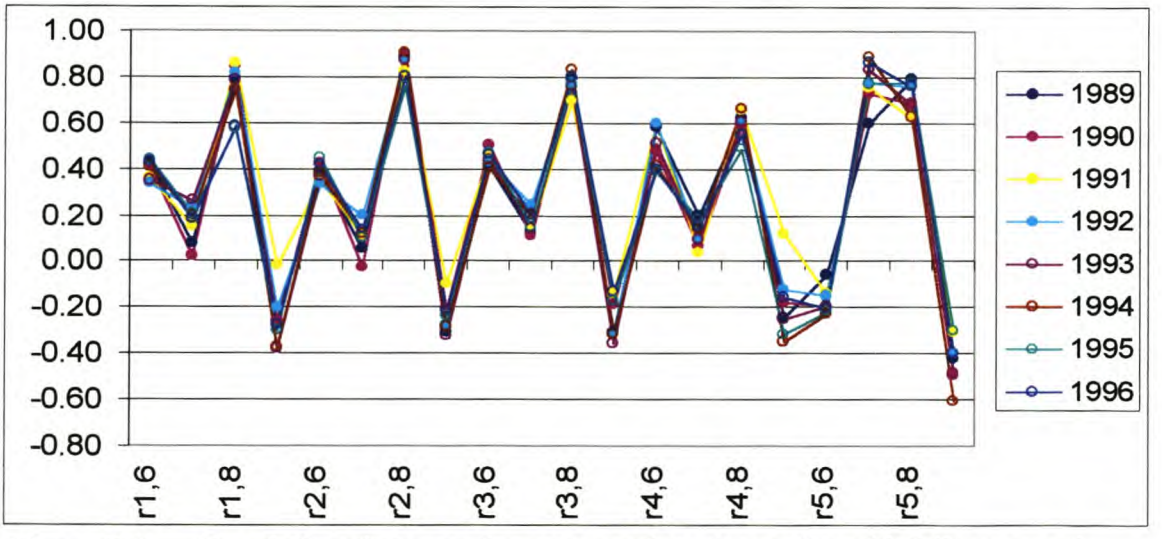


Figure 5.8: Correlations between the measures based on value added figures, and those not based on value added figures, calculated for the 60 enterprises providing value added figures

If a large negative correlation is found between two measures, this could be an indication that the measures are not measuring the same characteristic or, alternatively, that they are measuring the opposite characteristic. However, if two measures are measuring the opposite effect (capital and labour intensity in this study), it may be possible to use a measure which is normally used to quantify labour intensity (for instance, SAL:REV) to indicate capital intensity by assuming that a low degree of labour intensity indicates capital intensity. This, however, should be done very carefully, since a low degree of labour intensity does not necessarily indicate capital intensity. If large negative correlations between SAL:REV and the other measures are found, this would be an indication that it is possible to use the measure as an indicator of capital intensity. If the correlations between the measure SAL:REV and the other measures are investigated, however, it can be seen that the correlations are all relatively small. This could be an indication that the measure is not suitable to measure capital intensity.

Large positive correlations (varying between 0,484 and 0,907) exist between PPE:VA and the five measures considered in the previous chapter, while the three other measures of capital intensity based on value added figures have relatively small correlations with the five measures. Furthermore, both positive and negative correlations exist. If a principal component analysis is conducted for all nine of the measures, the first principal component will contain both positive and negative coefficients. It would therefore not be possible to use it as a size vector. However, it could still be used to evaluate the different measures. The coefficients of the first principal component will indicate the contrast between the different measures.

It is therefore not possible to include all nine of the measures in the composite measure, and in the remainder of the chapter only PPE:VA is included with the five measures which are not based on value added figures.

5.2.2 Principal component analyses

The six measures which are investigated in the remainder of this chapter are all positively correlated. The first principal component therefore forms a size variable, with its coefficients defining a linear combination of the six different measures. The principal component scores calculated for each enterprise from this linear combination of the different measures form a composite measure of an enterprise's degree of capital intensity. The lower the value of this composite measure is, the higher the degree of capital intensity, and, conversely, the higher the value is, the lower the degree of capital intensity.

The coefficients of the first principal component for each year of the study are provided in Table 5.4, while they are displayed graphically in Figure 5.9. The coefficients provide an indication of the contribution of the different measures to the composite measure. A measure with a coefficient close to zero will contribute little to the principal component score, while a measure with a large coefficient will make an important contribution to the score. Perusal of Table 5.4 and Figure 5.9 shows that the coefficients of the first principal component for the decline phase are very similar to those for the upswing phase, except for the measure PPE:VA during 1992. During this year a relatively small coefficient is calculated for the measure PPE:VA. It is of interest to note that when the measures not including value added figures were investigated (see Chapter 4), an exception also occurred for one of the measures during 1992, the year in which the change in the economic cycle occurred.

Table 5.4: First principal component for the 34 enterprises providing value added figures

RATIO	1989	1990	1991	1992	1993	1994	1995	1996	MEAN
TOT:REV	0,412	0,423	0,438	0,468	0,415	0,412	0,389	0,377	0,423
PPE:REV	0,435	0,438	0,439	0,474	0,444	0,446	0,447	0,449	0,438
PPE:TOT	0,402	0,385	0,402	0,420	0,378	0,397	0,407	0,406	0,395
DEP:REV	0,395	0,397	0,390	0,411	0,412	0,408	0,415	0,403	0,419
PPE:EMP	0,374	0,361	0,367	0,394	0,360	0,332	0,349	0,353	0,353
PPE:VA	0,428	0,439	0,409	0,235	0,433	0,445	0,436	0,453	0,416

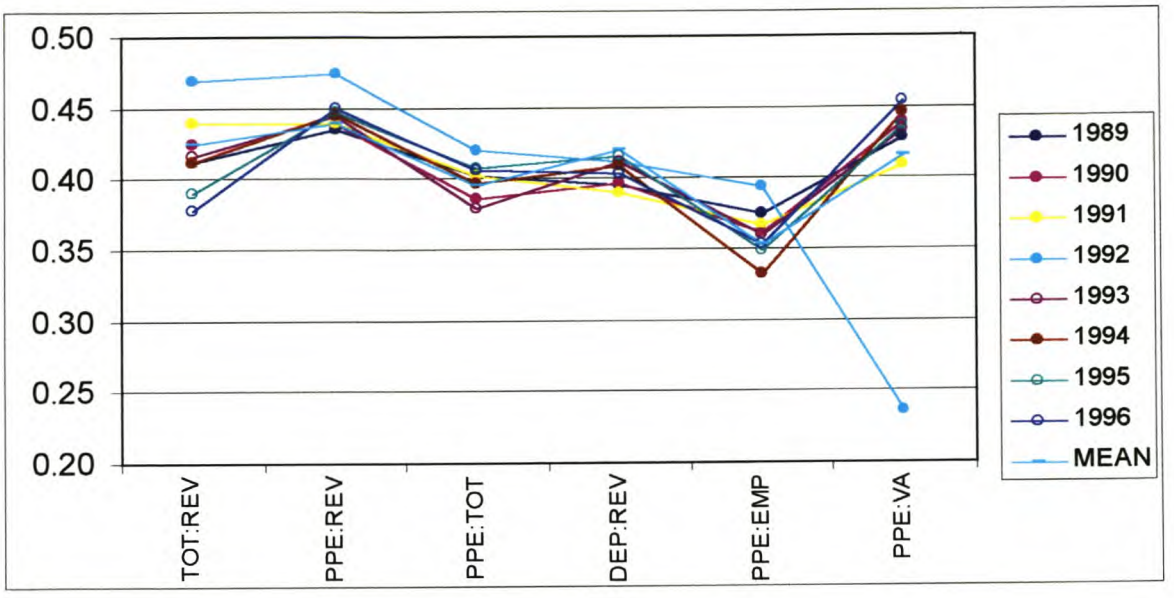


Figure 5.9: First principal component for the 34 enterprises providing value added figures for entire period

Similarly to the method used when the five measures of capital intensity which are not based on value added figures were evaluated, the mean values for the six measures are calculated for each enterprise for the period 1989 to 1996. The correlations between the mean values of the six measures are all positive and they are all relatively large. A principal component analysis is conducted on this correlation matrix. The coefficients of the first principal component are also provided in Table 5.4 and visually displayed in Figure 5.9. The coefficients calculated for the mean values are all relatively large (varying between 0,353 and 0,438) and indicate that all six of the measures make an important contribution to the principal component scores. If the coefficients of the first principal component are compared to those obtained in the previous chapter, it appears that the inclusion of the sixth measure (PPE:VA) resulted in a decrease in the value of all coefficients, except in the case of the measure DEP:REV, where an increase occurred.

The principal component scores are calculated for the 34 enterprises (Table 5.5) and they are ranked according to these scores (see Table 5.6). If the rankings are investigated, it is found that the enterprises with the large principal component scores are mainly located in the Stores and Food sectors, while those with lower scores are located in the Building and Construction, Engineering, Steel and Allied, and Electronics sectors. Enterprises from the same sectors were identified in the previous chapter.

Furthermore, if the rankings are compared to those compiled for the same 34 enterprises based on the combination of the five measures of capital intensity which were investigated in the previous chapter of the study, the largest difference in the ranking of an enterprise is only three positions (also see Table 5.6). In most cases exactly the same rankings are obtained. A very similar ranking as before is therefore obtained if the additional measure is included in the composite measure.

Table 5.5: Principal component scores for 34 enterprises providing complete value added figures

ENTERPRISE	SCORE	ENTERPRISE	SCORE	ENTERPRISE	SCORE	ENTERPRISE	SCORE
ABI	0,29630	CONSOL	0,96354	OCFISH	1,01784	SASOL	-3,36717
ADCOCK	0,71375	CROOKES	-5,21126	PEP	1,98871	SENCHEM	-0,51448
AFCOL	1,61090	FRAME	-1,60321	PIKNPAY	1,95296	TEJ	1,30249
AFROX	-1,97220	GRINAKR	2,22005	PPC	-1,91741	TRENCOR	0,94656
ALPHA	-5,43168	HAGGIE	0,61094	PUTCO	0,03622	UNISPIN	-2,51125
AMREL	1,72465	LASER	-0,53717	ROMATEX	0,31359	WOOLTRU	1,05557
CADSWEP	0,90939	METCASH	2,53755	SABIAS	0,59343	YORKCOR	-0,70879
CASHBIL	2,05479	MIDAS	2,48861	SADRUG	1,38501		
CHEMSVE	1,58386	NAMPAK	0,40304	SAPPI	-4,93512		

Table 5.6: 34 Enterprises ranked according to principal component scores based on the combination of 6 measures and 5 measures

6 MEASURES			5 MEASURES		
RANKING	ENTERPRISE	SCORE	RANKING	ENTERPRISE	SCORE
1	ALPHA	-5,43168	1	ALPHA	-5,51743
2	CROOKES	-5,21126	2	CROOKES	-5,14533
3	SAPPI	-4,93512	3	SAPPI	-4,72611
4	SASOL	-3,36717	4	SASOL	-3,48770
5	UNISPIN	-2,51125	5	AFROX	-2,09193
6	AFROX	-1,97220	6	PPC	-1,90340
7	PPC	-1,91741	7	FRAME	-1,33779
8	FRAME	-1,60321	8	UNISPIN	-1,33420
9	YORKCOR	-0,70879	9	YORKCOR	-0,61883
10	LASER	-0,53717	10	LASER	-0,60582
11	SENCHEM	-0,51448	11	SENCHEM	-0,56149
12	PUTCO	0,03622	12	PUTCO	-0,17597
13	ABI	0,29630	13	ABI	0,19967
14	ROMATEX	0,31359	14	ROMATEX	0,22896
15	NAMPAK	0,40304	15	NAMPAK	0,27492
16	SABIAS	0,59343	16	ADCOCK	0,47978
17	HAGGIE	0,61094	17	HAGGIE	0,50342
18	ADCOCK	0,71375	18	SABIAS	0,50584
19	CADSWEP	0,90939	19	TRENCOR	0,69607
20	TRENCOR	0,94656	20	CADSWEP	0,76939
21	CONSOL	0,96354	21	CONSOL	0,78623
22	OCFISH	1,01784	22	OCFISH	0,91474
23	WOOLTRU	1,05557	23	WOOLTRU	0,99510
24	TEJ	1,30249	24	TEJ	1,09101
25	SADRUG	1,38501	25	SADRUG	1,32111
26	CHEMSVE	1,58386	26	CHEMSVE	1,38857
27	AFCOL	1,61090	27	AFCOL	1,41575
28	AMREL	1,72465	28	AMREL	1,61018
29	PIKNPAY	1,95296	29	PEP	1,80737
30	PEP	1,98871	30	PIKNPAY	1,83280
31	CASHBIL	2,05479	31	CASHBIL	1,97784
32	GRINAKR	2,22005	32	GRINAKR	2,03481
33	MIDAS	2,48861	33	MIDAS	2,30514
34	METCASH	2,53755	34	METCASH	2,42479

The coefficients of the second principal component are provided in Table 5.7. During all the years of the study, except 1992, the coefficients of the second principal components indicate a contrast between the measure PPE:EMP, on the one hand, and some of the other measures on the other hand. During the period 1989 to 1991 the measure DEP:REV forms a contrast with PPE:EMP. In 1992 the measure PPE:VA (-0,882), which is the only measure based on value added figures, together with the measure DEP:REV (-0,236) forms a contrast with the measure PPE:EMP (0,331). During 1993 a contrast between PPE:TOT (0,661) and PPE:EMP (-0,684) is found, and during 1994 the contrast is between PPE:REV (0,276) and PPE:TOT (0,272), and

PPE:EMP (-0,908). During the last two years of the study, there is a contrast between the measures TOT:REV, PPE:REV, and DEP:REV, on the one hand, and PPE:EMP, on the other hand.

However, if the coefficients which are calculated for the mean values of the measures are investigated, it can be seen that the coefficients of the second principal component basically indicate a contrast between PPE:EMP on the one hand, and the other five measures on the other hand.

Table 5.7: Second principal components based on the six measures calculated for the 34 enterprises providing complete value added figures

RATIO	1989	1990	1991	1992	1993	1994	1995	1996	MEAN
TOT:REV	0,309	-0,273	-0,131	0,056	-0,253	0,005	0,412	-0,574	0,057
PPE:REV	0,108	-0,136	-0,102	0,169	0,165	0,276	0,279	-0,225	0,138
PPE:TOT	0,037	0,036	0,328	0,161	0,661	0,272	0,046	0,189	0,242
DEP:REV	0,506	-0,436	0,563	-0,236	0,062	-0,008	0,244	-0,279	0,242
PPE:EMP	-0,760	0,843	-0,738	0,331	-0,684	-0,908	-0,770	0,660	-0,922
PPE:VA	-0,242	0,067	0,051	-0,882	0,006	0,160	-0,312	0,265	0,104

The coefficients of all six of the principal components, calculated for the mean values of the measures over the period under review, are indicated in Table 5.8. If the coefficients of the first principal component displayed in Table 5.7 are considered, it should be noted that the sign of the coefficients differ from those provided in Table 5.4. However, since principal component analysis is unique in respect of multiplication by plus or minus one, both these tables can be investigated, and provides the same information. It is important to note that the coefficients indicated in Table 5.7 are used when the principal component scores provided in Tables 5.5 and 5.6 are calculated. This explains the large negative principal component scores in the case of a capital intensive enterprise, and the positive values in the case of labour intensive enterprises. In Figures 5.10 and 5.11 the negative coefficients are used, and the enterprises' degrees of capital intensity decrease when moving along the horizontal axis of the biplot.

If the coefficients of the third principal component are investigated, it is found that they indicate a contrast between the measures PPE:TOT (0,794) and TOT:REV (-0,537). It is interesting to note that in the previous chapter the measure PPE:TOT only had a

coefficient of 0,054 for the third principal component. In the fourth principal component a contrast exists between PPE:VA (-0,773) and the measures PPE:REV and TOT:REV (0,440 and 0,414). In the previous chapter the measure PPE:TOT had a relatively large coefficient of -0,771, while it now has only a relatively small coefficient of 0,083. The fifth principal component is a contrast between DEP:REV (0,822), and PPE:REV and PPE:VA (-0,373 and -0,399 respectively. The sixth principal component corresponds to the fifth principal component obtained in the previous chapter, and is a contrast between the measure PPE:REV (0,673), and the measures PPE:TOT and TOT:REV (-0,360 and -0,600). It therefore appears that the inclusion of the measure PPE:VA in the principal component analyses resulted in differences in some of the principal components, indicating some differences between this measure and the measure based on the five measures developed in the previous chapter. However, in this study the focus is mainly on the first principal component, which is used to calculate the principal component scores as composite measures of capital intensity. The remaining principal components are therefore not evaluated in the remainder of this study.

Table 5.8: Principal components based on the mean values of the measures, calculated for the 34 enterprises providing complete value added figures

	Principal component 1	Principal component 2	Principal component 3	Principal component 4	Principal component 5	Principal component 6
TOT:REV	-0,423	0,057	-0,537	0,414	0,025	-0,597
PPE:REV	-0,438	0,138	-0,066	0,440	-0,373	0,673
PPE:TOT	-0,395	0,242	0,794	0,083	-0,138	-0,360
DEP:REV	-0,419	0,242	-0,010	-0,172	0,822	0,245
PPE:EMP	-0,353	-0,922	0,136	-0,019	0,080	0,030
PPE:VA	-0,416	0,104	-0,242	-0,773	-0,400	-0,031

5.2.3 Biplots

Figure 5.10 is a biplot constructed for the mean values of the six measures in respect of the 34 enterprises providing complete value added figures. Since no values are available for most of the other enterprises in the sample of 60 enterprises providing

value added figures, it is not possible to interpolate the values of the other enterprises which are not included in the principal component analysis, as was done in the previous chapter.

The biplot display provides a graphic indication of the degree of capital intensity of the plotted enterprises. By considering the location of an enterprise on the biplot, its degree of capital intensity can be determined as well as its relationship with the other enterprises. The enterprises are arranged from left to right along the horizontal axis according to decreasing capital intensity. A very similar distribution of the enterprises is obtained on the biplot as in the case where only the five traditional measures of capital intensity were combined.

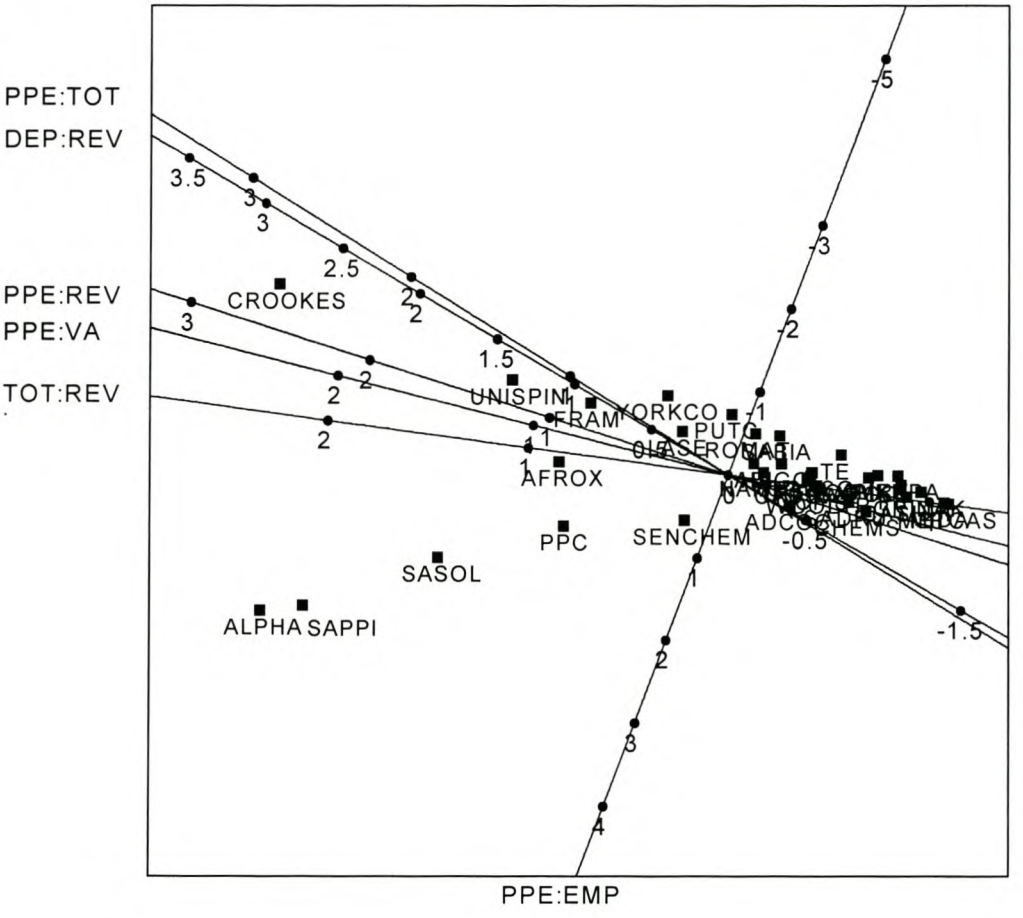


Figure 5.10: Biplot constructed for the 34 enterprises providing complete value added figures

The quality of fit of the biplot is relatively high (87,39% of the total variance is accounted for by the first two principal components together) and indicates that the different measures are represented relatively well. The adequacy for the different measures is also relatively high, with PPE:EMP having the highest value (0,974) and TOT:REV the lowest (0,182).

The biplot also provides information on the relationship between the six different measures. For instance, the angles between the axis of the graph indicate whether there is a strong (PPE:TOT and DEP:REV) or a weak relationship (PPE:REV and PPE:EMP) between the measures. The major difference between the biplot constructed in the previous chapter (Figure 4.5) and Figure 5.10 is the angles between the axes. In Figure 4.5 the axes are spread out fairly evenly, while Figure 5.10 is basically a contrast between PPE:EMP, on the one hand, and the other five measures, on the other hand. However, it must be taken into account that different enterprises were included when the two biplots were compiled. In the previous chapter 48 enterprises in total were included in the construction of the biplot, while only 34 enterprises are included in this chapter. If the same 34 enterprises which were used to compile the biplot for the six measures are investigated for the original five measures, the shapes of the biplots are very similar (Figure 4.5 vs. Figure 5.11). It therefore appears that the difference in the shape of the biplots is the result of different enterprises being included and not the effect of the additional measure being included when the biplot is compiled.

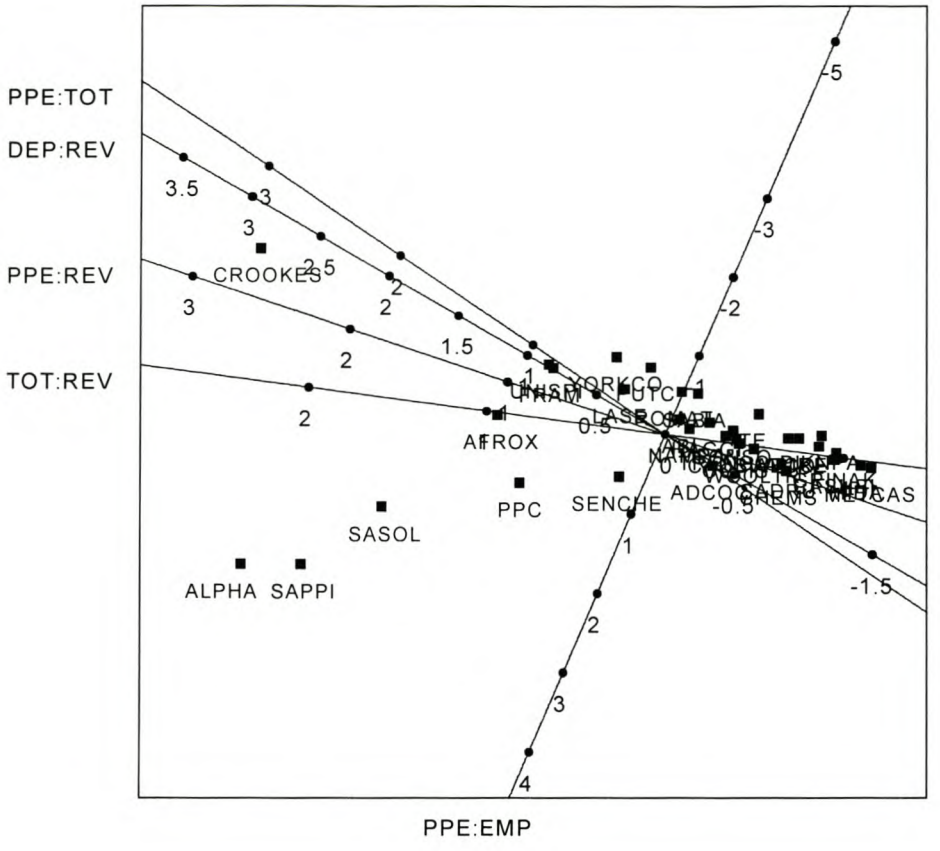


Figure 5.11: Biplot constructed for the 34 enterprises providing complete value added figures, based on the five measures of capital intensity not based on value added figures

5.3 Summary

Nine measures of capital intensity are investigated in this chapter. These measures include five traditional measures of capital intensity and four measures based on value added figures. The objective of this chapter is to investigate the four measures which are based on value added figures, and to determine if it is possible to include them in a proposed measure of capital intensity consisting of the five measures not based on value added figures. A sample was selected consisting of enterprises listed in the Industrial Sector of the Johannesburg Stock Exchange (see Table 3.1). However, complete financial data were only available for 48 of these enterprises. In the previous chapter of

the study, the five measures not based on value added figures were calculated for these 48 enterprises providing complete financial data. Value added statements were not available for all the enterprises in the sample. A total of 60 enterprises published value added figures during the period under review. However, only 34 of these enterprises provided the necessary financial information to calculate all nine measures for the entire period of the study. In this chapter the focus is on the nine measures calculated for the 34 enterprises providing complete financial data.

If the four measures based on value added figures are investigated, it seems that not all of them are ideally suited to be used as measures of capital intensity. Some of the measures only indicate capital intensity for enterprises in specific sectors, while in some cases it seems that they do not provide an accurate measurement of capital intensity at all. Not all the correlations between these four measures and the five traditional measures investigated in the previous chapter are positive and most of them are relatively small. Only one of the measures (PPE:VA) has a large positive correlation with the five measures and it is included with the five traditional measures in the remainder of the chapter to determine the composite measure of capital intensity.

The same procedures which have been used with the five traditional measures in Chapter 4 are used in the case of the four measures based on value added figures. Statistical procedures which could possibly be used to evaluate the data include principal component analyses (PCA) and related biplots. Principal component analysis explains the variance-covariance structure of a data set through a few linear equations accounting for as much of the variation as possible. The principal component scores obtained with the first principal component are linear combinations of the six measures and can be used as a composite measure of the degree of capital intensity. The coefficients of the first principal component indicate the contribution of the different measures to this composite measure. Since these coefficients are all relatively large, all six of the measures are included. The principal component scores for the 34 enterprises were calculated and used to arrange the enterprises according to increasing degrees of capital intensity. Finally, biplots were constructed to provide a two-dimensional visual representation of the data. The results do not differ substantially from those obtained in the previous chapter and indicate that a number of enterprises listed in the Building and Construction, Engineering, Steel and Allied, and Pharmaceutical Sectors are relatively

capital intensive, while enterprises listed in the Stores and Food sectors are in most cases less capital intensive.

5.4. Conclusions and recommendations

In the previous chapter, based on the traditional measures of capital intensity, the principal component scores obtained from the first principal component are proposed as a composite method to measure the degree of capital intensity. These principal component scores represent a linear combination of five of the traditional measures of capital intensity discussed in the literature. However, due to problems with a number of other measures of capital intensity based on value added figures, they were not included in the analyses conducted in the previous chapter. These measures behave differently than the five traditional measures. Relatively small correlations are found between the four measures not based on value added figures and the five traditional measures not based on value added figures. Furthermore, not all the measures based on value added figures always provide an accurate measurement of capital intensity for all enterprises in the sample. Finally, one of the measures based on value added figures (PPE:VA) is included in the principal component analyses.

The results of this chapter indicate that the measures of capital intensity which are based on value added figures cannot be used in exactly the same way as the five measures which are not based on value added figures. As was indicated in the study by Burger and Hamman, it appears as if the measures based on value added figures are not always suitable to be used as indicators of capital intensity. Furthermore, it seems as if the measures can only be used as measures of capital intensity for enterprises in certain sectors (Erasmus, Lambrechts, Le Roux and Gardner, 2001). Care should therefore be taken when the measures based on value added figures are used to measure capital intensity. The results indicate that, although differences occur when the additional measure based on value added figures is included in the composite measure, these differences are not really substantial.

One of the major shortcomings of this chapter is that the measures which are based on value added figures were not evaluated for specific sectors. It may be possible to use certain of the measures which are based on value added figures as a measure of capital intensity for enterprises in specific sectors only. In this chapter the focus is on the first principal component, which was used as a size vector to determine the principal component scores for the enterprises. The other principal components can also provide important information and should receive further attention in future studies. The role of economic cycles should also be considered in more detail.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The ability to differentiate between capital and labour intensive enterprises could lead to an improvement in the quality of financial decision-making during periods where changes in the economic cycle occur. However, to be able to classify an enterprise as capital or labour intensive, there is a need for some efficient measure(s) which can be used to determine the enterprise's degree of capital intensity.

In this study a method which can be used to measure an enterprise's degree of capital intensity is developed. For this purpose the different measures of capital intensity which have been developed in the literature and which are generally used to indicate capital intensity are identified. Their ability to measure capital intensity are investigated and those measures which provide an accurate indication of capital intensity are included in a composite measure of capital intensity. The contributions of the different measures to this composite measure are also investigated.

Apart from the introduction, this chapter consists of three sections. A short summary of the findings of the study is provided in the first of these sections. This is followed by a section containing the major results and conclusions obtained from the research. Finally, the chapter is concluded with some recommendations and a discussion of a number of aspects which require further investigation in future studies.

6.2 Summary

The main objective of this study is to determine a method which can be used to measure the degree of capital intensity of an enterprise. For this purpose a sample of enterprises listed in the Industrial sector of the Johannesburg Stock Exchange is used to evaluate the different measures of capital intensity which are referred to in the literature.

The first chapter of the study provides the background to the research. The importance of being able to differentiate between capital and labour intensive enterprises is highlighted and different definitions of capital intensity are discussed. A capital intensive enterprise is defined as an enterprise which requires or uses a very large amount of capital relative to its need for using labour, while a labour intensive enterprise is defined as an enterprise which requires a large amount of labour relative to its need for using capital. Finally, the objectives of the study as well as its basic structure are also provided.

Chapter 2 consist of a literature survey. The main objective of the chapter is to identify the different measures which are generally used to indicate capital intensity. For this purpose the focus of the chapter is on the measures of capital intensity developed in the literature. A total of nine different measures of capital intensity are identified. The different measures are defined and their methods of calculation are discussed. The five traditional measures of capital intensity which have been identified, namely total assets to revenue; property, plant and equipment to revenue; property, plant and equipment to total assets; depreciation as a percentage of revenue; and property, plant and equipment per employee are not based on value added figures. The other four measures, namely property plant and equipment to value added; salaries to value added; value added per employee; and salaries to revenue are based on value added figures.

Chapter 3 provides an outline of the research methodology. Firstly, attention is given to the design of the sample. The study is conducted for enterprises listed in the Industrial sector of the Johannesburg Stock Exchange over the period 1989 to 1996. This period consists of a decline phase in the economic cycle (1989 to 1992), where negative

economic growth occurs, followed by an upswing phase (1993 to 1996), where positive economic growth is experienced. The economic growth is measured by the Gross Domestic Product. A main sample is obtained (Table 3.1). However, since value added figures are not available for all of these enterprises, a sub-sample consisting of all the enterprises which published value added figures during the period under review is compiled from the main sample (Table 3.3). Next, the calculations of the different measures of capital intensity are discussed and the financial data which are used to calculate the measures are described. The financial data, value added figures and employment figures were obtained from the McGregor BFA Database, the University of Stellenbosch Graduate School of Business Value Added Database and the Johannesburg Stock Exchange handbook. Finally the statistical procedures which are used in the study are introduced. These include principal component analyses as well as related biplots. Principal component analysis explains the variance-covariance structure of a data set through a few linear equations accounting for as much of the variation as possible. Biplots are used to provide a two-dimensional visual representation of the multivariate data.

The five traditional measures of capital intensity which are not based on value added figures and the other four measures which are based on value added figures are investigated individually. In Chapter 4 the five measures which are not based on value added figures are calculated for the main sample and reviewed. The correlations between these five measures are all positive and relatively large. This indicates that to some extent the five measures are measuring the same characteristics and it can therefore be assumed that the five measures are all able to indicate capital intensity. Principal component analyses are conducted on these measures. Since the correlations between the measures are all positive, the first principal component can be considered a size vector. The principal component scores obtained with the first principal component are linear combinations of the five measures and can be used as composite measures of capital intensity. The coefficients of the first principal component are all relatively large and indicate that all five the measures provide an important contribution to the principal component scores. Finally biplots are compiled to provide a two-dimensional visual

representation of the data. By considering the location of an enterprise on the biplot, it is possible to determine its degree of capital intensity.

All nine of the different measures of capital intensity which were identified are investigated in Chapter 5. These measures include the five measures which have been evaluated in Chapter 4 as well as the other four measures which are based on value added figures. The measures are calculated for the sub-sample of enterprises providing value added figures. However, if the correlations between the measures are investigated, it appears that not all the measures based on value added figures are suitable to use as indicators of capital intensity. Only one of the measures based on value added figures, PPE:VA, is included with the five traditional measures in the remainder of the chapter. Principal component analyses and biplots are then again used to evaluate these six measures. Since these six measures are all positively correlated, the first principal component can again be considered a size vector. The principal component scores based on the first principal component are calculated as a composite measure of capital intensity. The coefficients of the first principal component are all relatively large, indicating that all six the measures are providing an important contribution to the principal component score. Furthermore, since the coefficients are all relatively large, all six of the measures should be included in the proposed composite measure of capital intensity.

6.3 Conclusions

The main objective of this study was to develop a measure(s) which could be used to determine the capital intensity of an enterprise. Nine different measures of capital intensity were identified and evaluated to determine their ability to indicate capital intensity. The five traditional measures are not based on value added figures, while the other four measures are based on value added figures.

The correlations between the five traditional measures of capital intensity are positive and relatively large. It is therefore assumed that these five measures are able to indicate capital intensity. However, it appears that the four measures of capital intensity which are based on value added figures are not always suitable for use as measures of capital intensity. In some instances the measures do not indicate capital intensity at all, while in other cases it seems as if the measures can only be used as measures of capital intensity for enterprises in certain sectors. Care should therefore be taken when these measures based on value added figures are used to measure capital intensity. The results of the study supports the findings of Burger and Hamman (1999) to some extent, since problems with some of the measures based on value added figures are also experienced. However, it was found that one of the measures based on value added figures, PPE:VA, can be used to measure capital intensity and the measure is included in the remainder of the study.

The five traditional measures as well as the measure PPE:VA are included in the principal component analyses. The principal component scores obtained from the first principal component are proposed as a composite measure of capital intensity. These principal component scores represent a linear combination of the six measures of capital intensity. If a large principal component score is calculated, this indicates a relatively low degree of capital intensity and, conversely, if a lower principal component score is calculated, this indicates a relatively high degree of capital intensity.

If the principal component scores based on the combination of the five traditional measures are investigated, it is found that a number of enterprises listed in the Building and Construction, Engineering, Steel and Allied, and Electronics sectors are relatively capital intensive, while enterprises listed in the Stores and Food sectors are less capital intensive. In the case where the principal component scores are calculated for the combination of the five traditional measures and the measure PPE:VA, a very similar classification is obtained, again indicating that the Building and Construction, Engineering, Steel and Allied, and Electronics sectors are relatively capital intensive, and that the Stores and Food sectors are less capital intensive. Furthermore, if the rankings of

the enterprises based on the principal component scores calculated for the combination of the five measures are compared to those compiled for the principal component scores based on the six measures, very similar rankings are obtained.

If the composite measure developed in this study is calculated for the enterprises included in the study by Bloom (2001) and the enterprises are ranked according their degree of capital intensity, very similar results for most of the enterprises are obtained. The most capital intensive enterprises in Bloom's study are also amongst the most capital intensive enterprises when classified according to the principal component scores, and the least capital intensive enterprises are also the least capital intensive. However, since the measure developed in this study is based on more measures than in the method used by Bloom, some exceptions do occur. It is mainly in the case of those enterprises which are not very capital or labour intensive that the largest differences in the rankings occurred.

This study was conducted for a period which consisted of a decline followed by an upswing phase in the economic cycle. The reason for investigating the measures over the two phases is to determine if the measures behave differently during the two phases. The results of the principal component analyses provide mixed results. If the first principal component is considered, differences between the values of the coefficients calculated for the two periods are not substantial and the coefficients remain reasonably stable over the different years of the study. In the case of the second principal component calculated for the combination of the five traditional measures, however, it appears as if some differences occur between the two phases. However, since the principal component scores based on the first principal component are proposed as a composite measure of capital intensity, the measure developed in this study can be used in both the economic phases.

Since no external objective classification of capital intensity exists in South Africa, it is not possible to determine the ability of the different measures to measure capital intensity by comparing their results to an existing classification. It is therefore not possible to use a technique like regression analysis to investigate the different measures and it was

therefore decided to use principal component analysis. The technique is firstly used to develop a composite measure of capital intensity consisting of six measures of capital intensity. Furthermore, by using principal component analyses, it is possible to investigate the contribution of the six measures to this composite measure. This provides an indication of whether the six measures are all measuring capital intensity. Since the coefficients of the first principal component are all relatively large, this indicates that all six of the measures make an important contribution to the principal component score.

The biplots used in the study provide a visual representation of the multivariate data. This not only allows easy interpretation of the results, but also provides a visual distinction between capital intensive and labour intensive enterprises.

The technique developed in this study consists of a combination of different measures of capital intensity. It does not focus on one specific aspect of an enterprise only and is therefore able to incorporate a number of different factors which could all influence an enterprise's degree of capital intensity. This is an advantage over the other measures of capital intensity which normally only focus on one specific aspect of an enterprise. It could therefore be assumed that the measure developed in this study would provide a more accurate measurement of capital intensity. The technique used to develop the composite measure also makes provision for the inclusion of more measures and variables which could also indicate capital intensity. It would also be relatively straightforward to evaluate these measures' ability to indicate capital intensity and, if necessary, to include them in the composite measure.

6.4 Recommendations

Since no existing objective classification of capital intensity exists in South Africa, the measure developed in this study can be used to provide an indication of an enterprise's capital intensity. In future studies this measure can therefore be used to provide an efficient measurement of capital intensity by incorporating different aspects which may

all influence an enterprise's degree of capital intensity. It is furthermore important that the measure should be evaluated further and that its ability to indicate capital intensity should be compared with other measures of capital intensity which may be developed in future studies.

In this study the focus was on enterprises listed in the Industrial sector of the Johannesburg Stock Exchange. The measure which was developed should be able to measure capital intensity for enterprises listed in other sectors as well (i.e. Mining and Financial Services) and it is therefore also necessary to evaluate the measure in these other sectors.

One of the major problems experienced during the study is that no external objective classification of an enterprise's capital intensity exists in South Africa. It is therefore not possible to evaluate the performance of a specific measure by determining its ability to correctly measure capital intensity. In future research an attempt could therefore be made to try and obtain an external indication of an enterprise's capital intensity and to evaluate the proposed method developed in this study by comparing the results with the actual degree of capital intensity.

The focus in this study was mainly on the first principal component. Although the other principal components were also considered, they were not analysed in detail. These components, however, could also provide important information about the different measures of capital intensity. In future studies more attention should therefore be paid to these other principal components.

When a number of the measures based on value added figures are evaluated, it appears as if some of the measures are not able to indicate capital intensity for all the enterprises investigated in this study. However, if the measures are considered for specific sectors only, it seems as if in some instances they are indeed able to indicate capital intensity for enterprises from some of these sectors. In future studies a distinction could therefore be

made between the different sectors and the measures could be evaluated for these sectors individually.

In this study the focus was only placed on the different measures which could be used to determine the physical capital intensity of an enterprise. However, in recent studies the role of intellectual capital has been receiving an increasing amount of attention. In futures studies it may therefore be necessary to evaluate the degree of intellectual capital intensity as well.

The research in this study was conducted for a period which included a decline and upswing phase in the economic cycle. The intention of the study was not to determine how capital and labour intensive enterprises react to an upswing and decline in the economic cycle, but rather to investigate if the different measures of capital intensity behave differently during the two phases. However, to obtain a more accurate indication of the behaviour of the measures during the periods of economic change, multiple periods of economic change should be included. This would provide an indication of whether the different measures maintain the same behaviour during the different periods. Investigating a longer period, however, will result in a substantial reduction in the number of enterprises which could be included in the sample.

REFERENCE LIST

BOOKS AND THESIS

Bloom, J.Z. (2001). The behaviour of financial ratios for capital intensive and labour intensive enterprises during an upswing and decline phase of the economic cycle. Unpublished doctoral dissertation, University of Stellenbosch, Stellenbosch.

Brigham, E.F., Capenski, L.C. (1991). Financial Management: Theory and Practice. (6th ed.). Chicago, Illinois: The Dryden Press.

Cureton, E.E., D'Agostino, R.B. (1983). Factor analysis: An applied approach. New Jersey: Lawrence Erlbaum Associates.

Dornbusch, R., Fischer, S. (1992). Makro-ekonomie (2de uitgawe). Johannesburg: Lexicon.

Dunteman, G.H. (1989). Principal Component Analysis. Newbury Park: SAGE Publications.

Flury, B.D. (1997). A First Course in Multivariate Statistics. New York: Springer-Verlag.

Garrison, R.H., Noreen, E.W. (1997). Managerial Accounting (8th Edition). Chicago: Richard D. Irwin.

Gower, J.C., Hand, D.J. (1997). Biplots. London: Chapman & Hall.

Joliffe, I.T. (1986). Principal Component Analysis. New York: Springer-Verlag.

Riahi-Belkaoui, A. (1992). Value Added Reporting: Lessons for the United States. New York: Quorum Books.

ARTICLES AND PAPERS

Ahiakpor, JCW. (1986). The capital intensity of foreign, private local and state owned firms in a less developed country: Ghana. Journal of Development Economics, 20(1), p.145-162.

Banerji, R. (1978). Average size of plants in manufacturing and capital intensity. Journal of Development Economics, 5(2), p.155-166.

Bell, RT. (1978). Capital intensity and unemployment in South African industry. The South African Journal of Economics, 46(1), p.48-61.

Bloom, J.Z., Lambrechts, I.J., Le Roux, N.J. (1998). Distinguishing between capital intensive and labour intensive enterprises listed in the industrial sector of the JSE. Management Dynamics, 7(4), p.39-68.

Bloom, J.Z., Lambrechts, I.J., Le Roux, N.J. (2001). Patterns in financial performance indicators of capital and labour intensive enterprises during an upswing and decline in the economic cycle. South African Journal of Accounting Research, 14(1), p.1-32.

Burger, J.H., Hamman, W.D. (1999). Measuring capital intensity in South African companies listed in the industrial section of the Johannesburg Stock Exchange (JSE). South African Journal of Business Management, 30(4), p.110-117.

Erasmus, P.D., Lambrechts, I.J., Le Roux, N.J., Gardner, S. (2000, July). Determining a method to measure the capital intensity for enterprises listed in the industrial sector of the Johannesburg stock exchange for the period 1989 to 1996. Paper presented at the 11th FMA congress, Erasmus University, Rotterdam.

Erasmus, P.D., Lambrechts, I.J., Le Roux, N.J., Gardner, S. (2001, January). Measuring the capital intensity of enterprises listed in the industrial sector of the Johannesburg Stock Exchange: The use of value added measures. Paper presented at

the 10th SAFA conference, University of Cape Town Graduate School of Business, Cape Town.

Gabriel, K.R. (1971). The biplot graphic display of matrices with application to principal components. Biometrica, 58, p.453-467.

Goldin, C., Katz, L.F. (1998). The origins of technology-skill complementarity. The Quaterly Journal of Economics, 113(3), p.693-732

Harris, Fh.de B. (1994). Asset specificity, capital intensity and capital structure: An empirical test. Managerial and Decision Economics, 15, p.563-576.

Ismail, B, Choi, K. (1996). Determinants of time-series properties of earnings and cash flows. Review of Financial Economics, 5(2), p.131-145.

Kaplinsky, R. (1995). Capital intensity in South African manufacturing and unemployment, 1972-90. World Development, 23(2), p.179-192.

Kay, J., Davis, E. (1990). What makes a company a chart topper? Accountancy, August, 98-101.

Lim, D. (1976). On the measurement of capital intensity. Weltwirtschaftliches-archiv, 112(4), p.760-766.

Miller, EM. (1986). Determinants of the size of the small business sector: They are labor Productivity, Wage Rates and capital intensity. American Journal of Economics and Sociology, 45(4), p.390-402.

Osborn, E., Lings, KS. (1993). Capital intensity in the manufacturing sector. Management Dynamics, 2(3), p.89-108.

INDUSTRY PUBLICATIONS

South African Reserve Bank. (1999, December). Quarterly Bulletin No. 214. Pretoria.

The Stock Exchange Handbook. (1996, July – December). Johannesburg: Profile Media.

COMPUTER SOFTWARE

McGregor BFA (Pty) Ltd. (1999). RAID Station.

University of Stellenbosch Graduate School of Business. Value Added Statement Database. University of Stellenbosch, Stellenbosch.