

Review of subnational credit rating methodologies and their applicability in South Africa

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*By His grace alone
“I can do all this through Him who gives me strength.”
(Philippians 4:13, NLT)*

Summary

The objectives of the research study are to review existing subnational credit rating methodologies and their applicability in the South African context, to develop the quantitative parts of credit rating methodologies for two provincial departments (Department of Health and Department of Education) that best predict future payment behaviour, to test the appropriateness of the proposed methodologies and to construct the datasets needed.

The literature study includes background information regarding the uniqueness of South Africa's provinces and credit rating methodologies in general. This is followed by information on subnational credit rating methodologies, including a review of existing subnational credit rating methodologies and an assessment of the applicability of the information provided in the South African context. Lastly, the applicable laws and regulations within the South African regulatory framework are provided.

The knowledge gained from the literature study is applied to the data that have been collected to predict the two departments' future payment behaviour. Linear regression modelling is used to identify the factors that best predict future payment behaviour and to assign weights to the identified factors in a scientific manner. The resulting payment behaviour models can be viewed as the quantitative part of the credit ratings. This is followed by a discussion on further investigations to improve the models.

The developed models (both the simple and the advanced models) are tested with regard to prediction accuracies using RAG (Red, Amber or Green) statuses. This is followed by recommendations regarding future model usage that conclude that the department-specific models outperform the generic models in terms of prediction accuracies.

KEY WORDS: Subnational governments - Subnational credit rating methodologies - Department of Health - Department of Education - Payment behaviour - Linear regression modelling - RAG statuses - prediction accuracy

Opsomming

Die doelwitte van hierdie navorsing is om bestaande subnasionale kredietgraderingsmetodologieë en hul toepaslikheid in die Suid-Afrikaanse konteks te hersien, om die kwantitatiewe dele van kredietgraderingsmetodologieë vir twee provinsiale departemente (Departement van Gesondheid en Departement van Onderwys) wat toekomstige betalingsgedrag die beste voorspel te ontwikkel, om die toepaslikheid van die voorgestelde metodologieë te toets, en om die nodige datastelle saam te stel.

Die literatuurstudie sluit agtergrondinligting oor die uniekheid van Suid-Afrika se provinsies en kredietgraderingsmetodologieë oor die algemeen in. Dit word gevolg deur inligting oor subnasionale kredietgraderingsmetodologieë, insluitend 'n hersiening van bestaande subnasionale kredietgraderingsmetodologieë en 'n evaluering van die toepaslikheid van hierdie inligting in die Suid-Afrikaanse konteks. Laastens word die toepaslike wette en regulasies binne die Suid-Afrikaanse regulatoriese raamwerk voorsien.

Die kennis wat uit die literatuurstudie opgedoen is, word op die data wat versamel is om die twee departemente se toekomstige betalingsgedrag te voorspel, toegepas. Lineêre regressie-modelle word gebruik om die faktore te identifiseer wat toekomstige betalingsgedrag die beste voorspel, asook om gewigte aan die geïdentifiseerde faktore toe te ken op 'n wetenskaplike wyse. Die ontwikkelde betalingsgedrag-modelle kan gesien word as die kwantitatiewe deel van kredietgraderings. Dit word gevolg deur 'n bespreking oor verdere ondersoeke om die modelle te verbeter.

Die ontwikkelde modelle (beide die eenvoudige en gevorderde modelle) is getoets ten opsigte van voorspellingsakkuraatheid met behulp van ROG (Rooi, Oranje of Groen) statusse. Dit word gevolg deur aanbevelings oor toekomstige gebruik van die modelle wat aandui dat die departement-spesifieke modelle die generiese modelle oortref in terme van voorspellingsakkuraatheid.

SLEUTELWOORDE: Subnasionale regerings - Subnasionale kredietgraderingsmetodologieë - Departement van Gesondheid - Departement van Onderwys - Betalingsgedrag - Lineêre regressie-modelle - ROG statusse - Voorspellingsakkuraatheid

List of Acronyms and Abbreviations

Auditor-General	The Auditor-General of South Africa
Backward	Backward elimination variable selection technique
Basel	Basel regulatory framework for capital adequacy
BCBS	The Basel Committee on Banking Supervision
Borrowing Act	Borrowing Powers of Provincial Governments Act (No 48 of 1996)
C (CT)	Combined dataset without time (with time)
CRISIL	Credit Rating and Information Services of India Ltd
DBRS	Dominion Bond Rating Service Limited
E (ET)	Education dataset without time (with time)
EAD	Exposure at default
Education	Department of Education
Fitch	Fitch Ratings
Forward	Forward addition variable selection technique
GDP	Gross domestic product
H (HT)	Health dataset without time (with time)
Health	Department of Health
IMF	International Monetary Fund
IRB	Internal ratings-based
LGD	Loss given default
Moody's	Moody's Investor Services
National Treasury	The National Treasury of South Africa
PD	Probability of default

PFMA	Public Finance Management Act (No 1 of 1999)
PSRMF	Public Sector Risk Management Framework
RAG status	Red, amber or green status
S&P	Standard and Poor's
StatsSA	Statistics South Africa
Stepwise	Stepwise selection variable selection technique
US	United States of America
VIF	Variable inflation factor

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Chapter 1

INTRODUCTION AND MOTIVATION

1.1 Introduction

Subnationals are defined as all tiers of government and public entities below the sovereign or national government, including states, provinces, counties, cities, towns, public utility companies, school districts and other special-purpose government entities that have the capacity to incur debt (Liu and Waibel, 2008). The borrowing requirements of the subnational governments of developing industries have increased since the mid-1900's (Gaillard, 2006). One point of access to additional funds is loans from the banking industry.

Counterparty risk, i.e. the ability to repay a loan in a timely manner, should be assessed by banks and other investors before entering into loan agreements. One way of doing this is by using credit ratings. However, special credit rating methodologies are required to rate subnationals due to the unique way these governments are managed. Factors that require special attention when rating them include:

- the institutional frameworks within which they operate;
- the rules and regulations set by the national government regarding financial management, especially rules and regulations related to borrowing;
- budgetary flexibility allowed by the national government;
- economic profiles, including demographics and social structures;
- intergovernmental relations; and
- political environments

(see for example Fitch, 2011b).

South African subnationals are defined as provincial governments and provincial departments for the purpose of this thesis. None of South Africa's defined subnationals are credit rated at present (2014). The objectives of this thesis are to provide a literature review of existing subnational credit rating methodologies, to develop the quantitative parts of credit rating methodologies for South Africa's subnationals (focusing on provincial departments), to test the appropriateness of the methodologies and to construct the datasets needed to address these objectives.

1.2 Motivation

In general, the development of subnational credit rating methodologies bring benefits for the subnationals, its residents and the country as a whole. The subnationals could gain easier access to financial markets if such a methodology was to be established. Also, banks, investors and third parties could use this methodology to decide whether they want to conduct business with a specific provincial department. Credit ratings will enable subnationals with above average ratings to negotiate better collateral and guarantee agreements. The residents from South African provinces could also benefit, as the additional funding obtained could be used for infrastructure development. In addition, borrowing spreads the costs of financing infrastructure projects across present and future generations by matching debt maturity to the asset's economic life.

Two additional benefits, applicable in general and in the case of this specific thesis, result from developing a subnational credit rating methodology. Subnational governments could use the methodologies to identify areas on which they can improve. An indirect benefit is more effective management due to the competition among provincial governments that will stem from this. Fiscal transparency, as well as the budgetary and financial management practices of provincial department, will improve as a result of subnational credit ratings because South African subnationals will be forced to improve their financial record keeping.

1.3 Objectives

This thesis comprises one primary objective and three secondary objectives.

The primary objective aims to develop the quantitative parts of credit rating methodologies for South Africa's subnationals that best predict future payment behaviour. This objective focuses on department level subnationals only, specifically the Departments of Health and Education. The results of the developed methodologies are documented in Chapters 6 and 7.

The first of the secondary objectives is to test the appropriateness of the proposed methodologies. These are addressed in Chapter 8.

The next secondary objective is the construction of the datasets, assembled in order to address the two aforementioned objectives. The datasets were compiled by manually capturing the required information from a number of different reports (124 reports for development and 21 additional reports for validation). The details of the constructed datasets are documented in Chapter 5. The compiled datasets have been made available electronically; a CD containing the datasets is available at the back of the thesis.

The final secondary objective aims to provide a literature review of existing subnational credit rating methodologies and related information which is needed to address the other objectives. This is addressed in Chapter 3.

Other background knowledge required and groundwork used to achieve these objectives are documented in Chapters 2, 4 and 5.

1.4 Problem statement

To conclude, the problem statement of this thesis is to develop linear regression models that best predict future payment behaviour for the Departments of Health and the Departments of Education focusing on quantitative factors.

1.5 Thesis outline

Following this introductory chapter, the thesis commences by documenting South Africa's governing structure, providing a provincial overview and discussing credit ratings in general in Chapter 2. These are the key concepts for the remainder of the thesis.

Chapter 3 documents existing subnational credit rating methodologies and other applicable information on this matter. The knowledge gained, especially the information regarding typical variables included in these methodologies, the grouping of these variables into five broad factors and the importance of quantitative and qualitative factors, was used as background information for the development of subnational credit rating methodologies for the South African context.

Chapter 4 reviews the South African regulatory framework that governs borrowing by South African subnationals. This framework requires revision since these set the parameters within which subnational borrowing may take place. These laws and regulations must be adhered to when entering into a loan agreement with a South African subnational. Also, most of the data used for the development of the South African credit rating methodologies were collected from reports governed by South Africa's National Treasury (National Treasury). These reports are discussed briefly in this chapter.

The data and the methodology used to develop the quantitative parts of credit rating methodologies are discussed in Chapter 5. These include the compilation of the six datasets, a theoretical overview of linear regression modelling and an explanation of how linear regression models relate to credit rating methodologies.

Chapter 6 provides the methodology used to develop the linear regression models, also called payment behaviour models, using the six datasets. Note that one methodology will be used but a number of different models will be developed. The results of each model can be found separately in this chapter. These models were developed in three steps. Firstly, variable clustering was performed to deal with multicollinearity among the independent variables. The next step was to deal with irrelevant independent variables by using scatterplots of Spearman's correlation vs. Hoeffding's D ranks. Lastly, linear regression modelling based on four different variable selection techniques was used to develop the payment behaviour models. The aim of the developed models is to rank South African subnationals (specifically the provincial Departments of Health and Education) in terms of future payment behaviour, focussing on RAG (Red, Amber or Green) statuses.

In Chapter 7 four model advancement techniques are investigated namely: the use of an alternative dependent variable, using subject knowledge as a variable selection method, including interactions between the independent variables in the models and excluding outliers from the data.

Chapter 8 includes comparisons of all the resulting models. These comparisons are used to provide on which models should be used in future. Once the model recommendations are available, two models (one for the Department of Health and one for the Department of Education) are used for

illustrative purposes. These illustrations include: a comparison of the RAG statuses predicted by the models, with the actual RAG statuses and case studies to illustrate how the predicted RAG statuses (which are based on quantitative information only) can be overlaid with recent qualitative information to derive a final RAG status. The case studies only illustrate how the models could be used but does not represent an actual credit rating methodology.

Finally, Chapter 9 provides summaries of the key findings and offers recommendations and suggestions for future research.

Chapter 2

OVERVIEW OF KEY CONCEPTS

2.1 Introduction

In order to develop credit ratings methodologies for South African subnationals, some information regarding the specific subnationals as well as credit ratings in general are required. This chapter presents the relevant information.

Liu and Waibel (2008) define subnationals as “all tiers of government and public entities below the federal or central government. Subnational entities include states or provinces, counties, cities, towns, public utility companies, school districts, and other special-purpose government entities that have the capacity to incur debt”. In the view of Martell and Geuss (2006), subnational governments refer to any government structure that is inferior to the federal or central government.

In South Africa, the nine provincial governments are viewed as subnationals as they are subordinate to, but still represent, the central or national government. The nine provinces are: the Eastern Cape, the Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, the Northern Cape, North West and the Western Cape (Figure 2.1). Within these provincial governments there are provincial departments that administrate different functions of the provincial governments. For the purpose of this thesis, both provincial governments and provincial departments are defined as subnationals.

Scott (2003) defines a credit rating as “a grading of a borrower’s ability to meet its financial obligations in a timely manner.” Credit rating methodologies are the mechanisms used to derive these credit ratings. This study develops the quantitative parts of credit rating methodologies for South African subnationals by focussing on provincial departments. Due to the characteristics of the data, the study focuses on two departmental level subnationals, the Department of Health (Health) and the Department of Education (Education). The literature survey of this study subsequently focuses on subnationals in general.

Section 2.2 provides a brief overview of South Africa’s governing structure and the powers assigned to the provincial governments. Section 2.3 contains a comparative overview of the provinces. Section 2.4 introduces the reader to the essentials of credit ratings and Section 2.5 concludes.

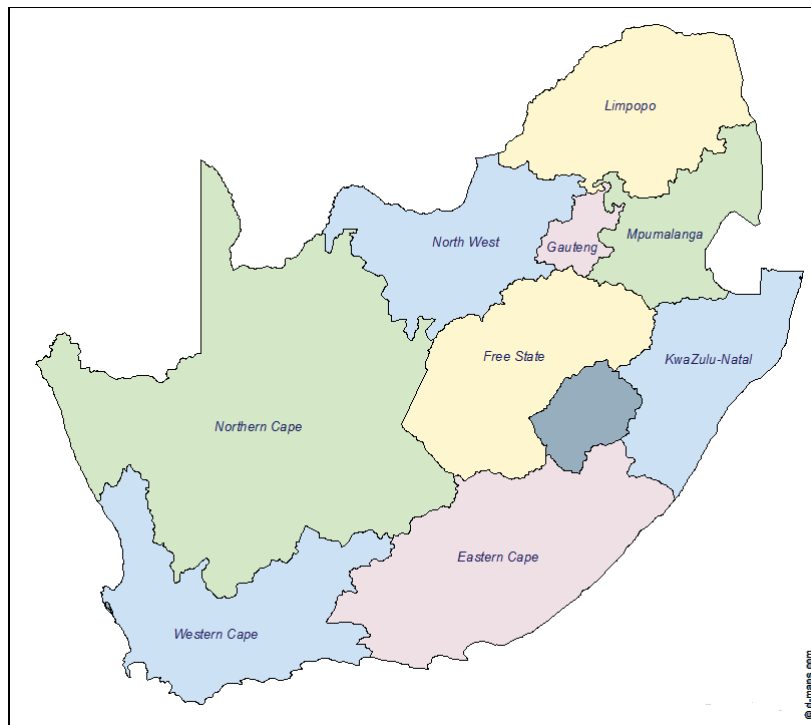


Figure 2.1: *Map South Africa's provinces (Anon., 2005)*

2.2 Governing structure of South Africa

The uniqueness of South Africa's subnationals needs to be taken into account when developing sub-national credit rating methodologies for these specific subnationals. The next two sections provide insight into the government structure of South Africa and explain each province's distinctiveness due to variations in some other aspects. These need to be reviewed as key concepts since it are responsible for some of the individuality of the South Africa's provincial governments and provincial departments.

Some of the uniqueness of the South African subnationals results from the federal-type structure of South Africa. Brookes et al. (2010) defines a federal government as a form of government in which power is shared among a central government and a number of regional governments. The Constitution of the Republic of South Africa establishes a three-tier governing structure. National government constitutes the first tier of the government system, provincial governments the second and local governments, or municipalities, the third. These governmental tiers are "distinctive, interdependent and interrelated" (North West Provincial Legislature, 2011b).

Also, the governments operate via three inter-connected arms at every level: legislature, executive and judiciary. Each tier has its own legislative and executive authority, but the judiciary operates independently of the tiers (North West Provincial Legislature, 2011b).

The rest of this section addresses the legislative and executive authorities of South Africa's sub-national or provincial governments, since the powers assigned to the provincial governments also affect the provincial departments residing within the provincial governments.

2.2.1 Provincial governments

Each of the nine provinces has its own provincial government. The executive power and the legislative power of the provinces are assigned to the individual provincial governments (South Africa, 2010i).

Legislative authority

Legislative authority concerns the power of enacting, amending and repealing legal rules (North West Provincial Legislature, 2011a). Provincial legislatures have the power of legislative authority of the province, but are bound by the national and provincial constitution and must act according to these constitutions and within their limits. Examples of the functional areas assigned to the provincial legislatures alongside the national legislature are: agriculture, education (excluding tertiary education), health services, housing, population development, regional planning and development (South Africa, 1996b). Each of these functions is administered by a provincial department.

As mentioned previously, the development of the quantitative parts of credit rating methodologies of this thesis will focus on two departments due to the characteristics of the data. The financial powers assigned to these departments are documented separately in Chapter 4, which deals with the applicable laws and regulations, since they affect the developed subnational credit rating methodologies.

Executive authority

Executive authority concerns the power of implementing and enforcing legal rules (North West Provincial Legislature, 2011a). The executive authority of provincial governments includes: implementing national and provincial legislation, developing and implementing provincial policy and coordinating the functions of the provincial administration and its departments (South Africa, 1996b).

2.3 Provincial overview

Although South Africa's provinces are all managed in the same way by means of the discussed governing structure, each of them is distinct in its own way. These distinctions arise from variations in aspects such as land area, population size, Gross Domestic Product (GDP), spending and economic activities.

These dissimilarities might affect the departments that operate within the provinces, and thus the applicable dissimilarities need to be taken into account when developing departmental credit rating methodologies. For example, a province with a large population will have to provide extensive education and health services. If this province has little money to distribute among departments for spending, departments like the Department of Education and the Department of Health might struggle to repay their creditors.

The next section provides a summary of some of the aspects causing the uniqueness among the provinces.

2.3.1 Capital and largest cities

For most of the provinces, the capital and the largest city are one and the same, the only exceptions being the Eastern Cape, KwaZulu-Natal and the North West provinces (Table 2.1).

Capital and Largest City		
Province	Capital	Largest City
Eastern Cape	Bisho	Port Elizabeth
Free State	Bloemfontein	Bloemfontein
Gauteng	Johannesburg	Johannesburg
KwaZulu-Natal	Pietermaritzburg	Durban
Limpopo	Polokwane	Polokwane
Mpumalanga	Nelspruit	Nelspruit
Northern Cape	Kimberley	Kimberley
North West	Mafikeng	Potchefstroom
Western Cape	Cape Town	Cape Town

Table 2.1: *Capital and largest cities of the provinces of South Africa (South Africa, 2010j)*

2.3.2 Land area

The Northern Cape has the biggest land area (372 889 km² or 30.5% of the total land area) and Gauteng has the smallest land area (16 548 km² or 1.4% of the total land area) (Table 2.2). The Eastern Cape, the Free State, Limpopo and the Western Cape's land areas sum to 45.4% of South Africa's total land area. Each of these provinces has an area greater than 125 000 km² and contributes more than 10% to the total land area. The rest of the provinces' land areas range between 76 495 to 106 512 km² or 6.3 to 8.7% of the total land area of South Africa.

Land Area (square kilometres)		
Province	Land Area	% of Total Land Area
Eastern Cape	168,966	13.8
Free State	129,825	10.6
Gauteng	16,548	1.4
KwaZulu-Natal	94,361	7.7
Limpopo	125,755	10.3
Mpumalanga	76,495	6.3
Northern Cape	372,889	30.5
North West	106,512	8.7
Western Cape	129,462	10.6
Total	1,220,813	

Table 2.2: *Land area in km² and percentage of total land area per province (South Africa, 2010j)*

2.3.3 Population

As can be seen from Table 2.3* the opposite is true for the Northern Cape and Gauteng in terms of population size. Over the last five years, Gauteng has had the largest population and the Northern Cape the smallest population. Gauteng and KwaZulu-Natal both have populations of more than 10 million people, each contributing to more than 20% of the land's total population. The proportional populations of the Eastern Cape, Limpopo and the Western Cape provinces range between 10.2 and 13.9%, and their population sizes between 4.9 and 6.8 million. The Free State, Mpumalanga, the Northern Cape and the North West provinces have populations of less than four million, and each of these provinces contribute 7.3% or less to the national population. The distribution of the proportion of population per province has remained stable over time (Table 2.4).

The Western Cape and Gauteng has had the highest normalised growth in population, as both had grown by about 7% over the last five years. The Free State's population had grown by only 1.2% in 2011 relative to 2007's figures. All the other provinces' populations increased by 1.8% to 4.9% (Figure 2.2).

Population					
Province	2007	2008	2009	2010	2011
Eastern Cape	6 706 253	6 739 563	6 771 185	6 801 228	6 829 959
Free State	2 728 079	2 735 518	2 743 166	2 751 161	2 759 644
Gauteng	10 599 423	10 784 862	10 968 290	11 149 487	11 328 203
KwaZulu-Natal	10 314 477	10 442 841	10 570 166	10 695 835	10 819 128
Limpopo	5 310 007	5 370 581	5 431 554	5 492 988	5 554 657
Mpumalanga	3 538 672	3 569 170	3 599 148	3 628 535	3 657 181
Northern Cape	1 073 819	1 079 823	1 085 567	1 091 159	1 096 731
North West	3 138 679	3 167 402	3 195 993	3 224 559	3 253 390
Western Cape	4 927 765	5 019 291	5 109 811	5 199 284	5 287 863
Total	48 337 174	48 909 051	49 474 880	50 034 236	50 586 756

Table 2.3: *Mid-year estimates of population per province (Statistics South Africa(StatsSA),2012)*

Percentage Population					
Province	2007	2008	2009	2010	2011
Eastern Cape	13.9	13.8	13.7	13.6	13.5
Free State	5.6	5.6	5.5	5.5	5.5
Gauteng	21.9	22.1	22.2	22.3	22.4
KwaZulu-Natal	21.3	21.4	21.4	21.4	21.4
Limpopo	11.0	11.0	11.0	11.0	11.0
Mpumalanga	7.3	7.3	7.3	7.3	7.2
Northern Cape	2.2	2.2	2.2	2.2	2.2
North West	6.5	6.5	6.5	6.4	6.4
Western Cape	10.2	10.3	10.3	10.4	10.5

Table 2.4: *Percentage mid-year estimates of population per province (Adapted from StatsSA, 2012)*

*On the completion of the thesis, data from 2011 were the most recent available across all measures used.

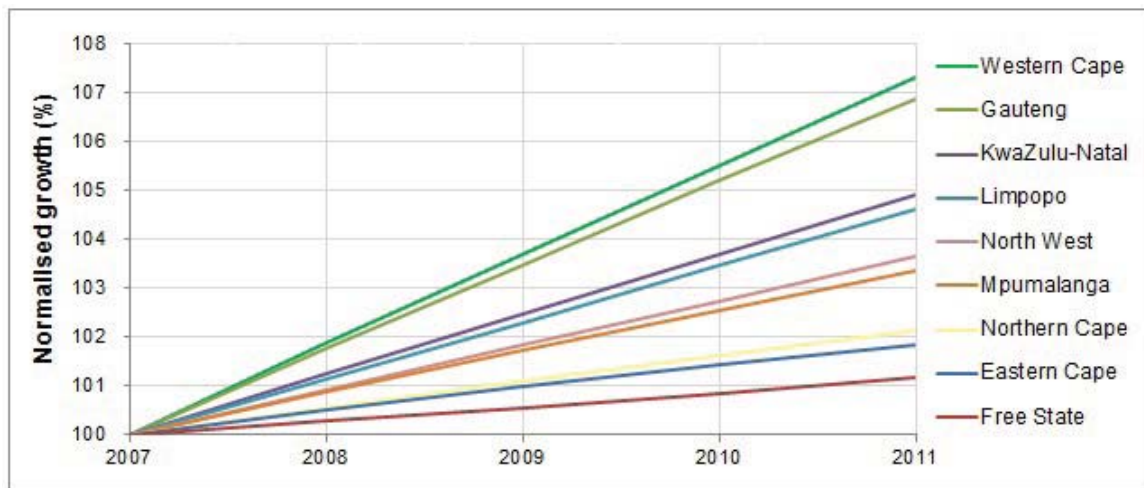


Figure 2.2: *Normalised growth in midyear estimates of population per province (Adapted from StatsSA, 2012)*

2.3.4 Gross Domestic Product

Gauteng has been the biggest contributor (approximately 34%) and the Northern Cape the smallest contributor (about 2%) to total GDP over the last five years. KwaZulu-Natal and Western Cape provinces' share of GDP is 15.7% (or R461 056 million) and 14.1% (or R413 474 million) respectively in 2011. The Eastern Cape, Limpopo, Mpumalanga the North West's shares of the total GDP range between 6.5% and 7.7% in 2007 to 2011. Their GDP's over the last five years ranged between R130 073 and R217 055 million (Tables 2.5 and 2.6).*

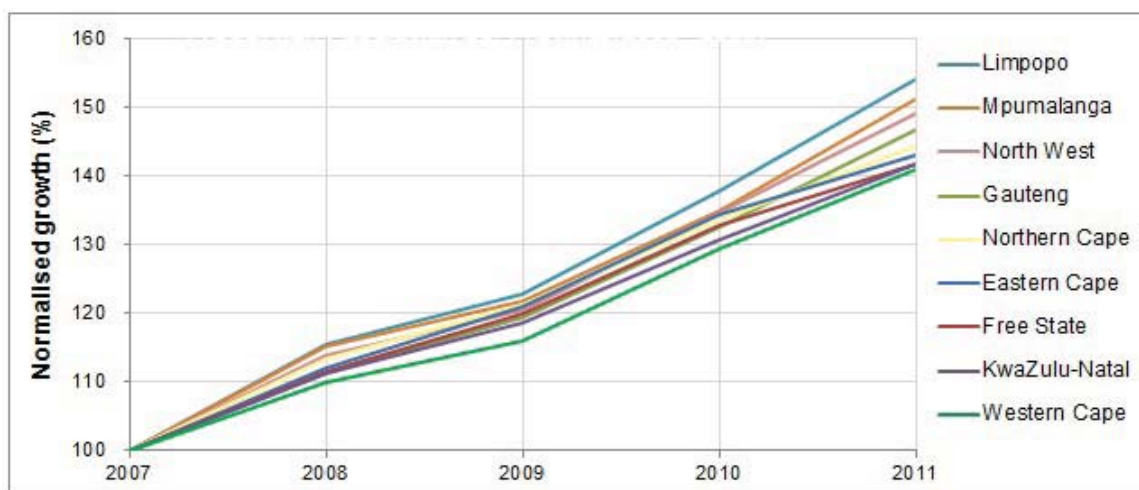
All provinces' GDP increased over the last five years (Figure 2.3).

GDP (Rand million)					
Province	2007	2008	2009	2010	2011
Eastern Cape	151 789	169 921	183 746	204 078	217 055
Free State	108 553	121 120	130 170	144 311	153 897
Gauteng	685 945	763 387	818 933	908 753	1 006 260
KwaZulu-Natal	324 965	361 751	385 655	424 618	461 056
Limpopo	137 274	158 600	168 605	189 130	211 478
Mpumalanga	138 844	159 810	169 167	187 345	209 927
Northern Cape	45 497	51 627	55 203	60 828	65 751
North West	130 073	148 177	156 607	175 016	193 833
Western Cape	293 246	322 092	339 990	379 691	413 474
Total	2 016 186	2 262 502	2 398 157	2 661 433	2 932 731

Table 2.5: *GDP per province (StatsSA, 2013)*

*On the completion of the thesis, data from 2011 were the most recent available across all measures used.

Percentage GDP					
Province	2007	2008	2009	2010	2011
Eastern Cape	7.5	7.5	7.7	7.7	7.4
Free State	5.4	5.4	5.4	5.4	5.2
Gauteng	34.0	33.7	34.1	34.1	34.3
KwaZulu-Natal	16.1	16.0	16.1	16.0	15.7
Limpopo	6.8	7.0	7.0	7.1	7.2
Mpumalanga	6.9	7.1	7.1	7.0	7.2
Northern Cape	2.3	2.3	2.3	2.3	2.2
North West	6.5	6.5	6.5	6.6	6.6
Western Cape	14.5	14.2	14.2	14.3	14.1

Table 2.6: *Percentage GDP per province (Adapted from StatsSA, 2013)*Figure 2.3: *Normalised growth in GDP per province (Adapted from StatsSA, 2013)*

2.3.5 Gross Domestic Product per capita

As can be expected considering the population and GDP figures reported in Sections 2.3.3 and 2.3.4, Gauteng has the highest GDP per capita. It has also made the biggest contribution towards the national GDP per capita at 17.3% in 2011. The Western Cape has had the second highest and surprisingly the Northern Cape has had the third highest GDP per capita and contributions toward South Africa's as a whole (15.3% and 11.7% respectively in 2011). The Free State, Mpumalanga and the North West's GDP per capitass ranged between R55 767 and R59 579 in 2011. This equates to a share of between 10.9% and 11.6% of the national GDP per capita. The three remaining provinces' GDP per capita ranged between R31 780 and R42 615, 6.2% and 8.3% contribution, in 2011 (Tables 2.7 and 2.8).*

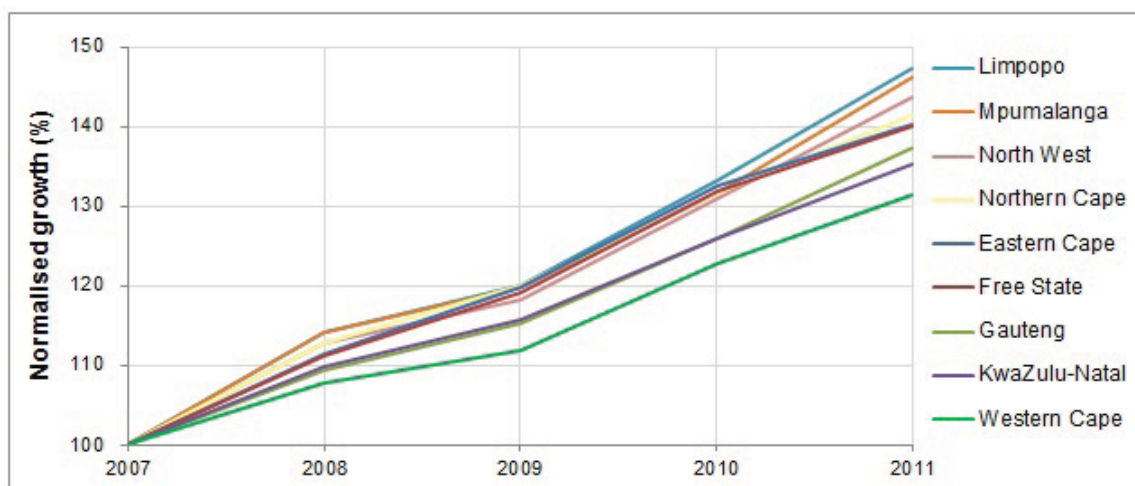
The GDP of all provinces except Gauteng, KwaZulu-Natal and the Western Cape have grown by more than 40% when comparing the figures of 2011 with those of 2007 (Figure 2.4).

*On the completion of the thesis, data from 2011 were the most recent available across all measures used.

GDP per capita					
Province	2007	2008	2009	2010	2011
Eastern Cape	22 634	25 212	27 136	30 006	31 780
Free State	39 791	44 277	47 452	52 455	55 767
Gauteng	64 715	70 783	74 664	81 506	88 828
KwaZulu-Natal	31 506	34 641	36 485	39 699	42 615
Limpopo	25 852	29 531	31 042	34 431	38 072
Mpumalanga	39 236	44 775	47 002	51 631	57 401
Northern Cape	42 369	47 811	50 852	55 746	59 952
North West	41 442	46 782	49 001	54 276	59 579
Western Cape	59 509	64 171	66 537	73 028	78 193
Total	41 711	46 259	48 472	53 192	57 974

Table 2.7: *GDP per capita per province (Author's own compilation)*

GDP per capita					
Province	2007	2008	2009	2010	2011
Eastern Cape	6.2	6.2	6.3	6.3	6.2
Free State	10.8	10.9	11.0	11.1	10.9
Gauteng	17.6	17.3	17.4	17.2	17.3
KwaZulu-Natal	8.6	8.5	8.5	8.4	8.3
Limpopo	7.0	7.2	7.2	7.3	7.4
Mpumalanga	10.7	11.0	10.9	10.9	11.2
Northern Cape	11.5	11.7	11.8	11.8	11.7
North West	11.3	11.5	11.4	11.5	11.6
Western Cape	16.2	15.7	15.5	15.4	15.3

Table 2.8: *Percentage GDP per capita per province (Author's own compilation)*Figure 2.4: *Normalised growth GDP per capita (Author's own compilation)*

2.3.6 Spending

Tables 2.9 and 2.10* indicate that KwaZulu-Natal's spending is the highest for the reviewed period and Gauteng's is the second highest. Both of these provinces contributed 18.4% or more to South Africa's spending. Their respective spending in 2011/12 was R78 643 830 for KwaZulu-Natal and R67 908 855 for Gauteng. Limpopo and the Eastern Cape spent between 11.6% and 14.6% of the national spending. The rest of the provinces spent 8% or less. The Northern Cape's spending was the lowest, it has been lower than 3% across the five years.

All provinces' spending increased in recent years. The North West province has the lowest growth at 156.8% from 2007/08 to 2011/12 (Figure 2.5).

Spending					
Province	2007/08	2008/09	2009/10	2010/11	2011/12
Eastern Cape	30 215 599	38 999 652	45 234 852	48 041 875	53 739 035
Free State	13 275 300	16 055 021	18 774 099	20 974 002	23 761 322
Gauteng	41 714 514	52 063 486	59 054 362	61 455 034	67 908 855
KwaZulu-Natal	44 482 826	55 508 791	63 809 284	67 703 429	78 643 830
Limpopo	24 735 315	30 662 160	35 596 585	41 064 402	43 236 964
Mpumalanga	16 265 247	20 067 665	23 684 351	26 208 827	29 392 411
Northern Cape	5 935 015	7 097 070	8 178 416	9 297 241	10 763 698
North West	15 263 649	17 587 312	20 365 345	21 873 188	23 939 623
Western Cape	21 523 432	25 614 598	30 106 431	34 059 649	36 949 272
Total	213 410 897	263 655 755	304 803 725	330 677 647	368 335 010

Table 2.9: *Spending per province (National Treasury, 2007 to 2013a)*

Percentage Spending					
Province	2007/08	2008/09	2009/10	2010/11	2011/12
Eastern Cape	14.2	14.8	14.8	14.5	14.6
Free State	6.2	6.1	6.2	6.3	6.5
Gauteng	19.5	19.7	19.4	18.6	18.4
KwaZulu-Natal	20.8	21.1	20.9	20.5	21.4
Limpopo	11.6	11.6	11.7	12.4	11.7
Mpumalanga	7.6	7.6	7.8	7.9	8.0
Northern Cape	2.8	2.7	2.7	2.8	2.9
North West	7.2	6.7	6.7	6.6	6.5
Western Cape	10.1	9.7	9.9	10.3	10.0

Table 2.10: *Percentage spending per province (Adapted from National Treasury, 2007 to 2013a)*

*On the completion of the thesis, data from 2011 were the most recent available across all measures used.

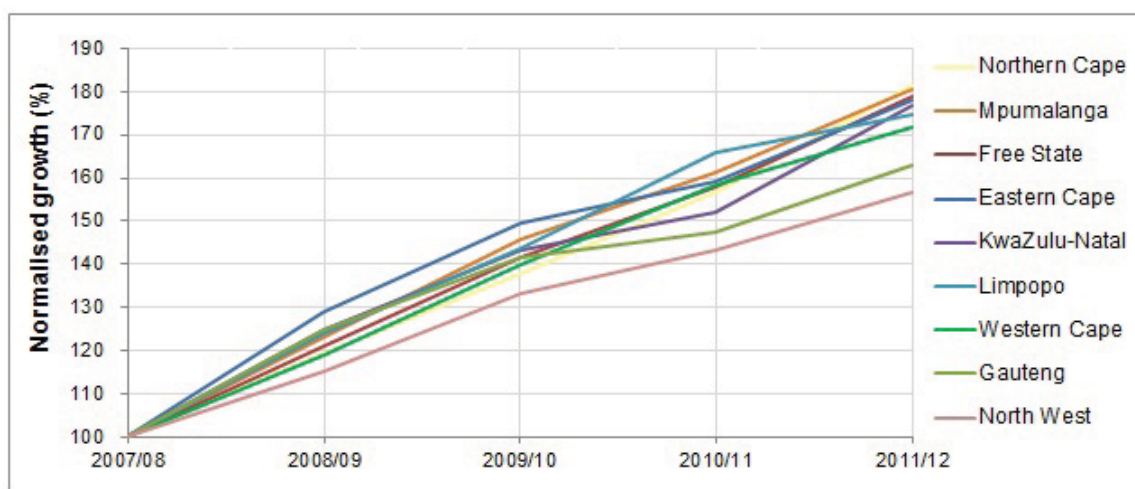


Figure 2.5: *Normalised growth of spending per province (Adapted from National Treasury, 2007 to 2013a)*

2.3.7 Comparative overview of 2011

The Eastern Cape province's proportional land area, population and spending were all approximately 14% in 2011. However its proportional GDP was only about half of that. The Free State's proportional land area is 11%, contrary to all other measures that ranged between 5% and 6%. Gauteng has the smallest land area, but it had the highest population and GDP in 2011. Gauteng province had the second highest spending and KwaZulu-Natal had the highest. KwaZulu-Natal's proportional population and GDP were 2.8 times higher than its proportional land area. The Limpopo, Mpumalanga and the North West provinces' proportions were comparable to each other, all measures ranged between 6% and 12%. Although the Northern Cape has the biggest land area, it had the smallest proportional population, GDP and spending for the period under review. The Western Cape's proportional land area, population and spending were in the 10% range; its contribution towards GDP was higher at 14%. This information is presented in Figure 2.6.*

*On the completion of the thesis, data from 2011 were the most recent available across all measures used.

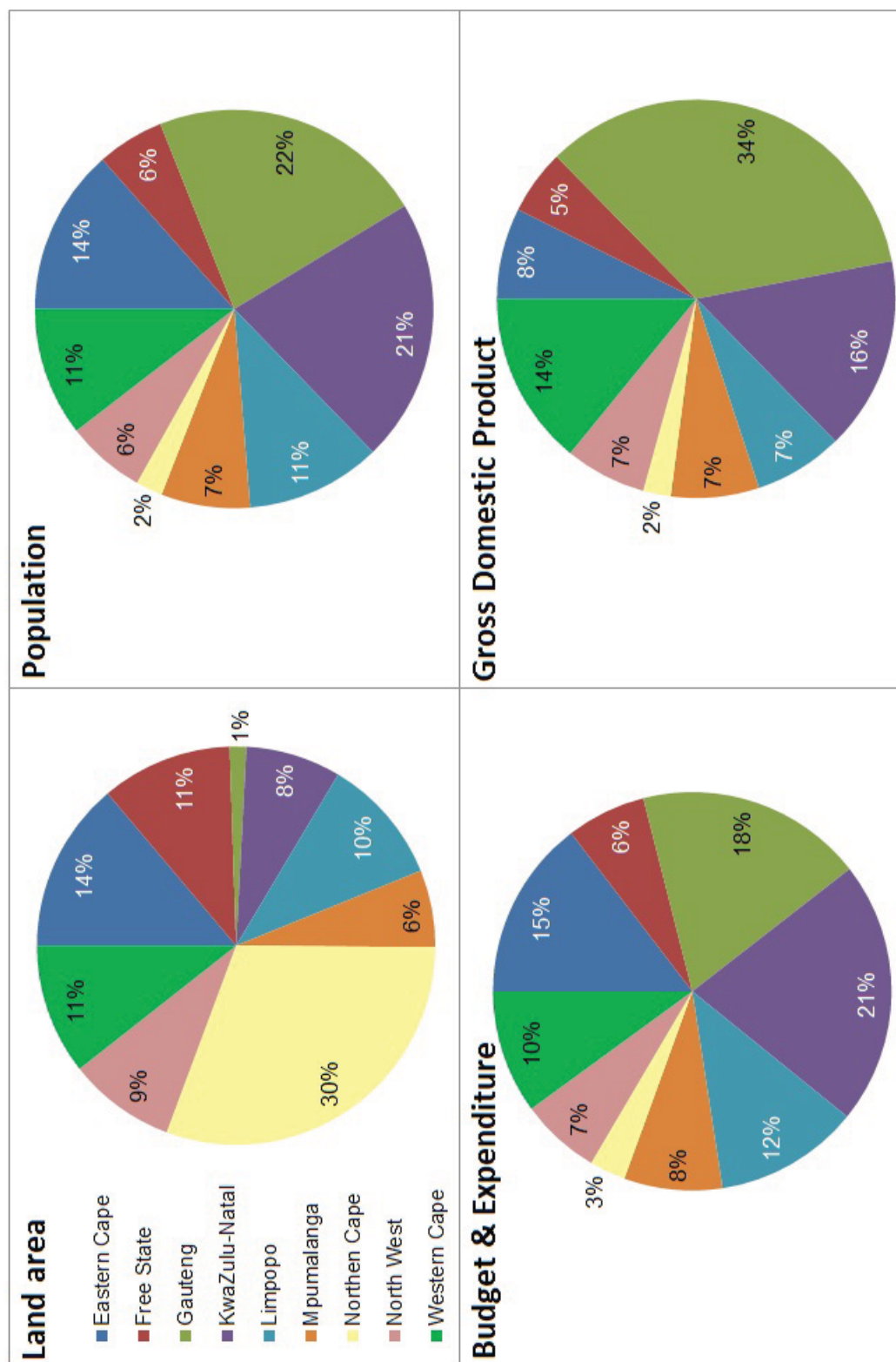


Figure 2.6: Summary of provincial statistics of 2011 (Author's own compilation)

2.3.8 Economic activities

Another aspect causing variations amongst South African subnationals are the economic activities in which they participate since each of the nine provinces engage in different economic activities. This section provides a summary of the economic activities within each province.

The Eastern Cape

The biggest economic activity of this province is automotive manufacturing. Wholesale and retail trade, hotels and restaurants, real estate, finance and business services are some of the other important industries within the Eastern Cape.

Fruit, chicory, coffee, tea, sheep, cattle, dairy products and fish are some of the agricultural products produced by the province (South Africa, 2010a).

The Free State

The Free State is the province with the most high-technology industries. The chemical and petrochemical sectors form a big part of the business sector. Gold, coal and diamonds are mined here.

The province produces: cherries, soya, sorghum, sunflowers, wheat, cut flowers, vegetables, as well as seeds of soya, sorghum, sunflowers and wheat (South Africa, 2010b).

Gauteng

The smallest province of South Africa in terms of land area contributes most of South Africa's GDP. The most imperative economic sectors that help to generate this GDP are: financial and business services, logistics and communications and mining. Manufacturing in this province includes: iron and steel, fabricated and steel products, food, machinery, electrical supplies, vehicle parts, accessories and chemical products. Food and beverage production also takes place in Gauteng.

The province provides: fresh produce, ground-nuts, sunflowers, cotton and sorghum (South Africa, 2010c).

KwaZulu-Natal

KwaZulu-Natal is home to the world's largest sand mining and mineral processing operations. The vehicle manufacturing and the automotive leather industries form part of this province's industries.

Sugarcane, subtropical fruit, vegetables, dairy and stock farming are the principal agricultural activities in KwaZulu-Natal (South Africa, 2010d).

Limpopo

The hunting industry is one of this province's biggest industries. Mining is another prominent industry found in this province. Platinum group metals, iron ore, chromium, coking coal, antimony, phosphate and copper are some of the mineral deposits found in Limpopo and the mineral reserves includes gold, emeralds, scheelite, magnetite, vermiculite, silicon and mica.

Extensive tea, coffee and forestry plantations are prominent in this province (South Africa, 2010e).

Mpumalanga

Mpumalanga produces most of South Africa's coal and hosts a number of coal-fired power stations. Forestry, agriculture, mining, manufacturing and electricity are also important industries within this province.

Subtropical fruit, citrus, nuts and vegetables are grown here (South Africa, 2010f).

The Northern Cape

The largest province of South Africa in terms of land area is rich in diamonds and contains the biggest source of iron ore. Other minerals found in this province are: alluvial, asbestos, manganese, fluorspar, semi-precious stones and marble.

Farming includes game farming, sheep farming and the cultivation of wheat, fruit, peanuts, maize and cotton (South Africa, 2010h).

The North West

The following minerals are mined in this province: platinum, gold, granite, marble, fluorspar and diamonds. The province's agricultural activities consist of farming with cattle, maize and sunflowers (South Africa, 2010g).

The Western Cape

The biggest contributors to this province's regional economy are finance, real estate, retail and tourism. Several petroleum, printing and publishing, clothing and textile companies are located in this province.

A number of agricultural products are produced in the province of which many products such as ostrich meat, feathers and leather ware and fruits such as apples, table grapes, olives, peaches and oranges are exported (South Africa, 2010k).

2.3.9 Provincial departments

Another interesting aspect of the provinces of South Africa is the difference in the provincial departments that reside within the provincial governments.

These provincial departments administer the functions of the provincial governments. Each provincial government decides for itself how to distribute these functions among the departments. Therefore the number of departments differs among the provinces. For example, the Eastern Cape groups Road and Public Works together, whereas Gauteng groups Roads and Transport together and does not have a department specifically administering Public Works. However, some commonality also exists. One such commonality is that all provincial governments have a Department of Health and a Department of Education.

The difference in the grouping of functions results in different numbers of provincial departments per province. Most of the provinces' governments have 13 provincial departments that administer the functions within the province. This includes the Eastern Cape, the Free State, Mpumalanga and North West. KwaZulu-Natal has the highest number of departments at 16 and Limpopo the

lowest at 10. Gauteng and the Northern Cape each have 13 provincial departments and the Western Cape has 14 (South Africa, 2014).

2.4 Credit ratings in general

A key concept that should be understood in addition to South Africa's provincial governments and the uniqueness of these provinces, is credit ratings. The next section provides some general information regarding credit ratings.

2.4.1 Definitions

The definitions of some terms underlying credit ratings have to be introduced first in order to gain a proper understanding of credit ratings.

One of the crucial terms is **default**, since the likelihood of default is the focus of credit ratings. Brookes et al. (2010) state that default is the failure to meet a financial obligation or failure to fulfil an obligation, more specifically to make a payment when it is due. According to Scott (2003) it is the failure to live up to the terms of a contract, or more generally the inability of a borrower to pay the interest or principal on a debt issue when it is due.

Another key concept is **credit risk**, defined by Scott (2003), "the risk that a borrower will be unable to make payment of interest or principal in a timely manner".

Scott (2003) also terms a **credit rating** as "a grading of a borrower's ability to meet its financial obligations in a timely manner".

Credit ratings can be used to rate issuers, for example companies, governments and subnational governments and also issues such as financial instruments or specific debt instruments. Thus it is evident that credit ratings have a very broad application. Section 2.4.8 describes the applications of credit ratings, but credit ratings itself will be defined and explained next.

2.4.2 Credit ratings

The three largest international credit rating agencies are Fitch Ratings (Fitch), Moody's Investors Services (Moody's) and Standard and Poor's (S&P). Although credit rating agencies will only be discussed in the next section, the way these agencies define credit ratings will be used to define and explain credit ratings for the purpose of this thesis. These three agencies each define credit rating in their own way.

Moody's asserts that their credit ratings represent an opinion about the relative creditworthiness of an issuer or issue (Moody's, 2011b). They establish creditworthiness by answering two fundamental questions, firstly, what are the risk to the debt holder of not receiving timely principal and interest payments and, secondly, how the level of risk measures up to the risk of similar issuers or issues (Moody's, 2011a).

Fitch defines the agency's credit ratings as relative measures of risk that are opinions of the relative ranking of vulnerability to default. This can also be termed as opinions of the relative credit quality of an issuer or instrument (Fitch, 2011a).

S&P's ratings express an opinion about the ability and willingness of an issuer to meet its financial obligations in full and on time. In the case of an individual issue, a credit rating expresses S&P's view on the credit quality of the issue, as well as the relative likelihood that the issue may default (S&P, 2011b). Prior to this definition S&P defined credit ratings as relative rankings among issuers and issues of the overall creditworthiness where creditworthiness encompasses the likelihood of default, payment priority, recovery and credit stability (S&P, 2009).

It is important to note that credit ratings:

- are relative rankings of creditworthiness, meaning that an issuer or issue with a higher ranking is considered to be of better credit worthiness than a issuer or issue with a lower ranking, in other words higher ranked issuers or issues will default less frequently than issuers or issues ranked lower, assuming everything else stays the same (S&P, 2009);
- are opinions, not facts, and therefore cannot be described as accurate or inaccurate;
- are the collective effort of a group or groups of individuals, for example, the mathematicians and a team of analysts, and therefore no individual or group of individuals is solely responsible for a credit rating (Fitch, 2011a).

2.4.3 Benefits and limitations

There are some benefits and limitations associated with using credit ratings. The benefits include that credit ratings:

- focus on the long term and therefore should not vary according to business cycles or short-term market movements (Moody's, 2011c);
- are comparable across sectors, geographies and over time (S&P, 2009);
- are forward-looking opinions that evaluate available current and historical information to determine the potential impact of foreseeable future events (S&P, 2011b);
- provide credit information which has been evaluated and summarised by a reliable third party (Credit Rating and Information Services of India Ltd (CRISIL), 2012) and thus could be seen as independent and objective measures of credit quality (Duan and Van Leare, 2012).

The limitations of credit ratings are that they:

- do not imply or convey a probability of default and therefore do not provide predictive measures of specific defaults;
- do not directly address any other risk than credit risk (Fitch, 2011a).

The notes listed in the previous section, as well as the benefits and limitations listed above, in particular the limitations of credit ratings, should be taken into account when using credit ratings as part of any decision-making process.

2.4.4 Credit rating agencies

Credit ratings are assigned by independent agents; known as credit rating agencies. Credit rating agencies specialise in evaluating the credit risk of issues and issuers. Bannier and Hirsch (2010) state that credit rating agencies offer statements on the creditworthiness of issuers and their financial obligations.

Credit rating agencies are intermediaries in the capital market, since they formulate rating opinions which investors and other market participants use when making investment and business decisions (S&P, 2011b).

The three largest international credit rating agencies are: Fitch, Moody's and S&P. Regional and functional niche ratings agencies that specialise in a geographical region or industry also exist. Examples of regional rating agencies are the Canadian Dominion Bond Rating Service Limited (DBRS), AustraliaRating and CRISIL.

Each rating agency employs their own unique methodology to assess creditworthiness.

2.4.5 Credit rating methodologies

A credit rating methodology is developed as part of an iterative process. This process starts off by analysts gathering information of issuers similar to the typical issuer that will eventually be credit rated by the methodology. This includes information on the background and history of the issuer, the political and regulatory environment within which the issuer operates, the quality and experience of management, the debt structure and attitude of the issuer towards risk taking, financial position and sources of liquidity. The gathered information can be qualitative (for example the quality and experience of management) or quantitative (for example data indicating the financial position).

A credit rating methodology can thus either be analyst-driven, statistical model-driven or a combination of both (S&P, 2011b). There are a number of different statistical models available to determine the variables, sub-factors and broad factors to be included in a credit rating methodology. Qualitative information cannot be directly quantified, but it does provide significant information regarding the willingness to repay debt. Qualitative information is therefore assessed by a team of analysts and then used as input into a statistical model (S&P, 2009), while quantitative information is used "as is". The output of such a statistical model is a preliminary credit rating.

The preliminary credit rating, as well as any other relevant risk factors, are presented to a rating commission, who makes a subjective conclusion about the credit rating of the issuer. The issuer is informed about the credit rating that the credit rating committee has decided on and the rating is published (S&P, 2011b).

Once this process is finished the credit rating agency will monitor the credit rating and the agency will publish rating actions or outlook changes (Moody's, 2011a). Outlooks is an additional service provided by rating agencies and provides an indication of potential future credit rating changes (Bannier and Hirsch, 2010).

An in-depth understanding of existing subnational credit rating methodologies will aid with the identification of information that is required to credit rate South African subnationals. Subnational government-specific credit rating methodologies are therefore documented in detail in Chapter 3.

2.4.6 Data sources and quality

The data required to rate an issue or issuer are dictated by the credit rating methodology. The data used should be sufficient and consistent in order for the agency to form an opinion about the creditworthiness of an issuer or issue (Fitch, 2011a).

The data used are publically available information and non-public information. Data needed should be provided by the issuer, underwriters and other parties. Although a credit agency might perform some verifications on the information provided, its accuracy remains the responsibility of the party providing the data.

The lack of essential data pertaining to an issuer or issue may prevent the credit rating agency from establishing a credit rating for the issuer or issue (Moody's, 2011b).

2.4.7 Credit rating scales

Risk Group	Fitch's rating scales	Moody's rating scales	S&P's rating scales
Upper investment grade	AAA AA+ AA AA- A+ A A-	Aaa Aa1 Aa2 Aa3 A1 A2 A3	AAA AA+ AA AA- A+ A A-
Lower investment grade	BBB+ BBB BBB-	Baa1 Baa2 Baa3	BBB+ BBB BBB-
Non-investment grade	BB+ BB BB-	Ba1 Ba2 Ba3	BB+ BB BB-
Lower non-investment grade	B+ B B-	B1 B2 B3	B+ B B-
Lower non-investment grade	CCC+ CCC CCC- CC C	Caa1 Caa2 Caa3 Ca C	CCC+ CCC CCC- CC C
Selective default	SD		SD
Complete default	D		D

Table 2.11: *The long term credit rating scales of the three international credit rating agencies divided into seven comparable risk groups (Adapted from Barlow, 2010)*

Credit rating agencies summarise their opinions about the creditworthiness of an issuer or issue in ratings that are graded by symbols such as AA-, BBB+ and Caa1. Issuers or issues with the same rating symbols will portray the same credit characteristics and hence have the same relative

creditworthiness. Credit rating scales are ordinal, which implies that all the ratings on a specific scale are comparable. These credit rating scales can also be used to rank issues or issuers.

There are two types of credit rating scales, long term and short term. Long term credit ratings scales summarises the opinions of credit rating agencies regarding an issuer's or issue's creditworthiness over a time horizon of three to five years, and short term credit rating scales over a shorter time period (Langohr and Langohr, 2008).

Each credit rating agency uses its own rating scale to express their opinions of relative creditworthiness, but one cannot assume that the same rating scale given by different credit rating agencies indicates the same level of credit risk (Moody's, 2011d). However, the long term credit rating scales of the three international credit rating agencies can be divided into seven comparable risk groups (Table 2.11).

A credit rating agency's credit rating scales should always indicate the same level of creditworthiness associated with each grade to ensure comparability. For example, it should be comparable across sectors and countries and thus should not be affected by external factors like issue type or currency (Moody's, 2011f). Hence the same scale should be used for nationals, corporates, bonds and structured financial instruments (Langohr and Langohr, 2008). It is important to note that credit ratings are relative measures and therefore it is possible that issuers or issues that are assigned the same category may have small differences in their degree of risk (Fitch, 2011a).

When a credit rating agency expects an issuer or issue's credit rating to change in the medium term, six to 24 months, they will assign an outlook indicating the expected direction of the change, for example positive, negative, stable or developing. When they expect a short term change they will issue a credit watch or place the issuer or issue on a watchlist. The expected direction will be also be indicated, for example upwards or downwards (Moody's, 2014b; S&P, 2011b).

2.4.8 Applications of credit ratings

Credit rating scales can indicate the credit quality of national governments, subnational governments, public utilities, banks, insurance companies, mutual funds, general obligation bonds and revenue bonds issued by municipalities.

Credit ratings are used by borrowers, intermediaries, regulators, savers, governments, economists and many other market participants and observers (Moody's, 2011e). Investors in particular use them as a screening method when making investment decisions and at the same time they aid issuers to enter the capital market by indicating their risk relative to the other participants. Thus, credit ratings enable growth and facilitate stability and efficiency in the capital markets.

Subnational government credit ratings are specifically used by banks and investors to establish a credit rating for subnational governments when they apply for credit. Other creditors use them to determine whether or not they wish to conduct business with a specific subnational government, since the rating will provide an indication of their probability to repay timeously. Subnational governments themselves use credit ratings to identify problem areas that they can improve on in order to make them more creditworthy.

2.4.9 Credit rating agencies, credit ratings and the credit crisis

One last aspect that should be reviewed in terms of credit ratings in general is the role that credit rating agencies and their credit ratings played the credit crisis that started in 2007. Credit rating agencies and their credit ratings are considered to have been a major contributor to the crisis (Hirth, 2014). However, subnational governments' credit ratings specifically did not have a direct impact on the crisis, but the crisis itself did influence the finances of these subnationals due to its negative impact on economic growth (Canuto and Liu, 2010).

Central to the credit crisis were two types of special financial products, residential mortgage-backed securities and collateralised debt obligations. These were marketable because credit rating agencies supported them (Darcy, 2009). In 2007 and 2008 the credit quality of these products depreciated swiftly and extensive downgrades of their credit ratings followed (Benmelech and Dlugosz, 2009). These downgrades indicated that the credit ratings agencies failed to rate these correctly (see Section 3.8 for the definition of a rating failure).

Critics asked questions as to why the credit rating agencies failed to rate these financial products correctly. Mullard (2012) lists six reasons for these rating failures:

- credit rating agencies focussed on generating fees, improving profits and trying to keep their market share since clients are prone to move to a competing credit rating agencies should its current credit rating agency give them an unsatisfactory rating;
- credit rating agencies experienced a conflict of interest since they were involved in the design of these financial products and it would have reflected badly on them if they assigned a low credit rating to a product they have helped design (Mullard, 2012; Gupta et al., 2010);
- the data used in the mathematical modelling process did not include data of these newly developed financial products and the credit rating agencies were unwilling to adjust their models;
- analysts that were unwilling to rate these products were ignored or disregarded when they expressed concerns regarding these ratings;
- credit rating agencies were understaffed and when they did appoint new analysts these analysts did not have the experience or expertise to rate these special financial products;
- the legal framework in place discharged the credit rating agencies from legal accountability for the role they played in the financial crisis.

According to Sinclair et al. (2008) the financial crisis of 2007/2008 brought forth some recommendations regarding the regulatory framework of credit rating agencies. The following can be mentioned:

- a credit rating agency should not be allowed to rate an issuer or issue if the data to verify the rating are not available;
- a credit rating agency should also not be allowed to rate an issue if the specific credit rating agency had advice on the issue;
- all credit rating agencies should be obligated to publish all ratings and rating upgrades and downgrades;

- an analyst involved in rating an issuer or issue may not be involved in negotiating the issuer's fee; and
- when a credit rating agency rates a special product, the regulator should insist that they explain the difference between rating the special product and a traditional product (Sinclair et al., 2008).

Bayar (2014) documents the new regulations that came into effect after the financial crisis. These include, among others, regular inspections of the credit rating agencies' operations and the monitoring of ratings. Also, credit rating agencies should disclose their procedures and methodologies, as well as any changes to these. However, Bayar (2014) concludes that although these would increase transparency and accountability of the credit rating agencies, they would not eliminate conflicts of interest or increase the competition among the credit rating agencies. Thus further regulatory changes may be required.

2.5 Conclusion

This chapter provided information regarding key concepts required as background knowledge for the remainder of the thesis.

This chapter proceeds as follows. Firstly, Section 2.2 provided an overview of the governing system of South Africa. Section 2.3 discussed the difference between the provinces of South Africa. This provides the reader with some insight into the government of South African provinces and explains each province's distinctiveness due to variations in some aspects. All of the afore-mentioned may affect the departments that operate within the provinces and should be taken into account when developing the subnational credit rating methodologies.

Section 2.4 explains credit ratings in general, since an understanding of credit rating is also important for the rest of this thesis, especially for Chapter 3, which documents existing credit rating methodologies of subnational governments.

Chapter 3

SUBNATIONAL CREDIT RATING METHODOLOGIES

3.1 Introduction

The exceptional urbanisation in developing countries has stimulated the need for large infrastructure investments. Fiscal transfers and subnational own-tax revenues are rarely sufficient to fund these investments and subnational governments from these countries are therefore forced to enter the financial market (Liu and Waibel, 2008). A valid, recognised credit rating is a requirement for any borrower wishing to enter the financial market. The credit rating of a subnational is defined by Liu and Tan (2009) as “the formal opinion of a subnational government’s capacity and willingness to honour commercial debt obligations, therefore to repay it in full and on time”. Subnational governments need these credit ratings in order to gain access to the financial market, and ultimately to finance infrastructure investments.

South African subnationals are defined as provincial governments and provincial departments in this thesis. None of these are being credit rated at present (2014). Municipal governments, on the other hand, are being credit rated. All 278 municipalities are rated by Municipal IQ, a data and intelligence service specialising in the monitoring and assessment of South Africa’s municipalities (Municipal IQ, 2013). Fitch and Moody’s also rate the municipalities but only a few, less than 5%. One reason why South African municipalities are being credit rated, but not the South African subnationals, is that municipalities generate and publish more comprehensive financial statements than provincial governments and departments. The reason for this is that municipalities use the accrual base accounting system and provincial governments employ a modified cash basis accounting system (National Treasury, 2013c).

This study develops the quantitative parts of credit rating methodologies for South Africa’s subnationals, focussing on provincial departments. A thorough understanding of existing subnational credit rating methodologies is required in order to create a credit rating methodology that can suit South African subnationals. Therefore, this chapter will pay particular attention to some existing subnational credit rating methodologies.

Interesting observations can be drawn from comparing the different documented credit rating methodologies. One observation is the five broad factors into which the information used to assess the creditworthiness of subnationals can be grouped. Another is the difference of the importance of quantitative and qualitative information for developed and developing countries. Typically, in

a developed country, the quantitative and qualitative information will be equally important as opposed to developing countries where the quantitative information only equates to 30% of a credit rating and the qualitative information to 70% of credit rating. Both of these will be applied in the remainder of this thesis.

This chapter proceeds as follows. Section 3.2 provides background information regarding subnational credit ratings, while Section 3.3 investigates the relationship between national government and subnational government credit ratings. Section 3.4 examines existing international subnational credit rating methodologies and Sections 3.5 and 3.6 examine existing regional subnational credit rating methodologies, for both developed and developing economies. Note that to improve the readability of this chapter, Sections 3.4 to 3.6 provide summarised versions of relevant rating methodologies, detailed versions of these methodologies can be found in Appendix A. Section 3.7 provides an introduction to the South African Public Sector Risk Management Framework (PSRMF), the details are documented in Appendix A. Section 3.8 discusses subnational defaults and rating failures. Sections 3.9 and 3.10 document methodological changes to subnational credit ratings, as well as challenges stemming from rating developing countries' subnationals. Section 3.11 reviews the challenges and benefits that emerge when developing subnational credit rating methodologies for the South African context, while Section 3.12 concludes.

3.2 Background

This section provides background to subnational credit ratings by listing the reasons for the increase in the number of subnational governments being credit rated, the benefits and the limitations of subnational borrowing and the risks involved in subnational borrowing.

3.2.1 Reasons for the increase of subnational credit ratings in recent years

Although the need for infrastructure investments was the initial reason for the development of subnational credit ratings, there has been a significant increase in the number of subnational governments being credit rated since the mid-1990s. The following six reasons have been listed by Gaillard (2006) and Gaillard (2009) for the increase in subnational credit ratings in recent years.

The first, but indirect, cause is the increasing number of countries moving towards greater decentralisation of fiscal revenue and spending responsibilities. This enabled all tiers of government, including subnationals, to increase their borrowing capacity.

The second cause is the development or extension of market-based borrowing policies. Fewer bank loans, but growing indebtedness forced subnationals to enter the financial market for funding. Due to the fact that a credit rating is a prerequisite for entering the financial market, the two afore-mentioned reasons lead to an increase in subnational credit ratings.

Thirdly, credit ratings improve credibility and promote investor confidence and therefore the number of subnationals willing to be credit rated increased since the mid-1990s. Subnationals that are willing to be credit rated demonstrate their trustworthiness.

Fourthly, subnational governments are also inspired to be credit rated due to the better borrowing conditions that accompany credit ratings, since these ratings enable subnationals to negotiate for, among other things, better collateral and guarantee agreements.

The fifth reason is that due to regulatory rules, subnational governments need credit ratings to enter financial markets. Some countries even require subnational credit ratings as part of their regulatory framework.

The last reason is the competition between credit rating agencies, since subnationals tend to request credit ratings from several credit rating agencies. A subnational might subsequently be recorded in more than one credit rating agency's statistics on the number of subnationals being credit rated. This leads to an over-estimation of the number of subnationals being credit rated (Gaillard, 2006; Gaillard, 2009).

The considerable increase in subnational credit ratings makes it possible for more and more subnationals to enter into the financial market in order to borrow money. However, there are some benefits and risks associated with subnational borrowing.

3.2.2 Benefits of subnational borrowing

There are several benefits, as listed by Liu and Waibel (2008), for the subnational and its residents, as well as the financial market as a whole involved in subnational borrowing.

The subnational and its residents explicitly benefit in two ways. Financing through borrowing allows subnational governments to keep up with the extraordinary infrastructure demands due to urbanisation. In addition, borrowing spreads the costs of financing infrastructure projects across present and future generations that will benefit from it by matching the maturity of the debt to the asset's economic life.

A credit rating is a prerequisite to enter the financial market. These credit ratings rely on independently audited public financial accounts. This requirement strengthens fiscal transparency, encourage sound budget and financial management and good governance. This benefits the subnational, its residents and the financial market as a whole.

Due to the growing demand for subnational borrowing, a more competitive financial market is developing, bringing forth an increasing number of buyers, sellers and financial products. Thus subnational borrowing is leading to a growing financial market.

The benefits applicable to South Africa are addressed in Section 3.11.2.

Although there are several benefits involved in subnational borrowing, there are also some risks associated with it. These are covered in the next section.

3.2.3 Risks involved in subnational borrowing

A country's regulatory framework for borrowing greatly affects the fiscal sustainability of the country's subnational governments. The risks associated with subnational borrowing in the absence of an effective regulatory framework are discussed next.

Unregulated borrowing may increase fiscal stress since fiscal deficits are only sustainable if it is financed properly, especially in an uncertain macroeconomic environment where unrestricted access to the financial market can outgrow the evolvement of revenue streams needed to repay these debts.

Significant borrowing to finance large operating deficits may lead to unmanageable debt positions.

In a macroeconomic crisis the vulnerability of fiscal positions of subnational governments can be exposed and a widespread subnational debt crisis can be precipitated, especially if the subnationals have risky debt profiles such as short maturities (Liu and Waibel, 2008).

Contingent or off-balance sheet liabilities of subnationals such as social obligations, public private partnerships and bailouts of private companies may result in the deterioration of the subnational government's financial health (Liu and Waibel, 2008).

The risks associated with subnational borrowing mentioned above are associated with unregulated borrowing, for example, when budget constraints are not imposed on subnational governments. Except for the regulatory framework that national governments have to set for subnational borrowing, they have a far-reaching effect on subnational governments. One example of these effects is that the national government's credit rating might have an impact on the subnational governments' credit ratings. The next section investigates the impact of national governments on subnational governments, in particular on their credit ratings.

3.3 National government credit ratings

The following section explains the major impact that sovereign factors and the sovereigns' credit rating exert on subnational governments' credit ratings. This is of importance since it needs to be assessed when assigning a credit rating to a subnational and thus also when developing subnational credit rating methodologies.

The impact that these have on a subnational's credit rating arises from the fact that a country's macroeconomic management affects the broader economic, fiscal and financial conditions under which a subnational government operates. For these reasons a country's sovereign factors can restrict a subnational government's credit rating and thus its ability to raise funds in the financial market, as well as its chances to change its credit standing (Liu and Tan, 2009). It is also possible that the national government's credit rating acts as a ceiling for the subnational's credit rating.

3.3.1 National credit ratings as ceilings for subnational credit ratings

In the past, a country's credit rating acted as a ceiling for its subnationals' credit ratings. In 2001 the credit rating agencies revised this policy and some conditions were set by them to allow a subnational government to be rated higher than its national government. Refer to Section 3.9.1 for a detailed discussion. However very few subnationals were rated higher than their national government in the past (Gaillard, 2006).

3.3.2 The political, economical and fiscal interdependence of national and subnational governments

In the event that a subnational government is rated higher than its national government, it is unlikely that the subnational's credit rating will be much higher than the national's credit rating, since a subnational's creditworthiness are impacted by what happens politically and economically at its national level. Therefore, it is possible for a national government to enhance or reduce a subnational government's creditworthiness by various policies and regulations.

One example of a subnational's dependence on its national government lies in the constitutional powers assigned to each sphere of government. For example, due the constitutional powers assigned to a national government giving it first claim over the country's foreign reserves and other resources, it is unlikely in a financial crises that the national government will default on its credit arrangements before any of its subnational governments (Liu and Tan, 2009). Also, the national government may modify the constitutional powers assigned to the different levels of government at any time (Gaillard, 2006).

The national government also establishes the investment climate and the negative investment trend of a national government will cause a negative environment for its subnationals too, regardless of the subnational governments' credit standings (Gaillard, 2006). The national government could introduce controls and restrictions that may reduce the subnational government's borrowing ability. Examples of such restrictions are allowing the subnationals to borrow for capital investments only, setting limits on key fiscal variables and a ban on foreign borrowing. These controls and restrictions may also have a positive effect on a subnational's credit rating, since these might force the subnational to improve its financial management. In turn, the improved credit rating will lead to better opportunities in the financial market. In the case where the national government provides guarantees to debt instruments issued by a subnational government, the national government improves the credit quality of these instruments (Liu and Tan, 2009).

The national government can affect a subnational government's credit rating through restrictions on the spending of the subnational (Gaillard, 2006). In most cases, especially in developing countries, subnational governments rely on fiscal transfers from the national government for income. These transfers may be set aside for specific expenditures. If this is the case the subnational government itself can do very little to change its expenditure profile and thus to improve its credit rating (Liu and Tan, 2009). Sometimes the responsibility of the provision of services historically provided by the national government is transferred to the subnational government, although the funds transferred to support the service may not be sufficient (Fitch, 2011d). The financial burden of these services becomes the problem of the subnational government and may have a negative impact on its credit quality. In the case of subnational having to adjust its budget deficit or budget surplus to help meet certain national targets the credit rating of the subnational may be influenced positively or negatively. This may also hinder the subnational's economic activity performance, which is seen as valuable to the local economy.

The national government can also affect the subnationals' credit ratings through restrictions on intergovernmental transfers and tax authority (Gaillard, 2006). These constraints may affect the fiscal sustainability of the subnational and may impact the subnational's economic growth. The national government may also assign specific economic activities to the subnational; this will hinder the subnational economy by restricting the government's ability to diversify production and to increase their competitiveness (Liu and Tan, 2009). These effects of the national government on the subnational government's economy will all have a negative impact on future revenue generation and thus will impact the credit quality of the subnational negatively too.

Subnational governments can benefit from the closeness to the national government in two ways. When there is a history of a national government providing bailouts to troubled subnationals the financial market may be more lenient to those subnationals. This will improve the subnational's creditworthiness (Liu and Tan, 2009). National governments also provide assistance in the form of enhanced financial management and controlled funding. These types of assistance may benefit the creditworthiness of a subnational government through the monitoring of the subnational's financial

position and strict boundaries on reserves, to mention just a few measures (Fitch, 2011d).

Due to the strong relationship between national and subnational governments and the effect that the national government may have on its subnational governments, the rating methodologies of these two types of governments are closely aligned.

3.3.3 Relationship between national and subnational credit rating methodologies

Both national and subnational rating methodologies assess political, economic, fiscal, financial and institutional factors and focus exclusively on determining the creditworthiness of these governments. The credit ratings resulting from these rating methodologies represent the opinions of the credit rating agencies' of the ability and willingness of a given government to fulfil their debt obligations in full and on time.

Qualitative measures contribute considerably to the assessment of a government's credit rating because, although political, social and institutional factors cannot be quantified directly, they nevertheless provide significant information regarding the willingness to repay debt. Quantitative measures such as: debt and other financial ratios as well as macroeconomic variables are also incorporated into governments' credit ratings (Liu and Tan, 2009; Gaillard, 2006).

One distinct difference, however, is that subnational credit rating methodologies contain an additional factor incorporating the national government's credit rating into the subnational government's credit rating. This is evident from Sections 3.4 and A.1, which reviews the three international credit rating agencies' subnational credit rating methodologies.

3.3.4 National credit ratings as a prerequisite for subnational credit ratings

Not only are national governments' credit ratings included in subnational governments' credit ratings, but a country's credit rating is a prerequisite for a subnational's credit rating. The reason for this is that a national government's credit rating contextualises the country's economic, fiscal and institutional situation.

In the case where a national government and a subnational government are being rated and a rating change occurs in the national government's credit rating, a similar adjustment will most probably follow in the subnational's credit rating.

Subnational credit ratings rely heavily on the national government's credit rating. As mentioned above, one of the factors of subnational credit ratings is the national's creditworthiness, therefore in the absence of a credit rating for the national government, the data for the subnational are incomplete (Liu and Tan, 2009).

Although South Africa's subnationals are not currently rated, all of the international credit rating agencies do rate South Africa's national government. Thus, in the event that an international rating agency should be interested in rating the subnationals, this one prerequisite has been fulfilled. A short overview of South Africa's historical credit ratings is provided next.

3.3.5 South Africa's history of credit ratings

The national government of South Africa has been credit rated since 1994 by Fitch and since 1995 by Moody's and S&P. Moody's considered South Africa to be of investment quality since they started rating it in 1995. S&P considered South Africa to be of non-investment grade up until 1999 and Fitch only upgraded South Africa to investment grade in 2001 (National Treasury, 2012a). Section 2.4.7 provides information regarding the grouping of credit rating scales into seven comparable risk groups, for example non-investment and investment quality. The historical credit ratings of the national government of South Africa is presented in Table 3.1.*

Date	Moody's	Fitch	S&P
2012	Baa1	BBB+	BBB+
2011	A3	BBB+	BBB+
2010	A3	BBB+	BBB+
2009	A3	BBB+	BBB+
2008	Baa1	BBB+	BBB+
2007	Baa1	BBB+	BBB+
2006	Baa1	BBB+	BBB+
2005	Baa1	BBB+	
2004	Baa2	BBB	BBB
2003	Baa2	BBB	BBB
2002	Baa2	BBB-	
2001	Baa3	BBB-	BBB-
2000	Baa3	BB+	BBB-
1999	Baa3	BB	BB+
1998	Baa3	BB	BB+
1997	Baa3	BB	BB+
1996	Baa3	BB	BB+
1995	Baa3	BB	
1994		BB	

Table 3.1: *South Africa's historical national government credit ratings (Adapted from National Treasury, 2012a)*

Historical changes

The past credit ratings of South Africa's national government as assigned by Fitch are indicated in Figure 3.1. The reasons for Fitch's changes are briefly summarised.

Fitch adjusted South Africa's national credit rating from a BB to a BB+ in June 2000. This upgrade occurred because the country's macroeconomic conditions and debt ratios improved. This improvement was caused by the improvements made to the fiscal and monetary policies. The decrease in the general deficit supported the change (Fitch, 2000).

The upgrade in 2003 was caused by the move to a floating exchange rate and a reinforced policy administration that resulted in improved economic indicators. South Africa had the best budget

*Information only available up to 2012.

performance of all BBB category countries. Debt ratios improved too (Fitch, 2003).

The build-up of reserves was the main reason for the improvement of South Africa's credit rating to a BBB+ in 2005. This build-up leads to improved economic growth and an improved balance sheet. Fitch expected the economic growth to continue after 2005. A key rating strength was South Africa's sound and transparent public finances (Fitch, 2005).

The decision to downgrade South Africa's national government credit rating was influenced by the heightened political uncertainty. This was caused by the high unemployment rates, social inequalities and strikes. Other issues influencing the decision are the worsening GDP and revenue growth prospects (Fitch, 2013).

On 13 June 2014, Fitch revised South Africa's outlook from stable to negative, the rating itself remained unchanged (Fitch, 2014). However, the negative outlook indicates that Fitch does expect it to be downgraded in the medium term.

The next paragraph contains a short discussion on South Africa's current strengths and weaknesses from a credit rating perspective.

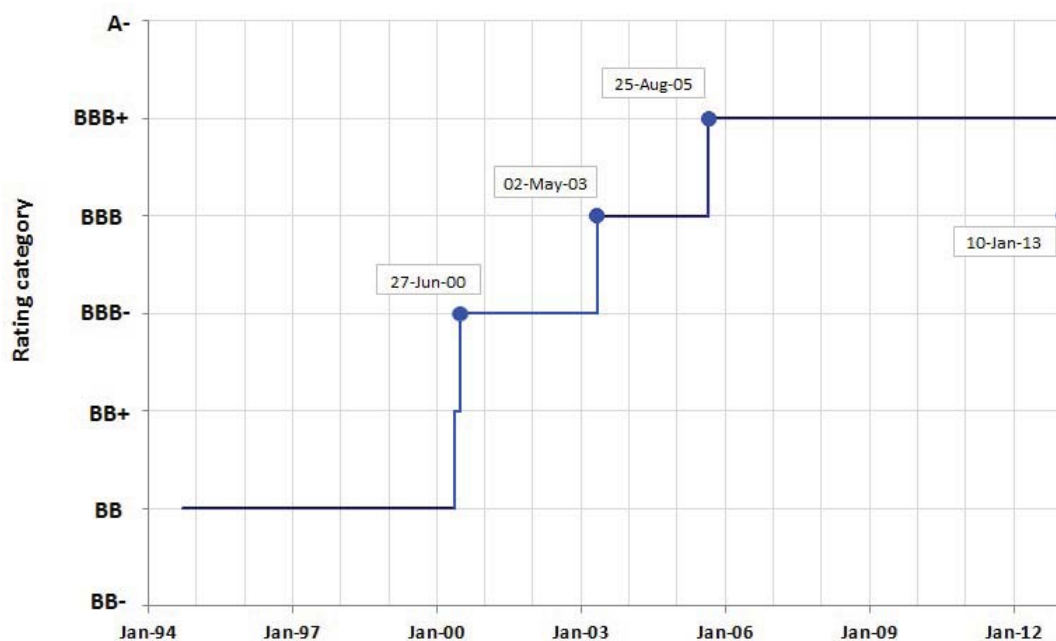


Figure 3.1: *South Africa's historical long-term credit ratings as determined by Fitch (Author's own compilation) - End point not in Table 3.1, but updated from Fitch (2013)*

South Africa's credit strengths

S&P (2011a) indicates South Africa's credit strengths as: political stability, external debt levels that are under control, established capital markets, a sound financial sector and an independent central bank. Fitch views South Africa's government institutions, legal institutions, banking sector and business environment being on the same level as its peers' as credit positives (Fitch, 2011c). Fitch (2013) listed South Africa's income level and business climate as strengths.

South Africa's credit weaknesses

South Africa's weaknesses are stated as: the high unemployment rate, volatile capital inflows and the increasing funding needs of government-related entities (S&P, 2011a). Fitch (2011c) also mention infrastructure bottlenecks, skills shortages, low economic participation and the low savings rates as disadvantages. The weak GDP growth and inability to improve growth potential is also listed as a weakness by Fitch (2014).

An understanding of a country's current credit position is needed in order to understand the environment its subnationals operate within. Since the aim of this study is to rate only South African subnationals with respect to each other, only a brief overview of the national government's credit stance is needed. A thorough understanding of the regulatory environment within which South Africa's provinces operates is also required. This is discussed in detail in Chapter 4. Also, crucial for developing subnational credit rating methodologies for the South African context is an understanding of existing subnational credit rating methodologies. Thus, the next three sections will pay particular attention to various credit rating agencies' subnational credit rating methodologies, both international and regional credit rating methodologies.

3.4 International subnational credit rating methodologies

This section summarises the credit rating methodologies of three international credit rating agencies Fitch, Moody's and S&P as applied to subnationals. The details of these credit rating methodologies are documented in Section A.1 of Appendix A.

These rating methodologies are generic and could be used to determine the creditworthiness of a number of different countries' subnational governments. Therefore, the three methodologies collectively will be referred to as international subnational credit rating methodologies for the remainder of this thesis. Note that theoretically these can be applied to South Africa's provincial governments, departments and municipalities due to the generic definitions of subnationals (local and regional governments).

3.4.1 Fitch's international local and regional governments rating criteria outside the United States (US)

This section draws from Fitch's international local and regional governments rating criteria outside the US (Fitch, 2011b), except if stated otherwise.

Fitch assesses the institutional framework within which the subnational government operates, as well as four other principal factors, including debt and other long-term liabilities, finances, management and administration, and the economic status of the subnational government (Figure 3.2). The institutional framework provides the context within which the four other factors interact.

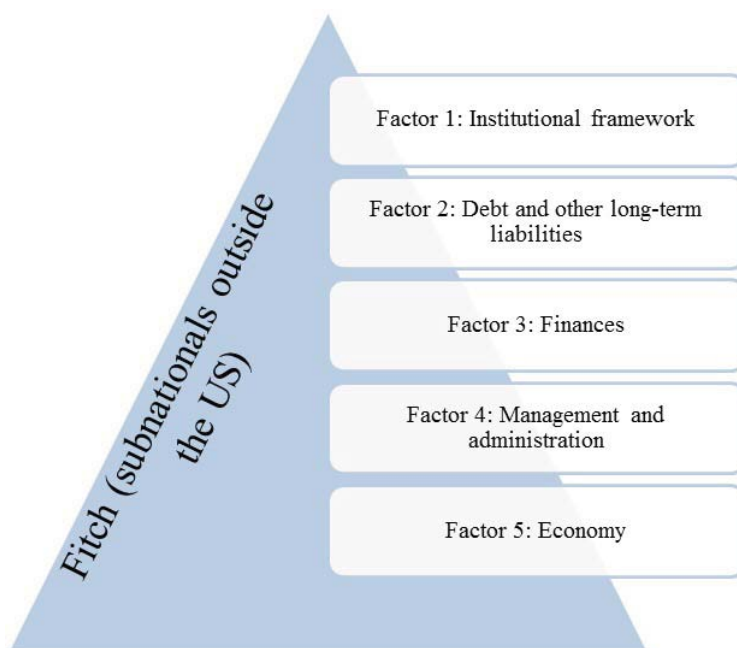


Figure 3.2: *Factors used by Fitch to credit rate subnational governments (Adapted from Fitch, 2011b)*

3.4.2 Moody's regional and local governments outside the US rating methodology

This section is based on Moody's regional and local governments outside the US updated rating methodology of 2008 (Moody's, 2008a).

Moody's determines the creditworthiness of a subnational by combining two key aspects, namely the standalone credit quality of the subnational and an assessment of the probability of the subnational receiving extraordinary support (i.e. the assistance provided by the national government, any other higher tier of government or the subnational's peers to prevent the subnational from defaulting). The latter criterion reflects the likelihood that the subnational may default in future and therefore might require extraordinary support. * The rest of this section focuses on the first key aspect, the assessment of the fundamental credit quality of the subnational itself.

The creditworthiness of a subnational is determined by evaluating different variables individually. These are then grouped into six factors, namely the operating environment, institutional framework, financial position and performance, debt profile, governance and management factors, and the economic fundamentals of the subnational under review (Figure 3.3). Different weights, allocated according to importance, are assigned to the factors to provide an estimation of the subnational's creditworthiness. The first two factors focus on the national government and the country's management system as a whole, and the other four focus on the subnational itself.

*Additional information regarding the assessment of the probability of the subnational receiving extraordinary support can be obtained from Moody's (2006b).

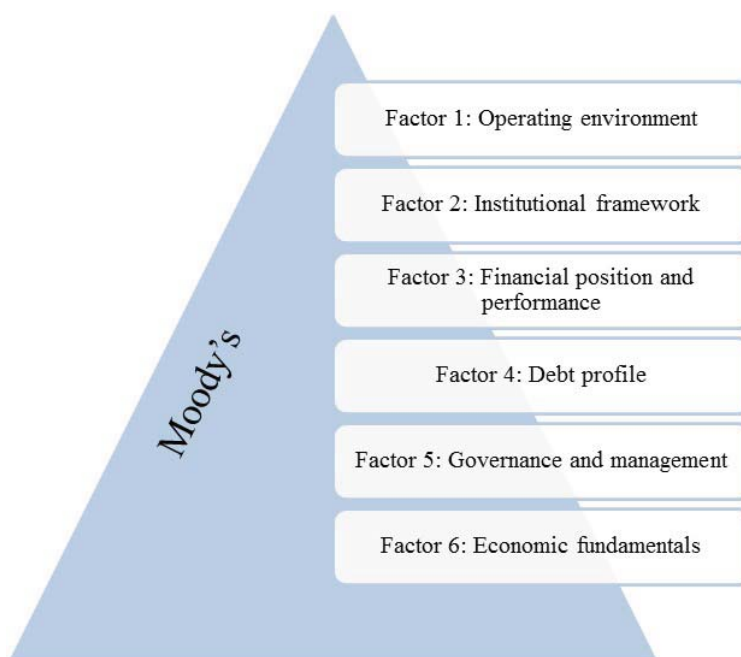


Figure 3.3: *The six factors used by Moody's to determine the creditworthiness of a subnational government (Adapted from Moody's, 2008a)*

3.4.3 S&P's methodology for rating international local and regional governments

S&P methodology for rating international local and regional governments, 2010 was used as the base for this section unless stated differently (S&P, 2010).

S&P employs eight main factors to determine the credit quality of a subnational government. The first one, the institutional framework, assesses the institutional and legal background of the subnational government. The remaining seven factors focus on the subnational government itself and are used to determine the standalone credit quality of the subnational. The factors used to determine the subnational's standalone credit quality are its economy, financial management, budgetary flexibility, budgetary performance, liquidity, debt burden and contingent liabilities (Figure 3.4).

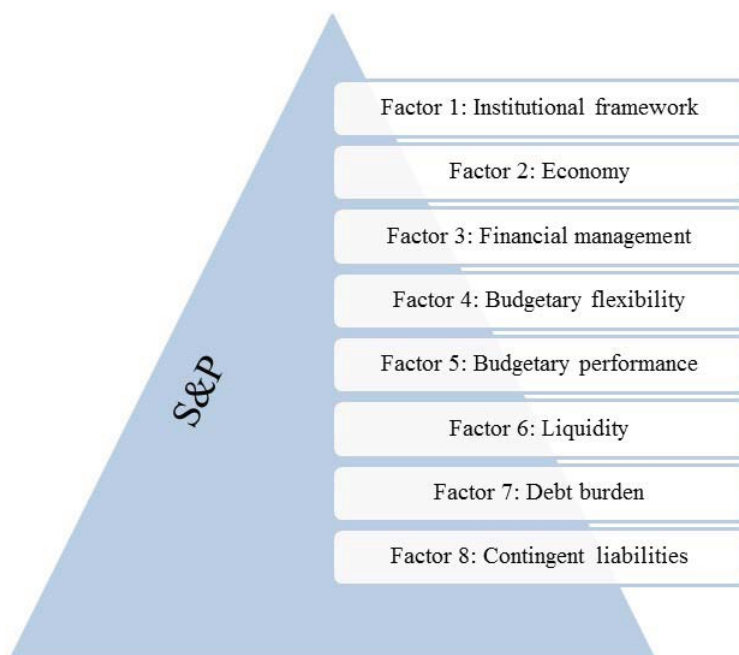


Figure 3.4: *The factors used by S&P to determine a subnational government's credit rating (Adapted from S&P, 2010)*

3.4.4 Comparison of the international rating agencies' rating methodologies

When considering the rating methodologies that the three international rating agencies use to determine the credit quality of subnational governments, it is evident that there are some similarities as well as some differences between these methods. The similarities and differences are discussed in the remainder of this section.

Similarities

The two main similarities between the rating methodologies are the rating criteria and the rating process.

- **Rating criteria**

The rating criteria used by the three rating agencies are very similar. The variables that they use can be divided into five broad factors. These factors are the subnational's economic conditions, the fiscal performance of the subnational, the financial and debt position of the subnational, the management quality and strength of subnational institutions, as well as the influence of the sovereign factors, intergovernmental relations and fiscal arrangements on the subnational (Figure 3.5).

Four of these involve only the subnational, while the fifth factor embraces the influence of sovereign factors, intergovernmental relations and fiscal arrangements on the subnational. This factor is omitted from the review process when country specific credit rating methodologies are considered. The reason for this is that all the subnationals to whom such a methodology is applied to reside within the same country, thus they share the same national government and therefore the characteristics of the national government (and therefore the outcome of the factor) remain the same for all subnational governments being reviewed.

The exclusion of the characteristics of the national government's influence on its subnationals will also be applicable when developing subnational credit rating methodologies specifically for the South African context.

The other broad factors are used as subject knowledge for the purpose of this study. More specifically, the aim was to include variables representing all of these broad factors in the developed credit rating methodologies. This was achieved in some cases, refer to the model comparisons documented in Chapter 8. Also interesting to note is that some of the information assessed by the international subnational credit rating methodologies proved to be important within the South African context too. Examples are sources of revenue, GDP per capita, population growth, capital expenditure trends and the quality of financial reporting.

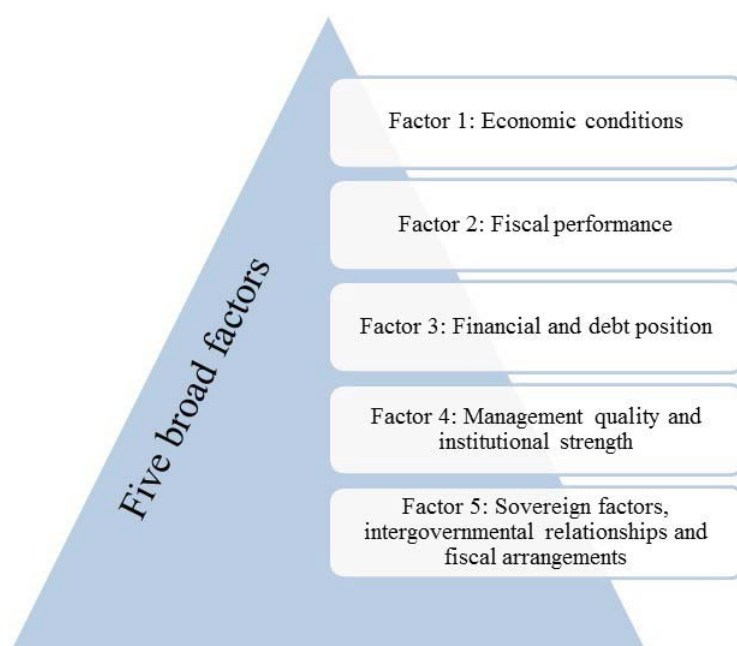


Figure 3.5: *The five broad factors used by international credit rating agencies to credit rate sub-national governments (Adapted from Liu and Tan, 2009)*

• Rating process

The rating process followed by international credit rating agencies to determine the credit position of subnationals are similar. However, all three rating agencies place more emphasis on qualitative aspects in the case of subnationals in developing countries, since these may provide information that will not necessarily be revealed by published information (Liu and Tan, 2009).

Differences

The three agencies' methodologies differ when it comes to the relative weights they assign to different rating variables, the changes to relative weights associated with the different variables over time and the importance they attach to the qualitative variables. At present only Moody's relative weights are publicly available.

Differences in the rating criteria are mostly caused by assigning rating variables differently to the five broad factors. For example, Fitch reviews liquidity under finances and S&P has a separate rating category for liquidity. Moody's does not explicitly list liquidity as a rating variable, but reviews it as part of the subnational's financial position and performance.

- **Relative weights**

Even though the three rating agencies use the same rating variables and the same broad rating factors, the emphasis or relative weights assigned to these may differ according to the agency's view of the importance of the specific variable or factor.

- **Changes to relative weights over time**

As a rating agency's view of the importance of a variable or factor changes over time, the relative weight assigned will change as well. The changes to the relative weights may differ from agency to agency since their views and the alterations to their views may differ.

- **Importance of qualitative variables**

The different views of the agencies regarding variables or categories especially apply to the qualitative variables used. The importance of qualitative factors are viewed differently by the different agencies (Liu and Tan, 2009).

Moody's (2007) states that typically the quantitative factors (financial fundamentals) and the qualitative factors (other key factors) included in the rating methodology for a developed country will be viewed as equally important. Thus, both will equate to 50% of the credit rating. In a developing country, the quantitative factors will only equate to 30% of the credit rating and the qualitative factors to 70% (Figure 3.2).

This principle will also apply to the credit rating methodologies of subnational governments and therefore is also relevant when developing credit rating methodologies for South African subnationals (Fourie et al., 2013).

Qualitative factors	70%	Factor 1	Variable 1
			Variable 2
			Variable 3
			Variable 4
		Factor 2	Variable 1
			Variable 2
			Variable 3
		Factor 3	Variable 1
			Variable 2
			Variable 3
			Variable 4
			Variable 5
Quantitative factors	30%	Factor 1	Variable 1
			Variable 2
			Variable 3
			Variable 4
			Variable 5
		Factor 2	Variable 1
			Variable 2
		Factor 3	Variable 1
			Variable 2
			Variable 3

Table 3.2: *Importance of quantitative vs. qualitative factors in developing countries (Adapted from Moody's, 2007)*

3.5 Regional subnational credit rating methodologies of developed countries

Section 3.4 focussed on the subnational credit rating methodologies of three international credit rating agencies. This section and the following one provide abbreviated summaries of the four exemplary regional subnational credit rating methodologies. More specifically Section 3.5 focuses on regional subnational credit rating methodologies used for developed countries and Section 3.6 focuses on regional subnational credit rating methodologies used for developing countries. Detailed discussion of these credit rating methodologies can be found in Appendix A.

The two examples of regional subnational credit rating methodologies for developed countries are DBRS's rating methodology for Canadian subnational governments and AustraliaRatings's methodology for Australian subnational governments. CRISIL and Fitch's credit rating methodologies for Indian subnational governments are discussed as the examples of methodologies used for developing countries.

It is interesting to note that although regional subnational credit rating methodologies might consider aspects concerning the intergovernmental structure and relations within the country, the national governments itself are never assessed. This is because all the subnationals reviewed within a specific country share the same national government and therefore the characteristics of the national government (and therefore the outcome of the factor) remain the same for all subnational governments reviewed. Consequently it is omitted from the review process.

3.5.1 DBRS's methodology to rate Canadian provincial governments

This section is based on the DBRS document that records the agency's methodology for rating Canadian provincial governments, referred to as DBRS (2011). Canada's subnational level of government comprises three territories and ten provinces. The methodology captured in this document is used by DBRS to establish the credit quality of only the ten Canadian provincial governments.

Although there are several differences between provinces, a number of similarities also exist, since they all function within the same operational environment. The similarities include broad taxation powers, broad revenue generating powers, responsibilities for providing services, a reasonably stable political and economical environment, as well as significant support from the national government. Although these similarities cause the provinces to have good credit ratings, these will not be used to rate these provinces among each other since these aspects remain stable from one province to another. The province's specific differences, however, will be used to rate the provinces. These differences include economic diversification, management styles, fiscal priorities, overall financial strength and economic differences. Due to the fact that these provinces already have good credit ratings because of their political and economical environment, these differences can only improve their credit ratings to a better or lesser extent. DBRS assesses only two different types of factors to determine the credit rating of a Canadian provincial government. These factors are the province-specific operating risk and the province-specific financial risk* (Figure 3.6).



Figure 3.6: *DBRS's factors used to credit rate Canadian provincial governments (Adapted from DBRS, 2011)*

*The DBRS document refers to province-specific aspect as issuer-specific factors.

3.5.2 AustraliaRatings' credit rating methodology for Australian states and territories

The document AustraliaRatings (2014) was used as the source document for this section.

Australia's subnational government comprises six states and two territories. Australia's history of political and organisational stability guarantees relatively high credit ratings for all Australia's states and territories.

The principal responsibility of the subnationals is to provide the necessary public services and infrastructure. The funds to fulfil these responsibilities are provided by the national government,* since the taxation powers and expenditure responsibilities reside with the national government.

AustraliaRatings examines the current and future economic and financial situation of a subnational, as well as the strategy of the specific subnational government. This analysis entails quantitative and qualitative measures and is based on four different factors, namely the economy, financial management, accounting and budgeting policies and the debt profile of the government (Figure 3.7).

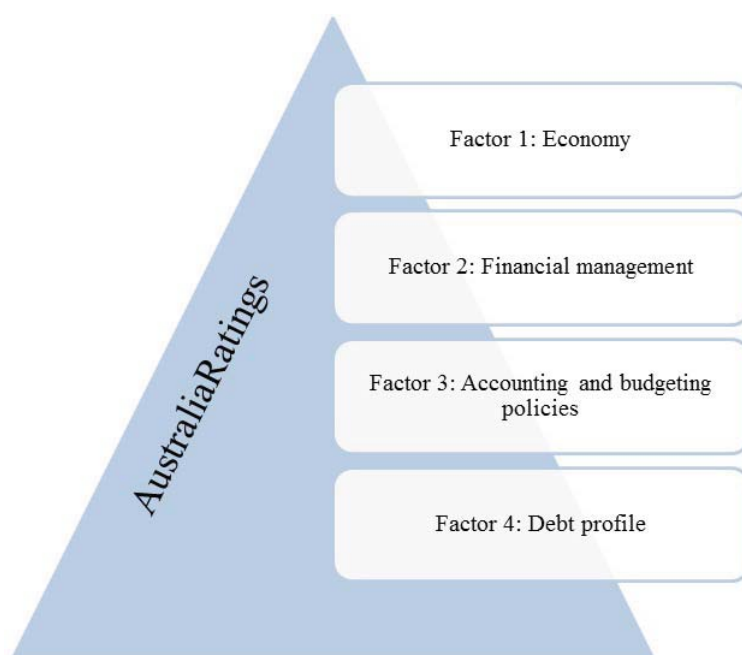


Figure 3.7: *The four factors used by AustraliaRatings to determine the creditworthiness of an Australian subnational government (Adapted from AustraliaRatings, 2014)*

*Indicated as the Commonwealth of Australia in original documentation.

3.6 Regional subnational credit rating methodologies of developing countries

The next section provides summaries of examples of subnational credit rating methodologies used to determine the creditworthiness of subnationals within developing countries. The details of these subnational credit rating methodologies can be found in Section A.3 of Appendix A. Two examples, Fitch's and CRISIL's credit rating methodologies for Indian subnational governments, are discussed.

3.6.1 Fitch's criteria report for Indian state governments' ratings

India's subnational level of government comprises 28 states and seven territories. The source document for this section, Fitch's criteria report for Indian state governments' ratings 2009, documents Fitch's methodology to determine the standalone credit profiles of India's subnational governments. The methodology could be used to determine the credit quality of Indian state or territory governments. This methodology is based on Fitch's credit rating methodology for international local and regional governments, as was discussed in Section 3.4.1, although the methodology for the Indian subnational credit ratings are based on the 2009 version rather than the 2011 version. The old factors can roughly be regrouped into the newer methodology's factors (Table 3.3). Fitch adjusted its international rating methodology to be applicable to India by taking into account India's complex inter-governmental relations, complex administrative, regulatory and financial structures, as well as the difference in the availability and presentation styles of data. Fitch employs five factors to determine the standalone creditworthiness of Indian subnational governments (Figure 3.8).

Regrouping of the factors of the 2009 and 2011 versions Fitch' international and local governments rating methodologies	
2009 Factors	2011 Factors
Institutional and administrative matters	Institutional framework
Economic and social profile	Economy
Fiscal and budgetary performance	Institutional framework and Finances
Debt, liquidity and indirect risk	Debt and other long-term liabilities
Management	Management and administration

Table 3.3: *Regrouping of the factors of the 2009 version of Fitch's international local and regional governments rating methodology into the 2011 version's factors (Author's own compilation)*

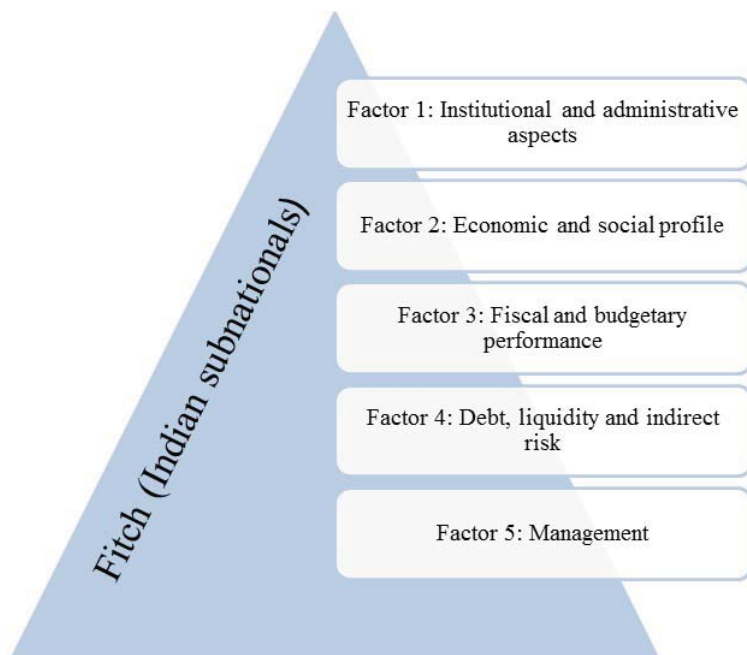


Figure 3.8: *Factors used by Fitch to credit rate Indian subnational governments (Adapted from Fitch, 2009)*

3.6.2 CRISIL's rating methodology for Indian state governments

This section is based on CRISIL's document containing their rating criteria for Indian state governments. CRISIL assesses the credit quality of most of India's state governments. The three factors used by CRISIL to evaluate the credit quality of Indian state governments are the economic structure of the state, the state government's finances and the economic management of the state government (Figure 3.9). The outcomes of the factors of the subnational government under review are compared with the outcomes of the factors of other states when assessing the credit quality of a specific state.

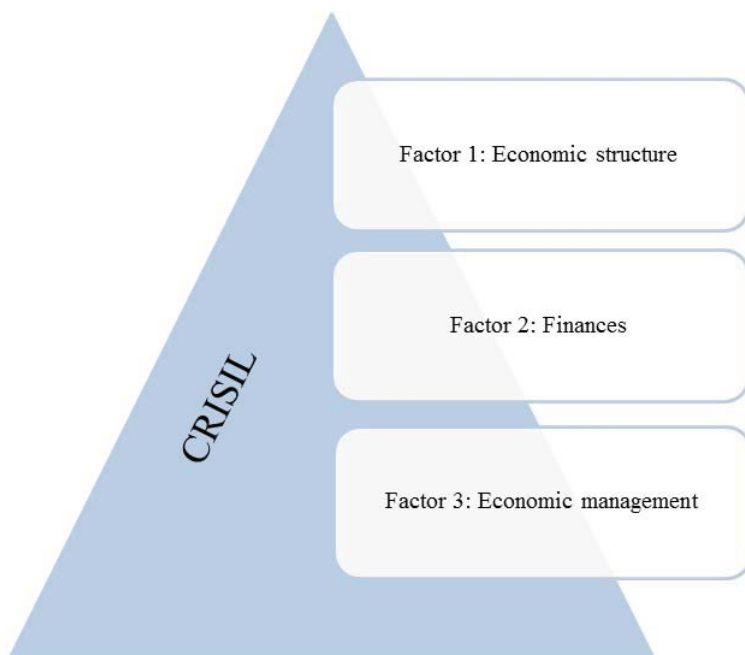


Figure 3.9: *CRISIL's methodology to determine the credit quality of Indian subnationals (Adapted from CRISIL, 2011)*

3.7 Public sector risk management framework of South Africa

The National Treasury developed the PSRMF to aid, among others, provincial governments and departments in their implementation and maintenance of effective, efficient and transparent systems of risk management and control. The PSRMF was developed in response to the Public Finance Management Act (PFMA). This act will be discussed in Chapter 4 along with some other South African regulatory information.

No regional subnational credit rating methodology, like the DBRS methodology for Canadian provinces or the CRISIL methodology for Indian states, currently exists for South Africa's subnationals. In the absence of such a regional subnational credit rating methodology the PSRMF could be reviewed in order to gain background knowledge for the development of South African subnational credit rating methodologies. However, this framework is considered to be vague. Thus for the purpose of this thesis Table A.11 in Appendix A lists some of these vague aspects but no formal review will be conducted. Note that the goal is not to document a complete assessment of the PSRMF, but only to highlight some of the vague aspects.

The booklet on the PSRMF, National Treasury (2010), was used as the source document of this section.

3.8 Subnational defaults and rating failures

Once a subnational credit rating methodology has been implemented, some analysis should be conducted from time to time to test the accuracy of the ratings resulting from the methodology. This can be done by investigating subsequent defaults and rating failures.

Liu and Tan (2009) define a subnational credit rating as “the formal opinion of a subnational government’s capacity and willingness to honour commercial debt obligations, therefore to repay it in full and on time”. Therefore default in this case is the inability to repay debt in full and on time. Bhatia (2002) defines a rating failure as the occurrence that a rating agency upgrades or downgrades the credit rating of a subnational, or in more general terms an issuer, by more than two ratings scales or categories within 12 months of the initial credit rating. This definition excludes any activities that involve the rating scales CCC or Caa and lower.

Only a small sample of subnational defaults and rating failures is available, therefore analyses based on these are normally viewed as inconclusive. However, some interesting observations can still be made the first being that subnational defaults are normally associated with national crises (Moody’s, 2008b). A more general observation is that the majority of subnationals that are credit rated are assigned credit ratings within the investment grade category. The remainder are assigned speculative grade ratings.

Although the accuracy of subnational credit methodologies can not necessarily be tested, rating agencies did recognise and implement some necessary changes over time. These methodological changes are discussed next.

3.9 Methodological changes to subnational credit rating methodologies

Credit rating methodologies have to be adjusted from time to time in reaction to changes in the structure of the entities being rated, as well as when new information and realisations come to light. Three major methodological changes were made to subnational credit rating methodologies in the past.

3.9.1 Revokement of country ceiling

As was briefly mentioned in Section 3.3.1, historically a country’s credit rating acted as a ceiling for its subnational’s credit ratings. In 2001 credit rating agencies revised this policy (Gaillard, 2006). The reason for the revision was that rating agencies acknowledged that a subnational government with stronger credit characteristics than the national government may be in a better position than the national government to repay debt in the event of an economical or political crisis (S&P, 2009). In spite of this realisation and subsequent changes very few subnationals have been rated higher than its national government in the past (Gaillard, 2006). S&P lists three conditions under which a subnational can be rated higher than its national. These conditions include if a subnational has stronger credit characteristics and is in a position to uphold it in a crisis, if the institutional framework of the country is predictable and prevents the national government from imposing negative intervention on the subnational governments, and when as the subnational is in a position to endure negative interventions that the national government may impose due to high financial flexibility and independent treasury management (S&P, 2009).

Upholding stronger credit characteristics

The ability of a subnational to uphold a better credit rating than the national government does not imply that the subnational will maintain its original credit rating should the national's worsen in a stress scenario, only that the subnational's will remain higher than the national's. S&P considers the following as essential for a subnational's credit rating to remain higher than the national's: the subnational's economy should be more diverse and wealthy than the national one, the subnational should have very good financial performance, insignificant dependence on the national government for revenue, and the subnational should exhibit good credit management and a strong economy that can withstand stresses specific to the country.

Stable institutional framework

A national government has the power to adjust the institutional framework of a country in such a manner that it could affect the financial position of its subnational governments, especially in times of distress. Thus a stable institutional framework is a necessity in cases where a subnational is rated higher than its national government. An institutional framework is considered to be stable if it does not have a history of frequent or radical changes.

Financial flexibility

A subnational with high financial flexibility and an independent treasury is in a better position to endure negative actions from the national government. Such subnationals are in control of their own revenues and expenditures and can consequently manage it according to their own needs in times of distress (Liu and Tan, 2009). Also, a subnational with financial flexibility has control over its liquidity (S&P, 2009). Financial flexibility is therefore considered a prerequisite when a subnational is rated higher than its national government.

3.9.2 Emphasis on contingent liabilities

Another change to subnational credit rating methodologies that became necessary in recent years is a stronger focus on contingent liabilities. Contingent liabilities, also referred to as indirect risks or liabilities, caused fiscal deterioration with regard to subnational finances on many occasions (Liu and Waibel, 2008). Contingent liabilities refer to, among others, debt guaranteed by the subnational government, debt obligations of enterprises of which the subnational government owns the majority of the enterprise and public-private partnerships (Moody's, 2008a). These liabilities are not reported in financial reports. In addition to this problem, the cash basis accounting system used by most developing countries does not record arrears to, for example, suppliers and contractors. It also does not indicate delayed payments of wages and pensions (Liu and Waibel, 2008). For these reasons rating agencies changed their approach in recent years to incorporate contingent liabilities into the credit assessment. Some agencies, like Fitch and S&P for example, consider it a specific credit characteristic. Others, like Moody's, just take it into account when analysing the debt profile of the subnational. Refer to Sections A.1, A.2 and A.3 for specific information regarding the agencies' treatment of contingent or indirect liabilities.

3.9.3 Focus on liquidity and debt profile

The stronger emphasis on contingent liabilities, which lead to more of a balance-sheet approach, caused rating agencies to pay more attention to the liquidity position, the cash management capability and the ability to repay short-term debt of a subnational government (Liu and Tan, 2009). Fitch and S&P reviews liquidity explicitly, whereas Moody's takes it into account when reviewing the financial position and performance of the subnational government. All three international agencies review debt as separate factor. Refer to Sections 3.4, 3.5 and 3.6 for a review of the rating methodologies of the different rating agencies.

In spite of the methodological changes made to subnational credit ratings, some challenges specific to developing countries still exist. Section 3.10 addresses these challenges.

3.10 Challenges of subnational credit ratings in developing countries

Notwithstanding the fact that credit rating methodologies have existed for some time now and that changes have been made to these methodologies, some challenges still exist when rating a subnational government, particularly those in developing countries. The challenges that rating agencies face when assessing the credit quality of subnational governments within developing countries are uncertainty and risk, as well as financial reporting, accounting systems and disclosure standards.

3.10.1 Uncertainty and risk

Qualitative measures, and subsequently subjective judgement, is important when assessing the credit quality of a subnational government. The qualitative measures have to be assessed to determine the effect that changes, for example a new way of allocating revenue or a change in the legal framework, may have on the repayment ability and thus the credit quality of a subnational government.

Changing legal and regulatory frameworks causes uncertainty about the binding nature of agreements with subnational governments. It is therefore even more important to evaluate these for developing countries, since most developing countries have evolving legal and regulatory frameworks. Policy changes are a common phenomenon in developing countries and the policy making process is normally not as transparent as the policy making process of a developed country. Other experiences common to developing countries that cause insecurity are the lack of management sophistication, the development of the strength of institutions and the development of the strength of management. The corrupt practices evident in developing countries also pose considerable risks.

3.10.2 Financial reporting, accounting systems and disclosure standards

Financial reporting within developing countries are normally conducted in a way that is required by the national government and does not necessarily comply to international standards. These governments do not keep historical records, and if they do, the records are not in a consistent form. This poses a challenge for forecasting fiscal capacity, which is a necessity when analysing the creditworthiness of a government.

The absence of an auditing culture and independent auditors often limit the disclosure and transparency of provided information. The carelessness of personnel and the inadequate legal systems found in developing countries often lead to contingent liabilities not being reported correctly, if reported at all.

Trained professionals are needed to fill jobs like accounting and auditing. The lack of these professionals in developing countries results in a lack of credibility of the financial reports produced and thus a general lack of creditworthiness. The integrity of the management team includes: a healthy management culture, the absence of corruption and the ability to handle political pressure. These characteristics need to be present to guarantee the financial soundness of a subnational government. However, these characteristics are not very common within the management teams of subnational governments within developing countries (Liu and Tan, 2009).

The above-mentioned experiences in developing countries influence the binding nature of debt agreements and undermine the credibility of subnational governments (Liu and Tan, 2009).

3.11 Challenges and benefits when developing a subnational credit rating methodology for South Africa

3.11.1 Challenges

Most of the challenges for developing countries listed in Section 3.10, and some additional unique ones, are applicable to the South African situation.

For example, the PSRMF was developed, among other reasons, to aid provincial governments in their implementation and maintenance of effective, efficient and transparent systems of risk management and control. This indicates that the South African government recognised that policy-making processes may not be as transparent as it should be and that its risk management could be improved.

Fraud and corrupt practices are also a known challenge in South Africa, as in other developing economies. This has even been reported by the Auditor-General of South Africa (Auditor-General). An example of such a report can be found in the Auditor-General's consolidated general reports on the national and provincial audit outcomes of 2009/10 (Auditor-General, 2007 to 2011).

Another challenge that also relates to South Africa is ineffective management. One example of ineffective management within a provincial government, or more specifically in a provincial department, is the on-going textbook scandal of Limpopo's Department of Education.*

The problem of inconsistent formats also exists in South Africa since the information contained in some reports (used for the purpose of this study) changes from year to year. Another problem relating to the data sources used is the availability of data. In theory, the historical records should be easy to access. However, these are often difficult to obtain in practice. Also, one would ideally like the data used to be available at least quarterly in order to update the credit ratings on a regular basis once the developed credit rating methodologies are finalised. However, most of the data available to develop subnational credit rating methodologies in South Africa is only made available once a year.

*Refer to documents (Anon., 2012; Anon., 2014c; Anon., 2014b) for additional information.

Again, a credit rating gives an indication of the capacity and willingness of a subnational to repay its debt. Simply put, to repay debt obligations in full and on time. Thus information is needed to indicate the outstanding amounts on debt obligations and the number of days/months that it has been outstanding. Due to the fact that South Africa's provincial governments and departments use the cash basis accounting system instead of the accruals basis accounting system, sufficient information to create such indicators are not available. At best, a proxy could be used to develop a credit rating methodology for South African subnationals. More detail is provided in Chapter 5.

3.11.2 Benefits

Even though many challenges are experienced when developing subnational credit rating methodologies for South Africa, as discussed in Section 3.11.1, the benefits will be ample as well (Fourie et al., 2013).

One such a benefit is that if a credit rating methodology is developed for South Africa's subnationals, the subnationals could gain easier access to financial markets.

The residents from South African provinces could also benefit, as the additional funding obtained could be used for infrastructure development. In addition, borrowing spreads the costs of financing infrastructure projects across present and future generations by matching debt maturity to the asset's economic life.

Banks, investors and third parties could use it to decide whether they want to conduct business with a specific provincial department. Credit ratings will enable subnationals with above average ratings to negotiate better collateral and guarantee agreements.

More specifically, subnational governments could use the methodology to identify areas on which they can improve. An indirect benefit is more effective management due to the competition among provincial governments that will be the result.

The fiscal transparency, as well as the budget and financial management practices of provincial departments will improve as a result of subnational credit ratings because South African subnationals will be forced to improve their financial recordkeeping. For example, historical records will have to be more easily accessible and financial reporting will have to take place more often, preferably quarterly, and will have to be more detailed.

Overall, credit ratings also improve credibility and promote investors' confidence (Gaillard, 2006).

3.12 Conclusions

In order to develop credit rating methodologies for South Africa's subnationals requires knowledge regarding existing subnational credit rating methodologies. Hence, different subnational credit rating methodologies and some related topics were documented and discussed in this chapter.

Section 3.2 provided background information regarding subnational credit ratings, while Section 3.3 investigated the relationship between national government and subnational government credit ratings. Section 3.4 examined existing international subnational credit rating methodologies and Sections 3.5 and 3.6 examined existing regional subnational credit rating methodologies for both developed and developing economies. Note that to improve the readability of this chapter, Sec-

tions 3.4 to 3.6 provided summarised versions of relevant rating methodologies; detailed versions of these methodologies can be found in Appendix A. Section 3.7 reviewed the South African Public PSRMF. Again, only a summary was provided in this chapter. The details are documented in Appendix A. Section 3.8 discussed subnational defaults and rating failures. Sections 3.9 and 3.10 documented methodological changes to subnational credit ratings, as well as challenges stemming from rating developing countries' subnationals. Section 3.11 reviewed the challenges and benefits that emerge when developing subnational credit rating methodologies for the South African context.

Two key findings were drawn from the literature discussed in this chapter. The first is that the variables used in subnational credit rating methodologies can be grouped into five broad factors namely the subnational's economic conditions, the fiscal performance of the subnational, the financial and debt position of the subnational, the management quality and strength of subnational institutions, as well as the influence of the sovereign factors, intergovernmental relations and fiscal arrangements on the subnational. The other key finding is the difference in the importance of quantitative and qualitative information for developed and developing countries. Typically, for a developed country the quantitative and qualitative information will both equate to 50% of a credit rating, as opposed to developing countries where the quantitative information will only equate to 30% and the qualitative information to 70% of a credit rating. Both of these observations will be applied in the remainder of this thesis.

Currently (2014) none of the South African subnationals are being credit rated. However, the discussion regarding the challenges and benefits when developing subnational credit rating methodologies for the South African context indicated that even though many challenges exist the benefits will be ample. This thesis develops the quantitative parts of credit rating methodologies for the South Africa's subnationals, focussing on provincial departments.

After consideration of the existing subnational rating methodologies, the special circumstances stemming from a country's regulatory framework still remains. These circumstances have to be taken into account when assessing the subnationals within a country. The next chapter documents the applicable laws and regulations.

Chapter 4

LAWS AND REGULATIONS

4.1 Introduction

In addition to knowledge regarding existing subnational credit rating methodologies, an understanding of the regulatory framework within which subnational governments operate is also required when developing a country specific subnational credit rating methodology. Martell and Geuss (2006) emphasise that countries need comprehensive legal and regulatory frameworks to prevent their subnationals from embarking on irresponsible borrowing.

The South African regulatory framework is summarised in the Borrowing Powers of Provincial Governments Act (No 48 of 1996) (Borrowing Act) and the Public Finance Management Act (No 1 of 1999) (PFMA), as well as the regulations that accompany this act, namely the Treasury Regulations for departments, constitutional institution and public entities. The Borrowing Act stipulates the borrowing powers of South Africa's subnational or provincial governments (South Africa, 1996a). The purpose of the PFMA and its Treasury Regulations is to "secure transparency, accountability and sound management of the revenue, expenditure, assets and liabilities of the institutions to which the act applies" (South Africa, 1999; South Africa, 2001).

Another act that relates to borrowing in South Africa is the National Credit Act (No 34 of 2005) (NCA) and the regulations formulated in terms of the act. The main purpose of the act is to promote a fair, competitive, accessible, equitable and sustainable credit market in South Africa. The NCA itself stipulates that organs of the state are excluded from the application of the act, and according to the Constitution of the Republic of South Africa, provincial departments are classified as organs of the state (South Africa, 1996b; South Africa, 2005; South Africa, 2006). Therefore, the NCA is not enforceable on provincial departments. However, it is still advisable to apply the act's principles when entering into borrowing agreements with provincial departments.

In addition to the influence of the laws regulating South African provincial governments and their departments, the Basel regulatory framework for capital adequacy (Basel) also influences transactions between provincial governments, their departments and internationally active banks, including South African commercial banks. The Basel Committee on Banking Supervision (BCBS) states that this regulatory framework aims to improve the soundness and stability of the international banking system as a whole (BCBS, 2006).

These laws and regulations should be investigated since the primary aim of this study is to develop the quantitative parts of credit rating methodologies for South Africa's subnationals (two provincial departments in this case). In order to develop a subnational credit rating methodology,

knowledge regarding the laws and regulations governing the subnationals is required since these set the parameters within which subnational borrowing may take place. Also, it is important to ensure that these laws and regulations are adhered to if it has been decided to extend credit to a subnational (based on a credit rating derived from applying the to-be developed subnational credit rating methodology), as non-adherence could lead to unenforceable loan agreements.

Section 4.2 establishes the relevance of the South African regulatory framework, while Section 4.3 reviews the applicability of Basel when developing credit rating methodologies for the South African context. Section 4.4 draws conclusions.

4.2 South African regulatory framework in terms of the Borrowing Act and PFMA

The South African regulatory framework for provinces is largely summarised in the Borrowing Act and the PFMA. This section reviews the relevance of these acts and the PFMA's Treasury regulations by dealing with all three sources at once.

Each of the acts has a different purpose. South Africa (1996a) states that the goal of the Borrowing Act is “to provide for norms and conditions in respect of the borrowing powers of provincial governments and for matters incidental thereto”, whereas the PFMA's purpose is stated as “to regulate financial management in the national governments and provincial governments; to ensure that all revenue, expenditure, assets and liabilities of those governments are managed efficiently and effectively; to provide for the responsibilities of persons entrusted with financial management in those governments; and to provide for matters connected therewith” (South Africa, 1999; South Africa, 2001).

The PFMA aims to promote good financial management. This part of the regulatory framework provides guidelines and rules to ensure that the objective is met and applies to national and provincial governments, departments, public entities under the control of the provincial governments, parliament, provincial legislatures and independent institutions (National Treasury, 2013b).

The acts provide stipulations regarding provincial borrowing, as well as financial statements and record keeping.

4.2.1 Specifications regarding provincial borrowing

The specifications regarding borrowing by South African subnationals can be divided into nine sub-specifications namely borrowing powers, types of loans, foreign currencies and financial markets, permitted uses of loans, duration, loan amounts, interest, repayment, as well as guarantees, indemnities and securities. These are discussed next. All are based on the Borrowing Act, PFMA and the applicable regulations.

Borrowing powers

Only the person responsible for finance in the province is allowed to borrow money, issue a guarantee, indemnity or security or to enter into a binding transaction on behalf of the provincial government. The executive authority may take these actions on behalf of a provincial department with written approval from the person responsible for finance in the province. The state or an

institution is not bounded by a loan agreement, guarantee, indemnity, security or any transaction which may bind an institution to a financial commitment if a person to whom the borrowing powers has not been assigned, entered into these transactions on behalf of the institution (South Africa, 1996a).

Types of loans

Provincial governments are only allowed to use prescribed products such as bridging finance and loans. Bridging finance is defined as funds used to finance current expenditure while awaiting the receipt of the current revenue that should be used for this purpose. This may not be used as continuous and unlimited revolving credit.

Loans in South Africa may be raised by subnational governments via the following means:

- loan agreements with commercial banks or financial institutions;
- issuing public stocks or bonds; and
- loan agreements through issuing financial instruments.

These loans must be denominated in rand.

The use of credit cards, fleet management cards or other credit card facilities are allowed, given that they must be repaid within 30 days from the statement date.

Foreign currencies and financial markets

Loans in foreign currencies and financial markets are only allowed under the following circumstances:

- written approval has been received from the minister of finance;
- the reasons for such a loan were motivated by the province's member of the executive council; and
- the minister of finance is satisfied that the loan is in the public interest and complies with general principles of loan agreements (South Africa, 1999; South Africa, 2001).

Permitted uses of loans

Provincial governments are only allowed to raise funds in order to fund capital expenditure. Only bridging finance may be used to fund current expenditure.

Duration

Any loans raised for bridging finance must be redeemed within 30 days after the end of the financial year. The financial year ends on the 31st of March, thus all bridging finance loans entered into in a financial year must be settled by 30 April of the next financial year. The maximum duration of these types of loans is consequently 13 months.

As mentioned previously, credit cards, fleet management cards or other credit card facilities must be repaid within 30 days from statement date.

Payments to creditors must be repaid within 30 days of the receipt of the invoice. In the case of civil claims, the repayments have to be made within 30 days of the date of settlement or court judgement. Exceptions are allowed if a different repayment term is stipulated in the contract or agreement (South Africa, 1999; South Africa, 2001).

The focus of this thesis is to establish credit rating methodologies that could be used to predict defaults of two South African provincial departments. An example of a well-known banking default definition is that a client is unlikely to honour its credit obligation if the client is in excess more than 90 days on its credit obligation, as per the BCBS's definition provided in Section 4.3.1. Thus, the desired dependent variable to be used to develop such credit rating methodologies is the number of days or months in arrears. Currently provincial governments and departments do not report on the number of days or months in arrears. However, because the PFMA stipulates that creditors have to be repaid within 30 days, the rand value of invoices not paid within 30 days are recorded. This could be used as a proxy for payment behaviour. The use of this information is discussed in Chapter 5.

Loan amounts

The total loan amount per province may not exceed the aggregated loan amount permitted by the loan committee for the province. The loan committee comprises the Minister of Finance and each province's member of the executive council or an authorised representative.

The total outstanding loan amount may not exceed the expected loan requirement of the province by more than 0.5%.

Interest

The total amount of interest payable on loans during a financial year may not exceed an amount equal to a percentage of the total amount budgeted for current revenue. It may also not exceed an amount equal to a percentage determined by the minister of finance.

Repayment

Loans and the interest payable are the responsibility of the provincial government who entered into the loan agreement and will be funded from the revenues and assets of the particular provincial government.

Guarantees, indemnities and securities

No guarantees will be provided by the national government for any financial commitments entered into by a provincial government to raise bridging finance or to conclude a loan denominated in rand or foreign currency. Each financial commitment must contain a statement indicating whether or not it is guaranteed by the national government. The person entering into the agreement on behalf of the province may provide securitisation if required. The issuing of guarantees, securities and indemnities in the case of provincial departments are not permitted unless written approval has been received from the member of the executive council of the province who is responsible for finance. It is important to take into account that the issuing of guarantees, securities and indemnities are usually not permitted when entering into a loan agreement with a provincial government (South Africa, 1996a).

Inference

It is important to ensure that these stipulations are adhered to when entering into a loan agreement with a South African subnational. Non-adherence could lead to unenforceable loan arrangements.

4.2.2 Financial statements and record keeping

The financial statements and record keeping of provincial governments and departments are also regulated by the PFMA and Borrowing Act. Therefore, the contents and formats are determined by the National Treasury. This makes these reports potential sources of data used to develop credit rating methodologies since it means that all the reports by provincial governments and departments' will contain the same information in the same format. The reports applicable to loans are listed below.

The provincial annual budgets must contain:

- estimations of the interest, debt servicing charges and the repayments of loans;
- planned borrowing and any other form of liability for the specific financial year;
- planned borrowing and any other form of liability for future financial years;
- projected borrowings of the previous financial year;
- an indication of any planned borrowing during the current year; and
- an indication of any planned borrowing during future financial years.

Each province needs to have a statement of current transactions for each financial year. The statement of current transactions must show:

- receipts from bridging finance; and
- repayments of bridging finance.

The statement of revenue and expenditure must state the actual borrowings for the period under review and for the remainder of the financial year.

Provincial treasuries must submit projections of their borrowing to the National Treasury by the 15th working day of March.

Each province must also have a statement of capital transactions for each financial year. This should offer a record of:

- outstanding loans due for redemption or conversion;
- earnings from loans;
- expected loan requirement; and
- capital surplus.

The capital surplus is the excess of the total amount of capital revenue, current revenue, receipts of capital transfers and proceeds of loans over the total amount of expenditures and amounts charged as capital expenditure and outstanding loans due for redemption or conversion. Capital revenue is all income intended for financing capital expenditure, excluding loans. Current revenue is all the income of a province other than receipts of bridging finance and loans, capital revenue and transfers. The expected loan requirement is the difference between the total budgeted amount for capital expenditure and outstanding loans due for redemption or conversion and the total budgeted amounts for capital revenue, current revenue, receipts of capital transfers, proceeds of loans and the capital surplus.

4.3 Basel and subnational credit rating methodologies

In addition to the influence of the laws regulating South African provincial governments and departments, Basel also influences the transactions between these subnationals and internationally active banks, including South Africa's commercial banks. This regulatory framework compiled by the BCBS aims to improve the soundness and stability of the international banking system as a whole (BCBS, 2006).

The remainder of this section introduces Basel and explains its relevance in the subnational credit rating methodology context.

4.3.1 Basel

The BCBS has no legal supervisory authority. However, Basel compliant banks are following the recommendations of the committee. One reason for a bank's willingness to comply is that a compliant bank is universally comparable with any other compliant bank, thus compliance opens up business opportunities and eases business negotiations. Non-willingness to comply may indicate deception, for example inadequate risk management practices. Due to a requirement stipulated by the South African Reserve Bank all South African banks must comply with the BCBS's recommendations (South African Reserve Bank, 2014).

The goal of the BCBS, via its recommendations, is to improve the soundness and stability of the international banking system. The recommendations ensure that internationally active banks maintain an adequate level of capital to safeguard against unexpected losses. The Basel II recommendations address credit risk, operational risk and market risk (BCBS, 2006).

Although the latest version of the official Basel regulation documents is the Basel III accord, the Basel II accord is currently in use. The Basel III accord was developed in response to some deficiencies in the Basel II accord that became evident as a result of the late 2000s financial crisis. Basel III does not replace the Basel II accord, but provides supplementary recommendations. It strengthens the bank capital requirements stipulated in the Basel II document and introduces new regulatory requirements on bank liquidity and bank leverage. Further information on Basel III can be found in BCBS (2011).

Substantial changes to the way in which risk in the trading book is measured and managed were recently proposed by the BCBS (2013). These changes affect only the trading book and are currently (2014) in the proposal phase. These proposals will not influence the results or conclusions of this thesis.

BCBS (2006) states that the recommendations can be divided into three main categories, or the three pillars of Basel II. These are the minimum capital requirements, supervisory review and market discipline (Figure 4.1).

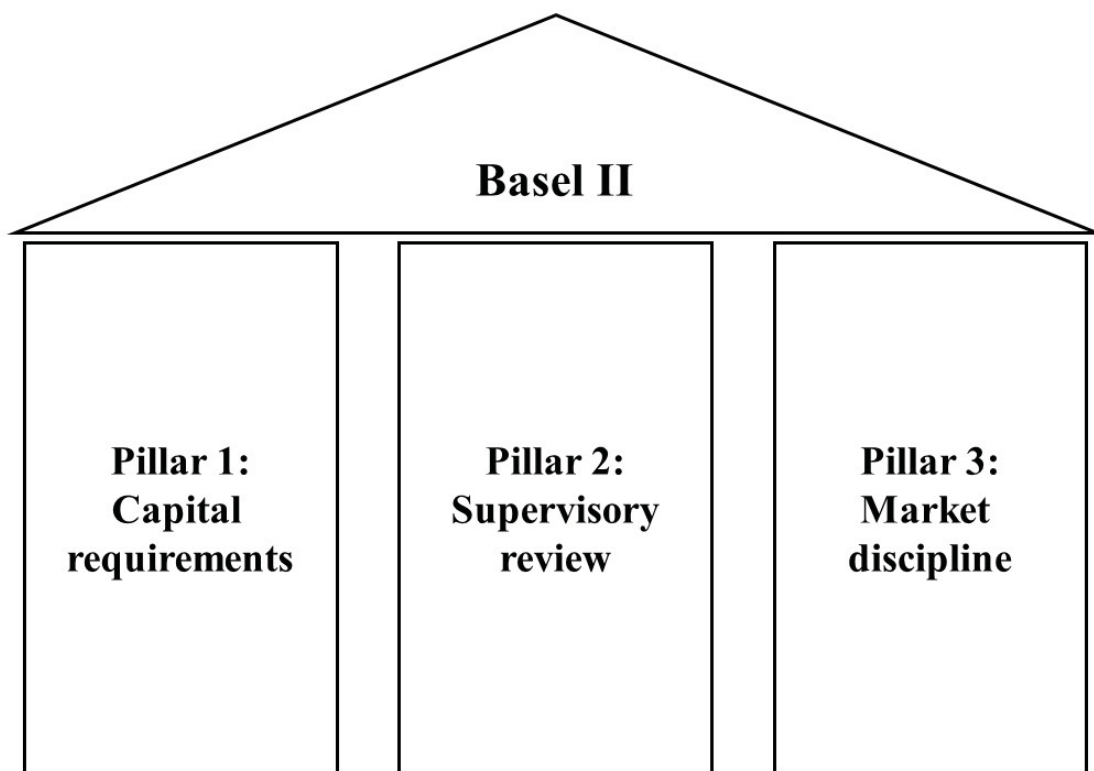


Figure 4.1: *The three pillars of Basel II (BCBS, 2006)*

Pillar 1 deals with the calculation of the minimum amount of capital that a bank needs to keep to satisfy the regulatory capital requirements. It stipulates the approaches that banks may use to determine the minimum amount of capital a bank needs to hold given the bank's position on credit risk, operational risk and market risk. The approaches a bank is allowed to follow are the standardised approach and the internal ratings-based approach (IRB approach).

Under the standardised approach banks have to measure credit risk using a standardised method. The capital adequacy calculation is based on external credit assessments.

The IRB approach allows banks to use their own internal rating systems to calculate the amount of capital deemed as adequate. The capital adequacy calculation is based on three different inputs, and the product gives the expected losses for which the bank must provide. The inputs used are: the probability of default (PD), the exposure at default (EAD) and the loss given default (LGD). The BCBS introduced a universal definition of default which states that default occurs when the client is unlikely to honour its credit obligation towards the bank or if the client is past due more than 90 days on its credit obligation. The credit assessment is based on an internal credit assessment, using the inputs, instead of external credit assessments.

In order for a bank to qualify to use the IRB approach the bank must prove to the regulator that their internal credit rating assessment systems, data collection and qualitative analysis are sufficient.

Pillar 2 addresses supervisory review by discussing its key principles, risk management guidance, stress tests, supervisory transparency, as well as supervisory accountability.

Pillar 3, market discipline, was introduced to support pillars 1 and 2. The set of disclosure requirements included as part of this pillar stipulates recommendations regarding the revelation of the bank's scope of applying Basel, its capital risk exposure, the risk assessment processes the bank uses, as well as its capital adequacy position (BCBS, 2006).

One significant impact of Basel was the introduction of regulatory capital that banks have to hold as a safeguard against unexpected losses. These do not only limit the business activities of banks that have adopted the Basel regulations, they also impact any business decisions, since the effect on the capital requirements have to be taken into account at all times. Banks using the IRB approach are impacted even more. The development and implementation of the sophisticated models needed has a cost effect that has a further limiting effect on business activities. However, through the improvement of the models used, banks should usually be able to lower the amount of capital that should be held as a safeguard. The bank will also be in a better position to assess the credit risk and therefore to reduce adverse selection. These two benefits, in turn, will improve the bank's business activities and profit margin.

4.3.2 Link between Basel and subnational credit rating methodologies

The relevance of Basel to this specific thesis is almost negligible, but this link is assessed for the sake of completeness. The only effect of the Basel regulations on subnationals is on lending transactions between subnationals and banks that adopted the regulations. In the case of such a transaction the bank has to assess the amount of capital needed as a safeguard in case of the event that the subnational defaults on the transaction. If the bank uses the standardised approach, the calculation is based on an external credit assessment. Thus it is the author's opinion that the credit rating the subnational government received from an international credit rating agency such as Fitch, Moody's and S&P could be used in this case. Banks that use the IRB approach under the Basel regulations have to assess the credit risk involved, thus the probability that the subnational government might default on the transaction, and the amount of credit needed as a buffer based on an internal credit risk assessment. One such an example is the bank's own credit rating of the subnational government it is dealing with. The credit rating resulting from the methodology proposed in Chapter 6 could be used by banks dealing with South African provincial departments as an internal credit rating under the IRB approach of the Basel regulations.

4.4 Summary

This chapter provided a condensation of the regulatory framework that impacts on South African subnationals. This framework details specifications to provincial governments and departments regarding their borrowing, as well as their financial statements and record keeping. The relevance of Basel and its relatively minor impact was also discussed.

The primary objectives of the thesis is to develop the quantitative parts of credit rating methodologies for two South African provincial departments. The next chapter discusses the data used

to develop these credit rating methodologies. These data will mainly be sourced from the financial statements and record keeping of provincial governments that are governed by the regulatory framework for South African subnationals.

Note that if the decision has been made to enter into a loan agreement with a South African provincial department (based on a credit rating derived from a credit rating methodology developed in this thesis), the specifications discussed in this chapter should be taken into account as non-adherence could lead to unenforceable loan arrangements.

An example of such a specification is that a provincial government may only enter into a loan agreement in a foreign currency or financial market once written approval has been received from the minister of finance, and the minister must agree that the loan is in the public's interest. Another example is that any loan raised for the purpose of bridging finance must be redeemed within 30 days after the end of the financial year, making the maximum loan duration 13 months. As a last example, the issuing of guarantees, indemnities and securities is usually not permitted.

Chapter 5

DATA AND METHODOLOGY

5.1 Introduction

The previous chapters documented information needed as background knowledge to develop the quantitative parts of credit rating methodologies for South African subnationals (focussing on provincial departments). Chapter 2 provided an overview of key concepts with regard to South African subnationals and credit ratings in general. Chapter 3 paid special attention to existing subnational credit rating methodologies and Chapter 4 reviewed applicable laws and regulations.

This chapter reviews the data and methodology that will be used to develop the quantitative parts of subnational credit rating methodologies for South Africa's subnationals. Section 5.2 documents general information regarding the data used. This includes the data sources used, the characteristics of the data and the construction of the datasets. Section 5.3 reviews the methodology used. Sections 5.4 and 5.5 pay special attention to the dependent and independent variables used. Section 5.6 provides an explanation of how linear regression modelling relates to credit rating methodologies. Section 5.7 concludes the chapter.

Note that the data analysis and output reported in this chapter was generated using the SPSS Inc. (2013) software.

5.2 Data

This section discusses the data that will be used in the next two chapters to develop the quantitative parts of credit rating methodologies for two South African provincial departments. Section 5.2.1 discusses the data sources used, Section 5.2.2 lists data characteristics resulting from the use of these specific sources, Section 5.2.3 explains how the datasets were assembled and the measures applied to eliminate data errors during the compilation of the datasets.

5.2.1 Data sources

Liu and Tan (2009) caution that data not kept in a consistent form often cause problems when developing a subnational credit rating methodology for a developing country. For this reason much attention has been paid to the identification of reliable data sources. The identified sources are discussed in the remainder of this section.

The financial records and record keeping of South Africa's subnationals are regulated by the National Treasury. This is stipulated by the PFMA, refer to Section 4.2.1 for more detail. Therefore most of the data used to develop the quantitative parts of the credit rating methodologies for South Africa's subnationals (focussing on provincial departments) were sourced from reports governed by the National Treasury.

The data requirements for this study were based on the information used in the existing subnational credit rating methodologies, especially the broad factors, documented in Chapter 3. The broad factors identified are economic conditions, fiscal performance, financial and debt position, as well as management quality and institutional strength. A thorough investigation was conducted to identify possible sources for the required information. The sources used were confirmed by National Treasury and a financial institution as part of a workshop held at National Treasury in 2013 (National Treasury, 2013d).

The six data sources used were compiled by four different types of institutions. The reports used are discussed next as compiled by these institutions, namely provincial departments, National Treasury, StatsSA and the Auditor-General.

Annual reports of provincial departments

These reports are not compiled per province, but per provincial department positioned within the provincial government. Conceptually, it should be possible to develop a subnational credit rating methodology for provincial governments by aggregating the department level information to a provincial level. However, the number of departments per province differs, for example KwaZulu-Natal has a total number of 16 departments, while Limpopo has only 10 (South Africa, 2014). Thus, the aggregation itself will pose difficulties due to the unequal number of departments and the data gathering will pose difficulties due to the volume of reports needed.

Also, as can be seen when reviewing the information obtained from the sources discussed in Section 5.5, about 70% of the information used was on a department level. The matter was discussed during the workshop held at National Treasury in 2012 (National Treasury, 2012b). It was recommended that focus be placed on provincial departments instead of provincial governments. Two departments, the Department of Health and the Department of Education, were selected as exemplary departments for the purpose of this thesis. This decision is based on the fact that their total expenditures equates to the biggest portion of the provinces' total expenditures. In the 2012/13 financial year the Department of Health's total expenditure equated to 31% of the province's total expenditure and the Department of Education's to 42%, thus a combined proportion of 73% (National Treasury, 2013a).

In theory, the annual reports of the provincial departments should be easily accessible. However, gaining electronic access to some of the reports proved problematic. For example, as at 23 May 2014, the only two annual reports available on Limpopo's Department of Health's official website were the reports of the financial years 2006/07 and 2008/09. Departments whose websites did not host all the needed annual reports were contacted and some sent hard copies via post. After the National Treasury was contacted, they provided photocopies of the pages required from the outstanding reports. As a result of National Treasury's cooperation, the financial reports of the financial years 2006/07 to 2011/12 contained in the annual reports of the provinces' Department of Health and the Department of Education were used. Thus a total number of 108 annual reports*

*Refer to bibliography for references.

were collected and captured manually as part of a tedious process.

Figure 5.1 provides the information captured from the annual reports of the provincial departments. As mentioned before, the data requirements were guided by the broad factors identified by literature. For this reason Figure 5.1 also provides an indication of the broad factors that the information relates to.

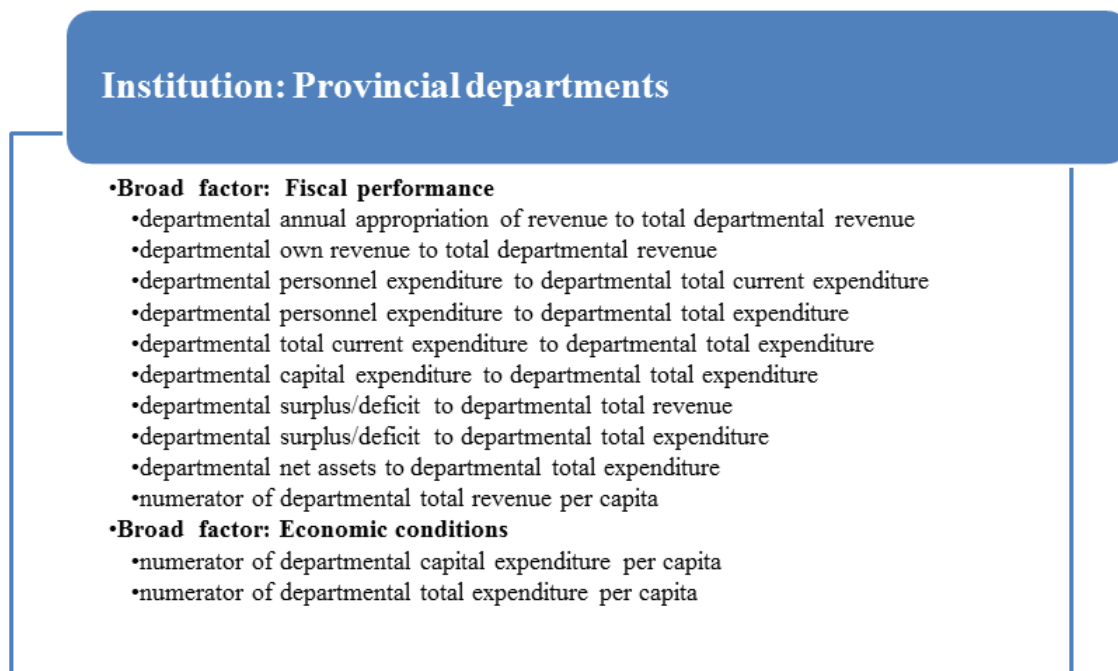


Figure 5.1: *Information obtained from the annual reports of the provincial departments and the broad factors it relates to*

National Treasury reports

The following reports are assembled on a regular basis by the National Treasury, and were also used:

- Fourth Quarter Year to Date Provincial Budgets and Expenditure Report (Preliminary Outcome) 2006/07 to 2010/11 (National Treasury, 2007 to 2013a); and
- Provincial Statements of Receipts and Payments for the 4th Quarter ended 31 March 2007 to 2011 (National Treasury, 2007 to 2011).

Five of each were used, thus 10 different reports were used in this case.

As can be seen from Figure 5.2, the information sourced from the National Treasury reports presented the fiscal performance as well as the financial and debt position broad factors.

Institution: National Treasury

•**Broad factor: Fiscal performance**

- departmental total expenditure to departmental adjusted budget
- departmental total expenditure to total provincial expenditure
- departmental personnel expenditure to departmental adjusted budget
- departmental personnel expenditure to total provincial personnel expenditure
- departmental own revenue actual collection to departmental adjusted budget
- departmental own revenue collection to total provincial revenue
- provincial surplus/deficit to provincial receipts
- provincial surplus/deficit to provincial payments
- provincial total receipts to provincial total payments

•**Broad factor: Financial and debt position**

- departmental capital expenditure to departmental adjusted budget
- departmental capital expenditure to total provincial capital expenditure

Figure 5.2: *Information and the broad factors it represents sourced from the National Treasury reports*

However, not all the data needed could be sourced from reports governed by the National Treasury. Examples of additional data needed are data portraying the economic conditions within a province as well as data indicating the management quality and institutional strength of the department. These data requirements resulted from the attempt to include information relating to all four broad factors identified by Liu and Tan (2009) in Section 3.4.4 in the proposed credit rating methodologies. Therefore data were also sourced from some StatsSA reports and from the audit reports of the departments. Note that only the numerators of the economic conditions variables listed previously were captured from the provincial annual reports, the denominators were captured from the StatSA reports.

StatsSA

The data needed to portray the economic conditions in the province as well as population information per province were sourced from information provided by StatsSA. The data sourced from this institution were:

- Gross Domestic Product. Annual estimates 2003 to 2012. Regional estimates 2003 to 2012. Third quarter 2013. Statistical release P0441 report. (StatsSA, 2013); and
- The interactive dataset containing the mid-year population estimates by province, gender, age group and year in Microsoft Excel (sourced from the official website of StatsSA) (StatsSA, 2012).

Most of the information derived from these reports represented the economic conditions broad factor (Figure 5.3).

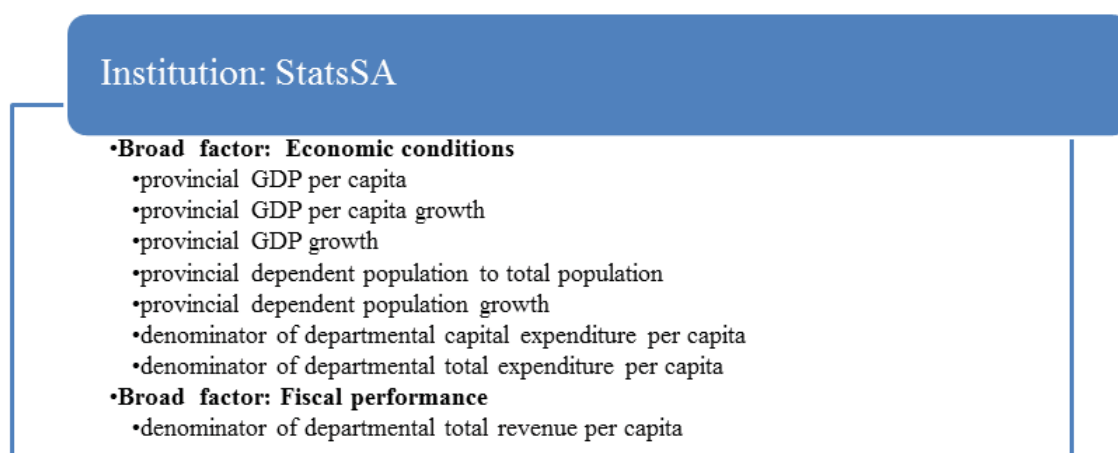


Figure 5.3: *Information (and broad factors) derived from StatsSA reports*

Unfortunately the data obtained from these sources were estimates and not actual values. The dates of the data contained in these sources did not correspond to the dates in the rest of the reports. The dates associated with these sources were calendar years, in other words January to December, and the dates relating to the other sources were financial years, being April to March. The datasets were constructed in such a manner that most of the months overlapped. For example, January to December 2006 will overlap with April 2006 to March 2007.

Auditor-General's consolidated general reports on the national and provincial audit outcomes

The last data requirement, i.e. the inclusion of information indicating management quality and institutional strength, was addressed by using reports compiled by the Auditor-General. The reports used are the consolidated general reports on the national and provincial audit outcomes of 2006/07 to 2010/11 (Auditor-General, 2007 to 2011). Refer to Figure 5.4 for the information sourced from these reports.

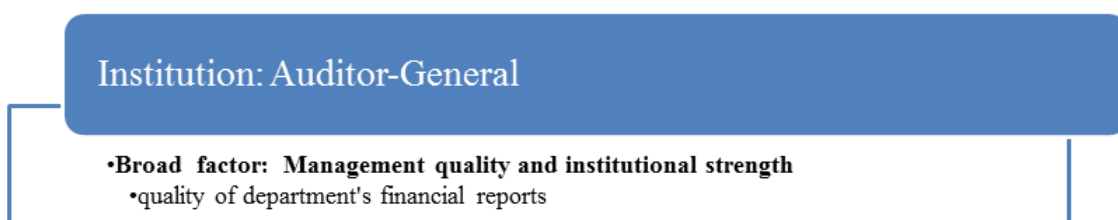


Figure 5.4: *Information obtained from the Auditor-General's reports*

Although these reports were very useful, the formats changed year on year. For example, the 2009/10 report (Auditor-General, 2011) contained information regarding compliance with laws and regulations. More specifically, a tabulation of the number and percentage of departments per province that did not comply with the stipulation that creditors have to be repaid within 30 days from the invoice date, as specified by the PFMA documented in Chapter 4. This information could not be found in the reports of any of the other years.

The additional five Auditor-General means that 124 different reports and one interactive dataset compiled by four institutions were needed to gather the data used to develop the quantitative parts of credit rating methodologies for two provincial departments. The data were captured manually and data error identification and rectification measures were applied as an iterative process throughout the data compilation and the model development phases, refer to Section 7.2.3 for more detail regarding error handling and rectification processes used. Five years' data were gathered from each of the sources; this equates to 45 data points per department and 90 data points when combining the data of the two departments. The constructed datasets are a secondary objective of the thesis.

5.2.2 Data characteristics

The characteristics of the data sourced highlighted some data constraints when using these data to develop the quantitative parts of subnational credit rating methodologies. A brief discussion of these constraints follows.

The changing formats of the auditor general's reports discussed previously is highlighted as a data constraint since it limited the information that could be used from these reports.

Not only did the characteristics of the existing reports cause problems, but also the future usage of these reports. Liu and Tan (2009) state that typically credit ratings are updated on a regular basis to adjust for changing risk situations. However, most of the reports used are only made available once a year, the only sources that are updated quarterly are the reports generated by the National Treasury. Thus only limited information will be available to update the departments' credit ratings on a regular basis in future. Ideally all the required information should be available at least quarterly.

Another problem that also relates to the future usage of the developed credit rating methodologies are the out-dated information contained in the available reports. For example, if one wants to use the developed credit rating methodologies in 2014, the latest available annual reports contain information relating to the financial year April 2012 to March 2013. Thus, a credit rating derived from this will be based on information that is up to two years old.

One way of compensating for the two previously mentioned problems is by taking recent qualitative information, such as newspaper articles, into account as an intuitive overlay. Two examples illustrating this are provided in Chapter 8.

The next data characteristic that causes problems is the fact that the annual reports are compiled per department and not per province. This is problematic since, although it should be possible to aggregate these data, the aggregation and the data gathering process pose difficulties, as was discussed in Section 5.2.1.

The last data constraint results from the accounting system used by provincial departments. The departments use the cash basis accounting system instead of the accruals basis accounting system. The application of the cash base accounting system caused some of the required information to be unavailable in the annual reports. For example, not enough information was available to provide an indication of whether a department's debt obligations were paid in full and on time. This is needed since it indicates a department's capacity and willingness to repay debt obligations in full and on time, as per the definition of credit ratings provided by Liu and Tan (2009). Instead, a proxy for the required information had to be used, refer to Section 5.4 for more detail.

It is therefore recommended that provincial governments and departments make use of the accrual base accounting system instead, since this generates more comprehensive financial statements. Already in 2001, the International Monetary Fund (IMF) also recommended that accrual base accounting system should be used for all governments' financial statements. The National Treasury confirmed in its budget review document that national and provincial governments employ a modified cash basis accounting system, while local authorities (municipalities) and public entities use the accrual base accounting system. It declared its intention to follow the IMF's recommendation over time, but stated that government data will be presented on a cash basis in the immediate future (National Treasury, 2013c).

To conclude, it would be preferable if the information regarding a provincial department's willingness and capability to repay debt obligations in full and on time are included in their financial reporting in future. Examples of this type of information are the number of months in arrears or amount in arrears. This could be achieved by using the accruals base accounting system. Another preference is that all the data used in this thesis to rate these subnationals should be available on a regular basis (for example quarterly) in order to update the credit ratings as often as possible. Considering the format of the reports used, it is suggested that these should stay constant over time. Therefore, it is recommended that these preferences should be requested from National Treasury if the developed credit rating methodologies are used in future.

5.2.3 Construction of the datasets

The required information, based on the literature study, was gathered from each of the data sources discussed in Section 5.2.1. The construction of the datasets based on these sources is discussed in the remainder of this section.

Warner (2008) states that analyses based on a dataset that contains errors can lead to misleading results. Seeing that the data used for the purpose of this thesis were captured manually, special care was taken to identify and correct data errors. During the compilation of the datasets scatterplots were used to identify any suspicious values. These values were verified against the original source and were corrected if transferred incorrectly. In some cases these turned out to be the actual values. In these cases the relevant sources were searched for any applicable notes or information. For example, Gauteng's Department of Health's accruals exceeding 30 days increased steadily from R 345 838 in 2006/07 to R 779 629 in 2009/10. This value was almost three times higher in 2010/11, since it increased to R 2 156 908. The notes included in the 2010/11 annual report were consulted with regard to the matter. The notes indicated that accruals had been accumulating over a period of time and that a cash flow crisis had been experienced during 2009/10 and 2010/11. This resulted in the high accruals values for 2010/11. Any other suspicious values noted during any other stage were also investigated and rectified if possible in a likewise manner. Thus the error identification and rectification measures were applied iteratively.

As was explained in Section 5.2.1, no provincial level annual reports are available, since these reports are compiled per department. Therefore it was decided to rather focus on provincial departments instead, specifically the Departments of Health and Education, since these equate to the biggest portion of the provinces' total expenditures. Although the information obtained from the two StatsSA reports and the National Treasury's Statements of Receipts and Payments reports were on a provincial level, all other data were on a department level (approximately 70% of the information used). In the afore-mentioned cases the same information was used for the Departments

of Health and Education.

Datasets were compiled for each department. The five years' reports of the nine provinces resulted in 45 data points. As explained in Section 5.2.1, one could consider aggregating the department level data to construct provincial level data. Although the aggregation of the data of all departments' data would pose difficulties (due to the unequal number of departments per province) a dataset combining data of the two departments was also compiled for the purpose of this study.

Two different datasets were compiled for each of the departments, one with a time variable included as an independent variable (HT, ET and CT datasets) and another without the time variable (H, E and C datasets). The time variable was coded as 1, 2, 3, 4 and 5 refer to Table 5.2 for the detail. Separate linear regression models will be developed for each of these datasets and will be reported, accordingly in Chapters 6 and 7.

Indicator variables (also known as dummy variables) take on the value 0 or 1 to indicate absence or presence. Indicator variables were used to indicate the presence of the provinces. This was done for all of the datasets. Another two indicator variables, Indicator.Department and time, were also added to the datasets. However, the Indicator.Department variable was only added to the Combined datasets to indicate which department's data are under review. Table 5.2 contains the detail regarding the coding of these variables.

Indicator_EC	1 if Eastern Cape, 0 if other
Indicator_FS	1 if Free State, 0 if other
Indicator_Gau	1 if Gauteng, 0 if other
Indicator_KZN	1 if KwaZulu-Natal, 0 if other
Indicator_Lim	1 if Limpopo, 0 if other
Indicator_Mpu	1 if Mpumalanga, 0 if other
Indicator_NW	1 if North West, 0 if other
Indicator_NC	1 if Northern Cape, 0 if other
Indicator_WC	1 if Western Cape, 0 if other
Indicator.Department	0 if Health, 1 if Education
time	1 = financial year April 2006 to March 2007, 2 = financial year April 2007 to March 2008, 3 = financial year April 2008 to March 2009, 4 = financial year April 2009 to March 2010, 5 = financial year April 2010 to March 2011

Table 5.2: *Information regarding the coding of the indicator variables added to the datasets*

The constructed datasets contain only quantitative information. This relates back to the principle of using only 30% quantitative information for rating purposes in developing countries. The models developed based on the information discussed in this chapter should therefore only equate to 30% of a final credit rating. The other 70% of the final credit rating should be based on qualitative information; this can be taken into account as an intuitive overlay. Chapter 3 contains a detailed discussion regarding the 30% quantitative vs. 70% qualitative principle and the intuitive overlay of qualitative information will be illustrated in Chapter 8.

5.3 Linear regression modelling

Hwang et al. (2010) state that there are several statistical methods available to develop credit rating predictions. Examples of these methods are linear regression modelling, multiple discriminant analysis, ordered linear probit modelling and linear logit modelling. Linear regression modelling was chosen for the purpose of this study to predict the quantitative part of the credit ratings of two provincial departments.*

This section provides some basic information regarding linear regression modelling and illustrates how linear regression modelling is used to predict the quantitative part of credit ratings.

5.3.1 Introduction

Hair et al. (2006) describe linear regression as a general statistical technique that is used to analyse the relationship between one single dependent variable and a number of independent variables. Pallant (2007) states that it is a family of techniques used to explore the relationship between one dependent variable and several independent variables.

The general form of a linear regression equation is:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \cdots + \beta_{p-1} X_{i,p-1} + \varepsilon_i \quad (5.1)$$

where:

Y_i is the dependent variable of the i th case ($i = 1$ to n where n is the total number of cases).

$X_{i1}, X_{i2}, \dots, X_{i,p-1}$ are the different independent variables (or known constants), in this case there are $p - 1$ different independent variables.

$\beta_0, \beta_1, \beta_2, \dots, \beta_{p-1}$ are the parameter coefficients of the independent variables.

ε_i is the error term, the difference between the actual and the expected value of the i th case (Kutner et al., 2005).

The parameter coefficients can be estimated. The estimated mode of Equation 5.1 becomes:

$$\hat{Y}_i = B_0 + B_1 X_{i1} + B_2 X_{i2} + \cdots + B_{p-1} X_{i,p-1} \quad (5.2)$$

where:

$\hat{Y}_i$ is the estimated or fitted value of the dependent variable of the i th case.

$B_0, B_1, B_2, \dots, B_{p-1}$ are estimates of the parameters $\beta_0, \beta_1, \beta_2, \dots, \beta_{p-1}$.

Kutner et al. (2005) state that a parameter estimate indicates the change in the dependent variable per one unit increase of the corresponding independent variable when the other independent variables are held constant. However, the parameter estimates are stated in the unit of the associated independent variable and therefore these cannot be compared directly. Ideally it would be

*Woolridge (2009) illustrates that the variables included in economic time series data can be viewed as random variables, and therefore linear regression modelling instead of time series analysis could be used for modelling purposes.

preferable to be able to compare the parameter estimates to determine the specific independent variable's relative explanatory power of the dependent variable (Hair et al., 2006). The relative exploratory power of the independent variables can also be viewed as the relative importance of the variables. It is advisable to calculate the standardised parameter estimates too, since these have been converted to the same scale throughout and are directly comparable (Pallant, 2007). They could therefore be used to determine the relative importance of the independent variables included in a model.

Linear regression models can be used for explanatory purposes by explaining the variance of the dependent variable or for prediction purposes. It is important to note that in order to forecast, the independent variables used to predict the dependent variable for the next year have to be lagging by a year. This also applies to this study since the aim is to predict the provincial departments' credit ratings for the next financial year (for example 2013/2014) based on this financial year's data (for example 2012/2013).

However, in order to develop linear regression models, some background information regarding the methodology of linear regression modelling is required. This information is provided in the remainder of this section.

5.3.2 Sample size

The first aspect of linear regression modelling that should be taken into account when applying this methodology is sample size, since it influences the statistical power and generalisability. However, adequate sample is debatable. For example, Hogg and Tanis (2010) view samples containing 25 or less data points as small samples. Warner (2008) states that a linear regression model with two independent variables requires a minimum sample of 100 data points. Hair et al. (2006) suggest another way to determine minimum sample size by assessing the number of observations to independent variables ratio. The minimum ratio is 5:1, thus five observations for each independent variable included in the linear regression equation, but the preferred ratio is 20:1.

The datasets used for this study contained 45 observations for the Health and Education datasets (HT, H, ET and E), and 90 data points for the Combined datasets (CT and C). However, due to the pre-processing steps applied (dealing with multicollinearity and irrelevancy) the number of observations to independent variables ratio used during the model development phase were close to the recommended 5:1 ratio since the number of independent variables ranged between seven and 15.

5.3.3 Variable selection techniques

Once the data needed to develop a linear regression model have been collected there are several techniques that could be used to determine which independent variables will best predict the dependent variable. The aim is to explain the most possible variance in the dependent variable with the smallest number of independent variables. Popular variable selection techniques include the backwards elimination (backward), forward addition (forward) or stepwise selection (stepwise) techniques. In addition to these three techniques the all-possible-subsets method (best subset) can also be used. However, this technique is not suitable for large datasets.

The backwards elimination procedure begins by including all the independent variables in the linear regression model. The independent variables that do not make a significant contribution to the prediction of the independent variable are deleted individually. Variables cannot be added to the model once they have been removed.

Forwards addition starts off with none of the independent variables included in the model. The independent variables are added one by one based on the explanatory power they contribute to the linear regression model. In this case variables cannot be deleted from the model once they have been included in the model.

The stepwise estimation procedure is a combination of the backward and forward methods. This procedure begins by determining the best predictor from a set of independent variables. Independent variables are added one by one based on their contributions to the prediction of the dependent variable. Variables can also be deleted from the model if their contribution drops to a insignificant level. The distinction between the stepwise procedure and the forward addition or backwards elimination procedure is the capability to add or remove a variable at any given stage.

The best subset or all-possible-subset method takes into consideration all possible combinations of independent variables. The researcher chose the best model, based on certain criteria, from the various models that include the different combinations of independent variables (Hair et al., 2006).

All of these variable selection techniques were used to develop the linear regression models documented in Chapters 6 and 7.

5.3.4 Significance levels

Significance levels (p-values) are used in conjunction with variables selection techniques explained in the previous section. Both of these concepts should be known to a user of linear regression modelling.

The significance levels are the criteria used to determine whether an independent variable should be included in a model (when the forward or stepwise methods are used) or whether an independent variable should be deleted from a model (when the backward or stepwise techniques are used). They state the risk, in terms of probability, the researcher is willing to take that the parameter estimate of a specific independent variable is different from zero when it actually is zero (Hair et al., 2006). Simply put, the probability that an independent variable is included in a linear regression model when it should not be.

The most commonly used level of significance is $p=0.05$. The significance level of $p=0.1$ is less strict and will detect significance more easily (Hair et al., 2006). Due to the small datasets used in the study the less conservative significance level of $p=0.1$ was used.

Note that significance levels do not need to be specified when the best subset variable selection techniques are used since this method will consider all different combinations of available independent variables, regardless of their contribution to the prediction of the dependent variable.

5.3.5 Model fit statistics

Once the different types of variable selection techniques, with their specified significance levels, have been applied to a dataset, different models will result. The different models need to be assessed in order to determine the best model to solve the specific problem. There are a number of statistics available to do this, known as model fit statistics. The coefficient of determination or R^2 , the adjusted coefficient of determination or adjusted R^2 and Mallow's Cp are examples of model fit statistics. These are also the measures used for the purpose of this study.

The R^2 indicates the amount of variance of the dependent variable that can be explained by the model (Field, 2005). This statistic can range between 0 and 1, the higher the value the better the prediction of the dependent variable based on the specific model. It is an indicator for the overall predictiveness accuracy of the model. The R^2 will always increase as more independent variables are added to the model (Hair et al., 2006).

The adjusted R^2 takes into account the number of independent variables included in the model and the sample size. This measure may decrease if independent variables with little explanatory power are added to the model. Due to the fact that this statistic takes the sample size and the explanatory power of independent variables into account, it could be used to evaluate different models based on different sample sizes and with different independent variables included (Hair et al., 2006).

Mallow's Cp concerns the total mean squared error, where the error is the difference between the actual and the expected values. Small values of Mallow's Cp criteria are preferable (Kutner et al., 2005). Mallow's Cp was used to select a model from the models resulting from the best subset variable selection technique. The model with the lowest Mallow's Cp was used as selection criterion when evaluating the best subset models.

5.3.6 Multicollinearity

Multicollinearity concerns the relationships between independent variables and occurs when independent variables included in a model are highly correlated, where correlation refers to the linear relationship between two variables (Pallant, 2007).

Multicollinearity should be taken into account before model building. One way of eliminating multicollinearity is by using variable clustering to group similar variables into clusters. The variables within a cluster are similar to one another, but as different as possible to variables within other clusters. Once the variables are clustered one variable is chosen from each cluster as the cluster representative. This decision could be based on the $1 - R^2_{ratio}$ of the variables within a cluster. The optimal ratio tends to zero as this indicates that the variable is closely correlated with the variables within its own cluster and uncorrelated with the other clusters. If the variable selection decision is based on the rule, the variable with the lowest ratio is selected. Alternatively, subject knowledge could be used to choose a cluster representative (Sanche and Lonergan, 2006).

Although multicollinearity should ideally be dealt with before the model building phase there are statistical measures available to ensure that the independent variables included in the model has "acceptable levels" of multicollinearity. For example, the variance inflation factors (VIF) of the independent variables can be calculated. The VIF shows whether or not an independent variable has a strong relationship with other independent variables. High VIF levels indicate high degrees of multicollinearity, generally a VIF of 10 and higher indicates high multicollinearity. (Field, 2005; Hair et al., 2006).

The variable clustering and VIF methods were used in this thesis. Dealing with multicollinearity in the pre-processing phase decreases the number of independent variables. This, in turn, will improve the number of observations to independent variables ratio recommended as a method to determine minimum sample size.

5.3.7 Irrelevant independent variables

In order to maximise the predictive power of a linear regression model the independent variables included in the model should have low multicollinearity among each other, as well as high correlations with the dependent variable.

Correlation measures the strength and direction of a linear relationship between two variables. A correlation coefficient can only range from -1 to +1. A positive correlation coefficient indicates that if the one variable increases, the other one also increases. On the other hand, a negative correlation coefficient indicates that if the one variable increases, the other one decreases. The size of the correlation coefficient indicates the strength of the linear relationship. If the correlation coefficient is equal to -1 or +1, it means there is perfect correlation between the two variables. A correlation coefficient equal to 0 means there is no correlation between two variables (Pallant, 2007).

There are a number of correlation coefficients that can be used to determine whether or not a linear relationship exists between two variables. For the purpose of this study Spearman's correlation coefficient and Hoeffding's D is used.* Note that both of these measures are based on ranked data. These measures were used in this study to identify irrelevant independent variables, i.e. independent variables with too low correlations with the dependent variable.

Again, due to the decrease in the number of independent variables caused by dealing with irrelevancy, the number of observations to independent variables will improve.

5.3.8 Assumptions

One last important aspect that needs to be discussed in terms of linear regression modelling is the underlying assumptions of linear regression modelling.

Some assumptions regarding the relationship or association between the dependent and the independent variables have to be assumed when building a linear regression model (Hair et al., 2006). These assumptions are assessed after the model was developed, since they are mostly concerned with the prediction errors. These assumptions are:

- normality: the prediction errors should be normally distributed (Pallant, 2007);
- linearity: the relationship that is being modelled is linear (Field, 2005);
- homoscedasticity: the variance of the prediction errors should be the equal for all of the predicted values (Pallant, 2007); and

*The Spearman correlation statistic is a correlation of the ranks of the independent variables a the binary dependent variable. The Spearman correlation statistic was used rather than the more general Pearson correlation statistic because Spearman is less sensitive to nonlinearities and outliers. However, when variables are not monotonically related to each other, the Spearman correlation statistic can miss important associations. A general and robust similarity measure is Hoeffding's D which will detect a wide variety of associations between two variables.

- independence: the prediction errors of any two observations should be independent (Field, 2005).

The common measure for prediction errors is the residuals. A residual is defined as the difference between the observed and the predicted values of the dependent variable. Scatter plots of the residuals against the predicted values of the dependent variable could be used to test the assumptions of normality, linearity and homoscedasticity (Hair et al., 2006). The overall shape of the scatter plot is the matter of interest. A scatterplot with points that are randomly and evenly distributed indicates that the assumptions are met. Normality plots (also called normal probability plots or Q-Q plots) can be used to assess whether the residuals are normally distributed. Observed values close to the expected values indicate that the normality assumption is met (Field, 2005). Prototype plots are provided in Figure 5.5.

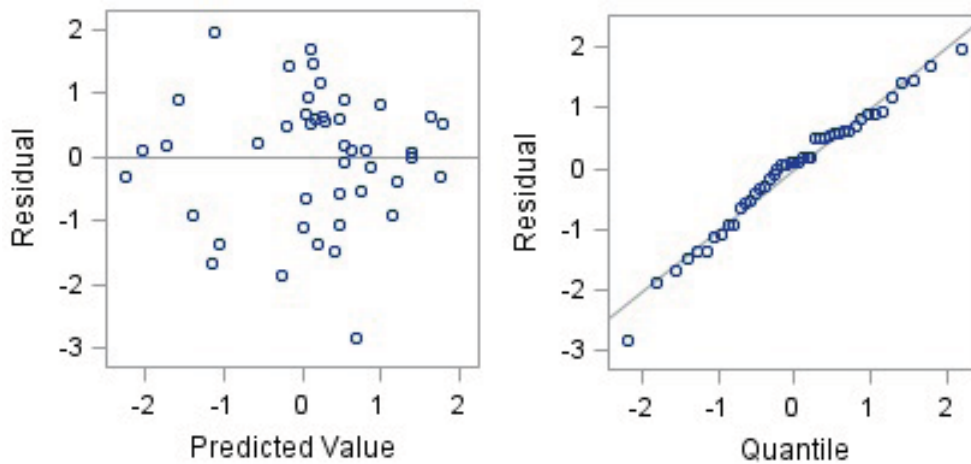


Figure 5.5: *Prototype plots of the residuals vs. predicted values and a Q-Q plot*

The violation of the normality assumption is typically caused by non-normal distributions of the dependent or independent variables and/or the violation of the linearity assumption. Transforming the variables in order to normalise their distributions is recommended as a remedy. It is suggested that the independent variables should be transformed in a case where only the linearity assumption is violated. The dependent variable should be transformed when the normality and equal variances assumptions are violated. In some cases it may be necessary to transform both the dependent and the independent variables to ascertain that all the assumptions are met. Possible transformations that could be applied are the inverse of the variable, a log transformation, the square root and the exponent of the variable (Kutner et al., 2005). As a safety precaution both the dependent and the independent variables distributions were normalised for the purpose of this study. Refer to Sections 5.4 and 5.5 for the transformations applied to achieve this.

Until this point the terms dependent and independent variables were referred to in general terms. The detail of the variables used as dependent and independent variables applicable to this study is documented in the remainder of this chapter.

5.4 Dependent variable

One of the most important variables contained in a dataset that will be used to develop a linear regression model is the dependent variable since this is ultimately the variable that will be predicted or tried to be explained. This section documents the details of the dependent variable that will be used for the purpose of this study.

The ultimate aim of a credit rating methodology is to predict default, which can be grouped into credit ratings. A common definition used is that a client is unlikely to honour its credit obligation if the client is in excess more than 30, 60 or 90 days on its credit obligation (Blochwitz and Hohl, 2011). For example, BCBS's definition documented in Section 4.3.1 states that a client is in default if the client is past due more than 90 days on its credit obligation. Typically a desired dependent variable is the number of days or months in arrears. However as discussed in Section 5.2.2, the provincial departments use the cash basis accounting system. The focus of this accounting system is not to make sure that bills are paid on time, but to manage the amount of cash in the bank. Therefore the number of days or months in arrears is not reflected in the departments' financial statements included in the annual reports.

A workshop was arranged with the National Treasury to find an alternative measure that could be used as an indication of payment behaviour. It was suggested that the accruals in excess of 30 days* figure that is currently reflected in the provincial financial statements be used (National Treasury, 2012b). This number reflects the rand value of all invoices not paid within 30 days from the invoice date. According to the PFMA provincial departments must pay their creditors within 30 days from invoice date, documented in Section 4.2.1. This explains why this figure is of interest. Note that the choice of the dependent variable is thus based purely on data availability.

As mentioned before, the accruals in excess of 30 days figure is a rand value. In order to make it comparable between departments it should rather be expressed as a ratio. Total expenditure and the total revenue were considered denominators. However, these two variables have an almost perfect correlation ($r=0.99$ for all the datasets). Thus there is no distinction with regard to which variable should be used to make the accruals in excess of 30 days comparable between departments. It was decided to use total expenditure.

This ratio (accruals in excess of 30 days / total expenditure) is viewed as a proxy for payment behaviour. It is important to note that a high value of this proxy indicates bad payment behaviour since it equates to a large portion of the department's total expenditure outstanding after 30 days. The lower the value of this ratio, the better the payment behaviour, since it indicates that the accruals in excess of 30 days is proportionally lower than total expenditure, thus only a small portion of the department's total expenditure is unpaid after 30 days. In summary, an increase in this ratio indicates worsening payment behaviour and a decrease, improving payment behaviour.

Note that the data contained in the dependent variable are one year later than the data contained in the independent variables since the aim of the models is to predict the outcome of the dependent variable for the next financial year. For example, the data of the financial year 2011/12 are used to predict the future payment behaviour of 2012/13.

As mentioned previously, normalising the distribution of the dependent variable (as well as the independent variables) was desired as a preventative measure to ensure that the assumptions of

*This is referred to as "accruals 30 days plus" in the provincial departments' annual reports.

linear regression modelling are met when applying this methodology. It is evident from Figure 5.6 that this variable is not normally distributed since the observed values are not always close to the expected values (especially in the higher and lower values). A natural log ($\ln$) transformation was applied in order to rectify the problem.

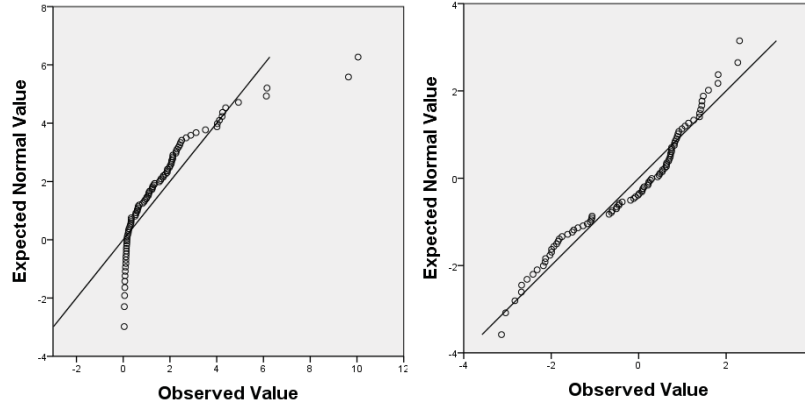


Figure 5.6: *Q-Q plots of (accruals in excess of 30 days / total expenditure) (left) and the natural log transformation (right) of the same ratio*

Consequently, the dependent variable used for the regression models in this study was:

$$Y = \ln\left(\frac{\text{accruals in excess of 30 days}}{\text{total expenditure}}\right)$$

The descriptive statistics of the dependent variable after the natural log transformation was applied are provided in Table 5.3. The discussion here provides a summary of the information contained in this variable by presenting the minimum, maximum, mean and standard deviation of the variable for each of the datasets.

Health				Education				Combined			
Min	Max	Mean	Std. D	Min	Max	Mean	Std. D	Min	Max	Mean	Std. D
-2.83	2.31	0.17	1.41	-3.14	1.14	-0.61	1.22	-3.14	2.31	-0.22	1.37

Table 5.3: *Descriptive statistics of the dependent variable*

Equally important to understanding the dependent variable used in a linear regression model is an understanding of the independent variables. The independent variables used in this study are discussed next.

5.5 Independent variables

As discussed in Section 5.2.1, data were captured from six different data sources. Some of the variables captured from these sources were in rand values. All rand values were transformed into ratios or percentages to make them comparable between departments. The variables used as denominators to create these ratios and percentages were excluded from the datasets once the ratios and percentages were calculated.

Note that the indicator variables for the provinces, department (only applicable to the Combined dataset) and the time variable added to the dataset (refer to Section 5.2.3) are also viewed as independent variables.

Table 5.4 summarises the information regarding the independent variables used. The table includes a list of all possible independent variables, their descriptions, the sources they came from and the broad factors they represent.

The remainder of this section discusses the transformation applied to the variables, the number of independent variables per dataset, the descriptive statistics of the variables and the broad factors they represent.

Source	Independent variable*	Description	Broad factor
Constant	Indicator_EC	1 if Eastern Cape, 0 if other	Indicator
	Indicator_FS	1 if Free State, 0 if other	
	Indicator_Gau	1 if Gauteng, 0 if other	
	Indicator_KZN	1 if KwaZulu-Natal, 0 if other	
	Indicator_Lim	1 if Limpopo, 0 if other	
	Indicator_Mpu	1 if Mpumalanga, 0 if other	
	Indicator_NW	1 if North West, 0 if other	
	Indicator_NC	1 if Northern Cape, 0 if other	
	Indicator_WC	1 if Western Cape, 0 if other	
	Indicator_Department	0 = Health, 1 = Education	
Derived from financial year	time	1 = financial year April 2006 - March 2007, 2 = financial year April 2007 - March 2008, 3 = financial year April 2008 - March 2009, 4 = financial year April 2009 - March 2010, 5 = financial year April 2010 - March 2011	time
National Treasury's Fourth Quarter Year to Date Provincial Budgets and Expenditure Report (Preliminary Outcome) reports	ln_x3	ln (departmental total expenditure to departmental adjusted budget)	Fiscal performance
	ln_x4	ln (departmental total expenditure to total provincial expenditure)	
	ln_x8	ln (departmental personnel expenditure to departmental adjusted budget)	
	ln_x9	ln (departmental personnel expenditure to total provincial personnel expenditure)	
	ln_x13	ln (departmental capital expenditure to departmental adjusted budget)	
	ln_x14	ln (departmental capital expenditure to total provincial capital expenditure)	
	x27_grouped	departmental annual appropriation of revenue to total departmental revenue (grouped)	
	ln_x28_Zmean	ln (departmental own revenue to total departmental revenue) (missing mean)	
	Indicator_x28_Z	0 if departmental own revenue = 0, 1 if departmental own revenue > 0	
	ln_x29	ln (departmental personnel expenditure to departmental total current expenditure)	
Provincial Departments' Annual Reports	ln_x30	ln (departmental personnel expenditure to departmental total expenditure)	Financial and debt position
	ln_x31	ln (departmental total current expenditure to departmental total expenditure)	
	ln_x32	ln (departmental capital expenditure to departmental total expenditure)	
	ln_x33	ln (departmental surplus/deficit to departmental total revenue)	
	ln_x34	ln (departmental surplus/deficit to departmental total expenditure)	
	ln_x36_Zmean	ln (departmental net assets to departmental total expenditure) (missing mean)	
	Indicator_x36_Z	0 if departmental net assets = 0, 1 if departmental net assets > 0	
	ln_x39	ln (departmental own revenue actual collection to departmental adjusted budget)	
	ln_x41	ln (departmental own revenue collection to total provincial revenue)	
National Treasury's Fourth Quarter Year to Date Provincial Budgets and Expenditure Report (Preliminary Outcome) reports			

*The inconsecutive numbers of the independent variables is caused by the exclusion of the variables used as denominators to create comparable ratios and percentages.

Source	Independent variable*	Description	Broad factor
National Treasury's Provincial Statements of Receipts and Payments 4th Quarter	ln_x48	ln (provincial surplus/deficit to provincial receipts)	Fiscal performance
	ln_x49	ln (provincial surplus/deficit to provincial payments)	
	ln_x50	ln (provincial total receipts to provincial total payments)	
Auditor-General's consolidated general reports on the national and provincial audit outcomes	x52	quality of department's financial reports: 1 = clean audit outcome, 2 = financially unqualified audit opinion, 3 = qualified audit opinion, 4 = adverse audit opinion and disclaimer of audit opinion	Management quality and institutional strength
StatsSA's Gross Domestic Product. Annual estimates 2003 to 2012. Regional estimates 2003 to 2012.	ln_x57	ln (provincial GDP per capita)	Economic conditions
Third quarter 2013. Statistical release P0441 report. and interactive dataset containing the mid-year population estimate	ln_x58	ln (provincial GDP per capita growth)	
StatsSA's Gross Domestic Product. Annual estimates 2003 to 2012. Regional estimates 2003 to 2012. Third quarter 2013. Statistical release P0441 report.	ln_x59	ln (provincial GDP growth)	
StatsSA's interactive dataset containing the mid-year population estimate	ln_x60	ln (provincial dependent population to total population)	
	ln_x61	ln (provincial dependent population growth)	
Provincial departments' annual reports and StatsSA's interactive dataset containing the mid-year population estimate	ln_x63	ln (departmental total revenue per capita)	Fiscal performance
	ln_x64	ln (departmental capital expenditure per capita)	Economic conditions
	ln_x65	ln (departmental total expenditure per capita)	

Table 5.4: Summary of the independent variables available for linear regression modelling purposes

5.5.1 Transformations applied

As was mentioned in Section 5.3.8, a principal aim was to normalise the distributions of the independent variables to ensure that the assumptions of linear regression modelling are met when applying the methodology later on. A good rule of thumb is to keep the independent variables on the same measuring scale as the dependent variable (SAS Institute Inc., 2009). In this case, since the dependent variable is a ratio to which a natural log transformation was applied, the same transformation were applied to all the independent variables (as far as possible). Q-Q plots were used to assess whether or not the independent variables were normally distributed (before and after the transformations). In most cases the transformation did not have a noteworthy impact on the distributions of the variables. However, in some cases the natural log transformation resulted in more normally distributed independent variables. Examples are x_{41} (departmental own revenue to total provincial revenue) and x_{57} (provincial GDP per capita). The Q-Q plots (before and after the transformation has been applied) of these two variables are shown in Figures 5.7 and 5.8.

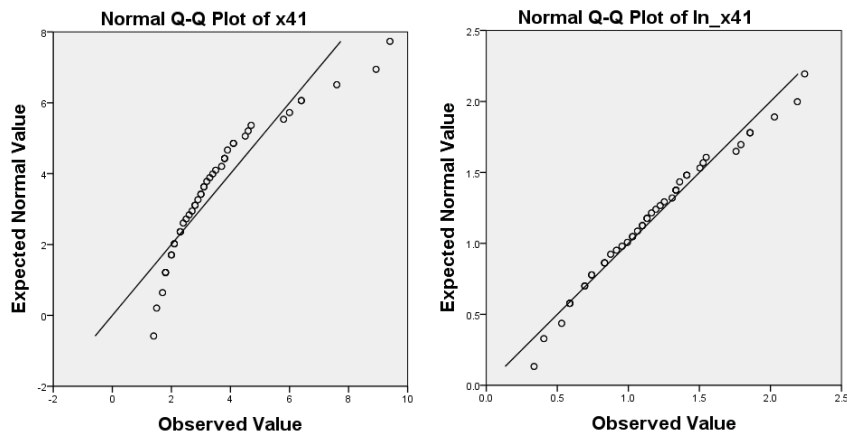


Figure 5.7: *Q-Q plots of variable x_{41} (departmental own revenue to total provincial revenue)*

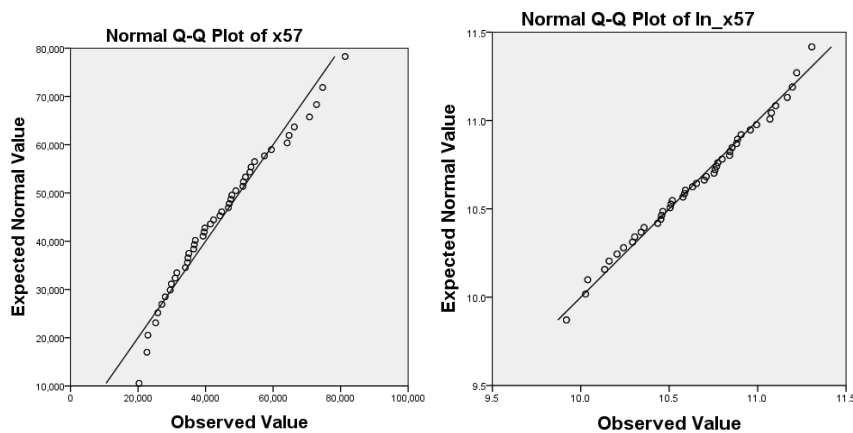


Figure 5.8: *Q-Q plots of variable x_{57} (provincial GDP per capita)*

Natural log transformations were applied as far as possible to normalise the distributions of the independent variables. However, in some special cases this transformation was not successful and other remedies had to be used.

In addition to the natural log transformation applied to the variable x27 (departmental annual appropriation of revenue to total departmental revenue), several other transformations were considered to enhance the distribution. Examples of the other transformations applied are the inverse and the square root of the variable. None of the applied transformations successfully transformed the variable into a more normally distributed variable. Therefore it was decided to group the information in this variable into three equal groups. A -1 was assigned to the lower values, 0 to the mid-range and 1 to the upper values. This was done separately for Health and Education.

Variable x28 (departmental own revenue to total departmental revenue) contained a significant number of zeros (Health 17.78%, Education 40.00% and Combined 28.89%). These zeros were replaced by the mean of the variable (ignoring zeros). These means were calculated separately for Health and Education. An indicator variable (Indicator_x28_Zmean) was created to indicate whether or not the variable was imputed. This method is recommended by SAS Institute Inc. (2010).

The independent variable departmental net assets to departmental total expenditure (x36) also contained a significant amount of zeros (Health 13.33%, Education 28.89% and Combined 10.00%). The same process as described above was followed.

Variables x9 (departmental personnel expenditure to total provincial personnel expenditure), x29 (departmental personnel expenditure to departmental total current expenditure) and x30 (departmental personnel expenditure to departmental total expenditure) displayed structure in the data according to department, even after the natural log transformations were applied. This is evident from Figures 5.9 and 5.10*, displaying Q-Q plots and histograms of these variables. This supports the decision to develop separate regression models for the Health and Education datasets since the structure within the data needs to be taken into account when developing the regression models. However, for the sake of completeness linear regression models will still be developed for the Combined datasets as well.

*The graphs are only displayed for the Combined dataset because the structures are not applicable at departmental level.

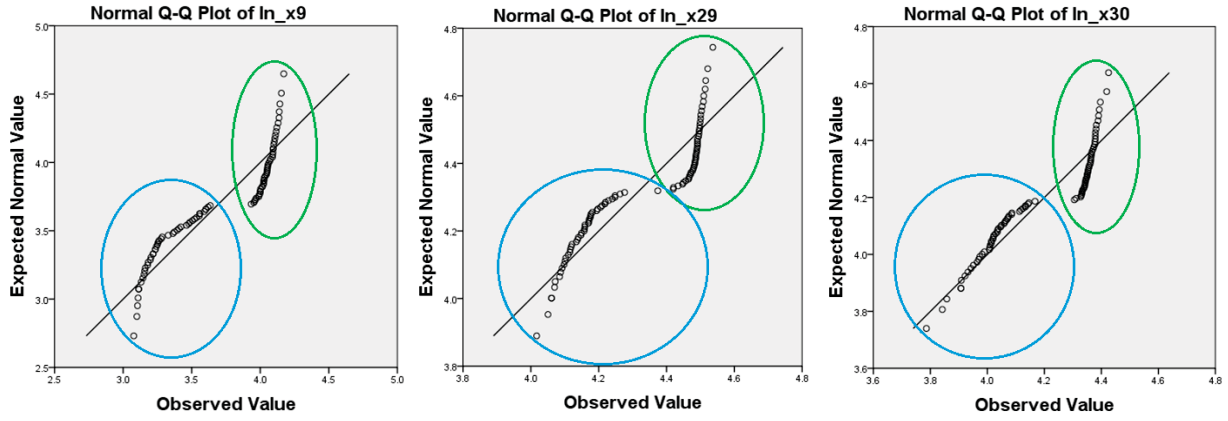


Figure 5.9: Q-Q plots of variables x_9 (departmental personnel expenditure to total provincial personnel expenditure), x_{29} (departmental personnel expenditure to departmental total current expenditure) and x_{30} (departmental personnel expenditure to departmental total expenditure) after the natural log transformations have been applied - Department of Health's information is indicated by the green circle and the Department of Education's by the blue circle

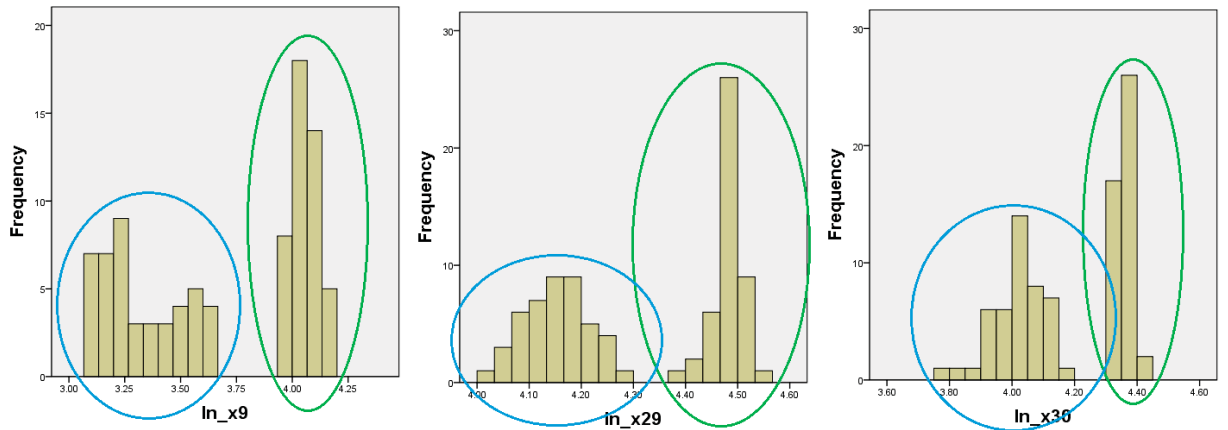


Figure 5.10: Histograms of variables x_9 (departmental personnel expenditure to total provincial personnel expenditure), x_{29} (departmental personnel expenditure to departmental total current expenditure) and x_{30} (departmental personnel expenditure to departmental total expenditure) after the natural log transformations have been applied - Department of Health's information is indicated by the green circle and the Department of Education's by the blue circle

5.5.2 Number of independent variables per dataset

Once the rand value used as denominators were excluded from the datasets and the required indicator variables were added to the datasets, the possible number of independent variables available for linear regression modelling purposes summed to a total number of 42.

However, the time and department indicators are not applicable when referring to the H and E datasets, thus these datasets contain only 40 independent variables. The HT and ET datasets contain 41 possible independent variables, since the time variable is included in this case. The Combined datasets include the additional department indicator variable, thus the C dataset con-

tains 41 possible independent variables and the CT dataset 42 (Table 5.5).

Dataset	Number of data points	Number of independent variables
H and E	45	40
HT and ET	45	41
C	90	41
CT	90	42

Table 5.5: *Number of data points and independent variables per dataset*

5.5.3 Descriptive statistics

Table 5.6 contains the descriptive statistics of each of the independent variables (the indicators variables, the time variable and x52 are omitted from Table 5.6).

Independent Variable	Health				Education				Combined			
	Min	Max	Mean	Std. D	Min	Max	Mean	Std. D	Min	Max	Mean	Std. D
ln_x3	4.54	4.71	4.60	0.04	4.55	4.67	4.60	0.02	4.54	4.71	4.60	0.03
ln_x4	3.10	3.59	3.33	0.13	3.48	3.91	3.73	0.12	3.10	3.91	3.53	0.23
ln_x8	4.54	4.77	4.63	0.05	4.54	4.67	4.61	0.02	4.54	4.77	4.62	0.04
ln_x9	3.08	3.63	3.32	0.18	3.93	4.17	4.05	0.06	3.08	4.17	3.69	0.39
ln_x13	2.54	4.72	4.37	0.33	3.78	5.09	4.53	0.23	2.54	5.09	4.45	0.29
ln_x14	2.00	4.07	3.36	0.35	1.53	3.78	2.96	0.49	1.53	4.07	3.16	0.47
ln_x28_Zmean	-4.67	1.08	-0.70	1.27	-4.67	-0.59	-1.93	0.95	-4.67	1.08	-1.32	1.27
ln_x29	4.02	4.28	4.15	0.06	4.37	4.54	4.48	0.03	4.02	4.54	4.32	0.17
ln_x30	3.79	4.17	4.02	0.09	4.30	4.43	4.36	0.03	3.79	4.43	4.19	0.18
ln_x31	4.34	4.53	4.47	0.04	4.44	4.54	4.48	0.03	4.34	4.54	4.48	0.03
ln_x32	1.55	3.05	2.12	0.31	0.31	1.90	1.29	0.36	0.31	3.05	1.71	0.54
ln_x33	-0.10	0.07	0.01	0.04	-0.09	0.06	0.00	0.03	-0.10	0.07	0.00	0.03
ln_x34	-0.09	0.07	0.01	0.04	-0.08	0.06	0.00	0.03	-0.09	0.07	0.01	0.03
ln_x36_Zmean	-5.04	-0.74	-2.45	1.18	-3.54	-0.39	-1.78	0.71	-5.04	-0.39	-2.11	1.02
ln_x39	4.42	4.99	4.69	0.11	4.42	4.99	4.69	0.11	4.42	4.99	4.69	0.10
ln_x41	0.34	2.24	1.16	0.46	0.34	2.24	1.16	0.46	0.34	2.24	1.16	0.46
ln_x48	0.00	0.13	0.07	0.03	0.00	0.13	0.07	0.03	0.00	0.13	0.07	0.03
ln_x49	0.00	0.13	0.07	0.02	0.00	0.13	0.07	0.02	0.00	0.13	0.07	0.02
ln_x50	-0.08	0.06	0.00	0.03	-0.08	0.06	0.00	0.03	-0.08	0.06	0.00	0.03
ln_x57	9.92	11.31	10.64	0.35	9.92	11.31	10.64	0.35	9.92	11.31	10.64	0.34
ln_x58	1.19	2.83	2.27	0.37	1.19	2.83	2.27	0.37	1.19	2.83	2.27	0.37
ln_x59	1.64	2.84	2.39	0.32	1.64	2.84	2.39	0.32	1.64	2.84	2.39	0.32
ln_x60	3.44	3.77	3.62	0.08	3.44	3.77	3.62	0.08	3.44	3.77	3.62	0.08
ln_x61	0.00	1.67	0.88	0.43	0.00	1.67	0.88	0.43	0.00	1.67	0.88	0.43
ln_x63	-0.14	0.90	0.45	0.24	0.20	1.27	0.82	0.26	-0.14	1.27	0.63	0.31
ln_x64	-2.76	-1.05	-2.04	0.36	-3.86	-1.63	-2.50	0.46	-3.86	-1.05	-2.27	0.47
ln_x65	-0.15	0.86	0.44	0.23	0.15	1.30	0.81	0.27	-0.15	1.30	0.63	0.31

Table 5.6: *Descriptive statistics of the independent variables*

Indicator_x28_Z indicates the number of zeros of the variable ln_x28 that were replaced by the mean of the non-zeros. The number of cases that were replaced ranged between 17.78% and 40.00% (Table 5.7).

	Health		Education		Combined	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
departmental own revenue = 0	8	17.78	18	40.00	26	28.89
departmental own revenue >0	37	82.22	27	60.00	64	71.11

Table 5.7: *Frequencies of Indicator_x28_Z*

Indicator_x36_Z indicates the number of zeros of the variable ln_x36 that were replaced by the mean of the non-zeros. The number of cases that were replaced ranged between 13.33% and 28.89% (Table 5.8).

	Health		Education		Combined	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
departmental net assets = 0	6	13.33	13	28.89	19	21.11
departmental net assets >0	39	86.67	32	71.11	71	78.89

Table 5.8: *Frequencies of Indicator_x36_Z*

None of the departments received a clean audit outcome during the five years of data under review. In most cases the Auditor-General granted the financial reports of the departments a qualified audit opinion (Table 5.9).

	Health		Education		Combined	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1 = clean audit outcome	0	0.00	0	0.00	0	0.00
2 = financially unqualified audit opinion	10	22.22	14	31.11	24	26.67
3 = qualified audit opinion	22	48.89	20	44.44	42	46.67
4 = adverse audit opinion and disclaimer of audit opinion	13	28.89	11	24.44	24	26.67

Table 5.9: *Frequencies of independent variable x52*

5.5.4 Representation of broad factors

Seven of the 42 independent variables used were indicators of the economic conditions within a province, 21 independent variables formed part of the fiscal performance factor, two formed part of the financial and debt position factor, only one variable provides an indication of the management quality and institutional strength. The rest of the independent variables were indicator variables and did not form part of any of the broad factors. See Figures 5.11 to 5.14 for a list of independent variables per broad factor.

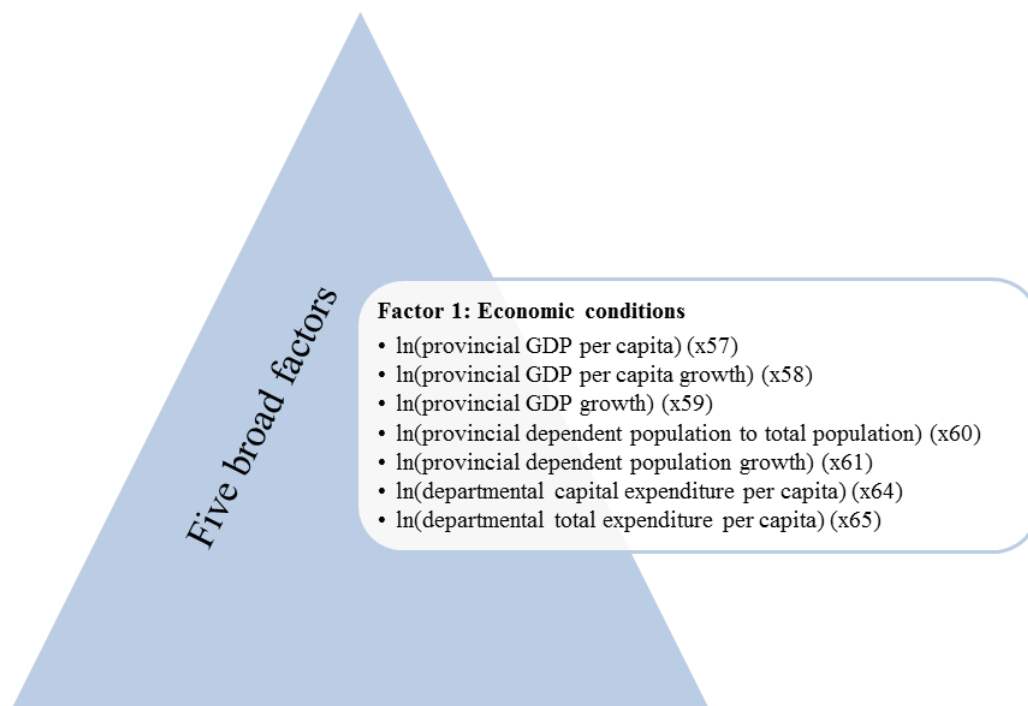


Figure 5.11: *List of the independent variables containing information regarding economic conditions within the province*

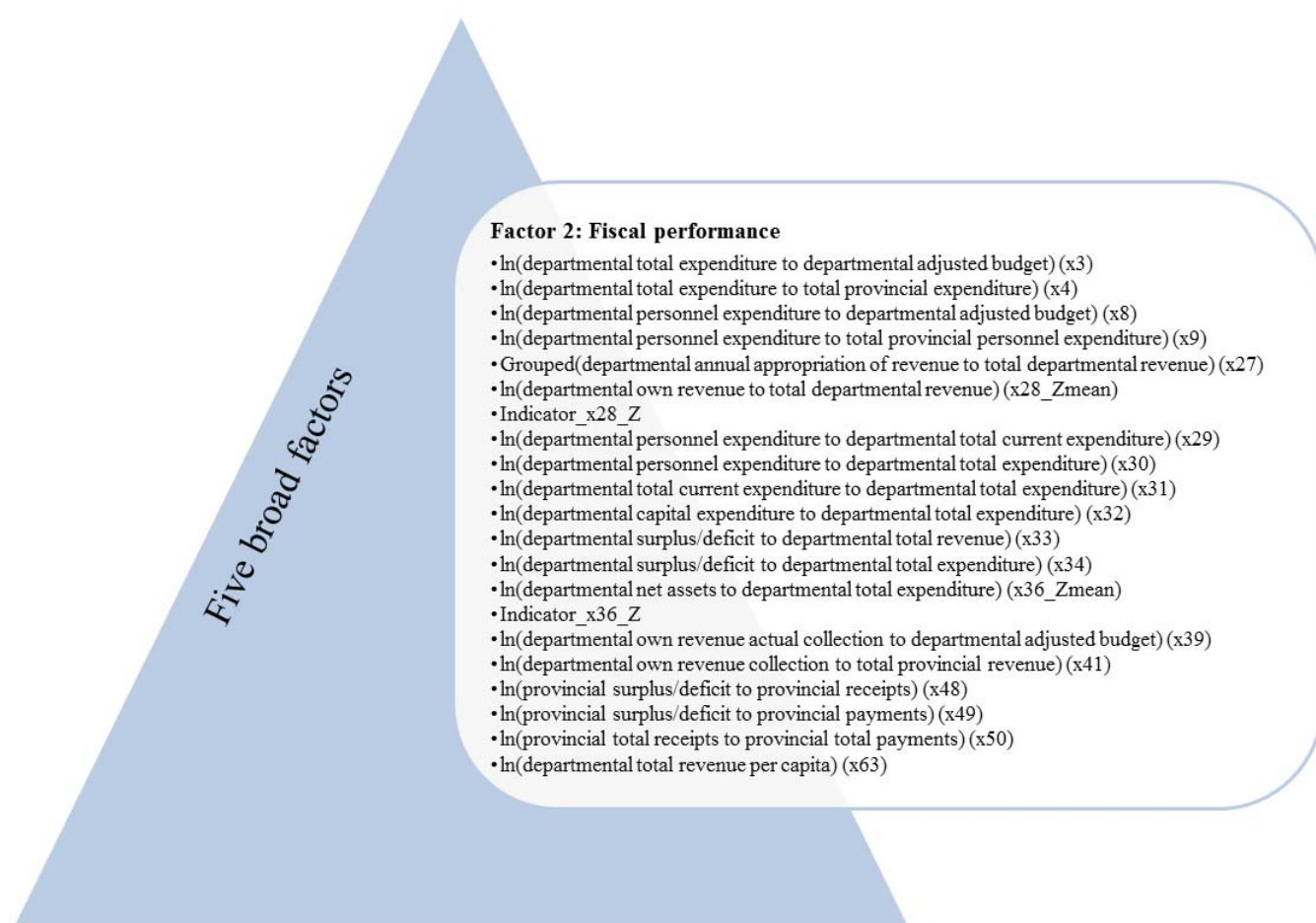


Figure 5.12: *The independent variables representing the fiscal performance broad factor*

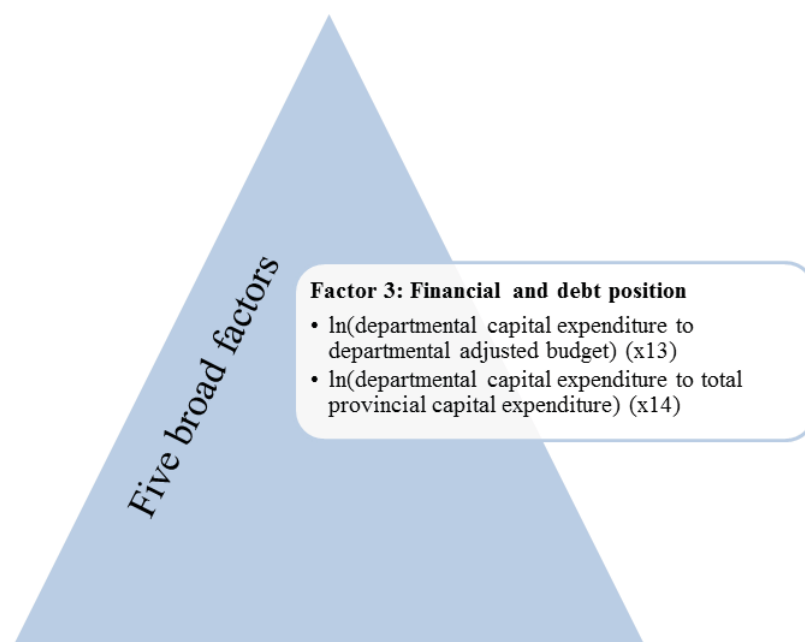


Figure 5.13: *The two independent variables representing the financial and debt position broad factor*

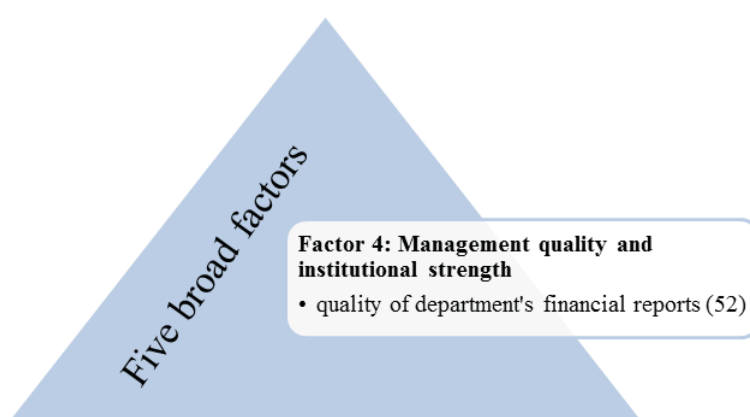


Figure 5.14: *The variable containing the management quality and institutional strength information*

5.6 Linear regression modelling and credit rating methodologies

The credit rating methodologies discussed in Chapter 3 are used to determine a subnational's relative creditworthiness, in other words its probability to default or willingness and ability to honour debt obligations. Linear regression modelling is one of the statistical methods that could be used to predict the quantitative part of such a credit rating. This section provides an explanation by means of an example as to how linear regression modelling could be used to predict the quantitative part of such a credit rating.

Moody's (2014a) states that one advantage of using linear regression modelling is that the parameter estimates are readily available. Another advantage of using linear regression is easy computation and implementation (Moody's, 2006a). A disadvantage of using linear regression modelling is that intuition is lost when too many independent variables are included in the final model (Moody's, 2014a).

The results of a linear regression model can be summarised into credit ratings that are graded by symbols such as AA-, BBB+ and Caa1. These symbols are used by credit rating agencies to indicate relative rankings of creditworthiness. An issuer or issue with a higher ranking is considered to be of better creditworthiness than an issuer or issue with a lower ranking, in other words higher ranked issuers or issues will default less frequently than issuers or issues ranked lower, if assuming everything else remains the same (S&P, 2009).

5.6.1 Example of using linear regression modelling to develop the quantitative part of a credit rating methodology

Section 5.2 of this chapter provided an overview of the data used and Section 5.3 offered a discussion of linear regression modelling in general. The data used in this thesis were discussed in detail in Sections 5.4 and 5.5 on the basis of dependent and independent variables as used in linear regression modelling. A simple example will be used next to illustrate how linear regression modelling will be used in this study to predict the quantitative part of a credit rating.

Examples of independent variables (selected from the Table 5.4) within the South African context that could be used to determine payment behaviour are:

- departmental personnel expenditure to departmental total expenditure;
- departmental net assets to departmental total expenditure;
- quality of department's financial reports;
- provincial GDP per capita;
- departmental capital expenditure per capita.

The independent variables that predict payment behaviour best have to be selected from the independent variables available for modelling purposes. This can be done by applying the variable selection techniques explained in Section 5.3.3. The assigned parameter estimates from the resulting linear regression model indicates the weights assigned to each of the chosen independent variables. The standardised parameter estimates will indicate the relative importance of the independent variables.

Note that the linear regression models resulting from this thesis can also be referred to as payment behaviour models since the dependent variable used is payment behaviour.

The assumption is then only the variable provincial GDP per capita (thus $X_1 = \text{provincial GDP per capita}$) is selected from the five example independent variables as a good predictor for payment behaviour.

The linear regression model resulting from applying Equation 5.2 is:

$$\hat{Y}_i = B_0 + B_1 X_{i1} \quad (5.3)$$

($i = 1$ to n where n is the total number of cases)

or

$$\hat{Y}_i = B_0 - B_1(\text{provincial GDP per capita}_i) \quad (5.4)$$

(assuming $B_1 = -1$)

The interpretation is: the higher the provincial GDP per capita, the lower the value of the dependent variable. This can be interpreted as follows: the higher the provincial GDP per capita of a department, the better the payment behaviour and thus the better the quantitative part of a department's credit rating.

Note that in the case of this thesis the focus is not on the numerical value resulting from the linear regression model, but on the relative ranking of the departments based on the resulting expected future payment behaviours.

This method will be used in Chapters 6 and 7 to develop linear regression models based on the data discussed in Sections 5.4 and 5.5. The resulting linear regression models could be used to predict credit ratings for South Africa's subnationals, specifically the Department of Health and Education. The data discussed in the other parts of this chapter contained only quantitative information. Any linear regression models based on these data could be used in future to derive only the quantitative part of a credit rating. This will typically equate to 30% of the final rating, the other 70% of the rating will be based on qualitative information.

5.7 Summary

This chapter reviewed the data and methodology that will be used in the subsequent chapters to develop the quantitative parts of subnational credit rating methodologies for South Africa's subnationals. Section 5.2 documented general information regarding the data used and Section 5.3 the methodology used. Sections 5.4 and 5.5 paid special attention to the dependent and independent variables. Section 5.6 explained how linear regression modelling relates to credit rating methodologies.

In summary, five years of data were gathered from six different sources. This summed to a total number of 124 different reports and one interactive dataset. The data over five years equate to 45 data points per department and 90 when combining the data of two departments. The construction of the datasets was an secondary objective of the thesis.

The investigation regarding available data revealed that the number of departments per provincial government differ. In theory it should be possible to aggregate the data onto a provincial level to develop a provincial level subnational credit rating methodology, but in practice the unequal number of departments will pose difficulty with regard to the aggregation of the data. Another key finding is that most of the data used are only made available once a year. However, it is preferred that these are made available regularly, for example quarterly, because credit ratings have to be updated on a regular basis to adjust for changing risk situations. The last observation drawn from this investigation was that the formats of some of the reports used are non-static, this may pose problems with regard to the future usage of the developed credit rating methodologies.

These datasets, as well as the methodology discussed, will be applied in Chapters 6 and 7 to derive a number of different linear regression models that could be used as credit rating methodologies within the South African subnational context. Again, the resulting models will contain just quantitative information and therefore can only be viewed as the quantitative part of a credit rating methodology. Note that linear regression models will be developed for each of the datasets, thus models will be developed for the Department of Health and Education, as well as for the two Departments together.

Chapter 6

MODEL DEVELOPMENT AND RESULTS

6.1 Introduction

Typically credit rating methodologies comprise of 30% quantitative factors and 70% qualitative factors. The goal of this chapter is to develop linear regression models for the Department of Health and the Department of Education, focussing specifically on the quantitative factors that could be used to develop credit rating methodologies for South African provincial departments.

Chapter 5 explained the six different datasets used in this part of the study. In brief, data were collected for the Department of Health and Department of Education. The data were also pooled into a Combined dataset. Each dataset was adjusted to deliver a dataset with time included as an independent variable (HT, ET and CT) and without time (H, E and C). Linear regression models were developed for each of these six datasets, where the dependent variable used is a proxy for payment behaviour.

In order to apply linear regression modelling to the data, the following steps were followed. Firstly, variable clustering was performed to deal with multicollinearity among the independent variables. The next step was to deal with irrelevant independent variables by using scatterplots of Spearman's correlation vs Hoeffding's D ranks. Finally, linear regression modelling based on four different variable selection techniques were used to develop the payment behaviour models. The data analysis and output was generated using the SAS Institute Inc. (2011) software. Note that one methodology will be used but a number of different models will be developed.

The results of each dataset are presented separately in the remainder of this chapter, Sections 6.2 to 6.3 contain the results from the two Health datasets, Sections 6.4 to 6.5 contain the results from the Education datasets and Sections 6.6 to 6.7 contain that of the Combined datasets. Section 6.8 provides a summary of all the results and concludes the chapter.

It should be noted that the ultimate aim of these models is not to predict a department's numerical value of the dependent variable. The goal is to rank the departments' expected future payment behaviours with regard to each other based on these values.

6.2 Health with time dataset (HT)

The HT data comprises 45 data points and 41 independent variables. Multicollinearity and irrelevancy had to be dealt with before the linear regression models were developed. The number of independent variables will decrease as a result of this.

6.2.1 Variable clustering

As was mentioned previously, variable clustering was used to deal with multicollinearity among the independent variables. The Varclus procedure of the SAS Institute Inc. (2011) software was used to perform the analysis.

One variable was chosen from each cluster of variables as the cluster representative. The decision was either based on the lowest R^2 Ratio, thus having a high correlation with its own cluster, but low correlations with rest of the clusters. Alternatively, the decision was based on subject knowledge. This approach is recommended by Sanche and Lonergan (2006).

For the purposes of this study subject knowledge was based on aiming to include independent variables that represent all four broad factors identified by the literature (refer to Section 3.4.4 for a discussion of the four broad factors) in the final model.

The only exception was the time variable. The time variable was chosen as the cluster representative regardless of the other variables R^2 Ratios and broad factors. This is only applicable to the HT, ET and CT datasets.

The results of the variable clustering of the HT dataset, the variable chosen, the factor it represents and the reason for choosing the specific variable are presented in Table 6.1.

Cluster	Variables*	1 – R^2_{ratio}	Chosen variable	Broad factor of chosen variable	Reason
Cluster 1	Ind_Gau ln_x57 ln_x60	0.44 0.31 0.09	ln_x60	Economic conditions	Lowest R-Square Ratio
Cluster 2	ln_x3 ln_x8 ln_x33 ln_x34	0.06 0.53 0.06 0.06	ln_x33	Fiscal performance	Lowest R-Square Ratio
Cluster 3	ln_x31 ln_x32 ln_x64	0.29 0.18 0.37	ln_x64	Economic conditions	Subject knowledge (Broad factor)
Cluster 4	time ln_x63 ln_x65	0.24 0.05 0.07	time		Health with time model
Cluster 5	Ind_NW Ind_x36_Z	0.06 0.05	Ind_x36_Z	Fiscal performance	Lowest R-Square Ratio
Cluster 6	ln_x48 ln_x49 ln_x50	0.00 0.00 0.00	ln_x50	Fiscal performance	Lowest R-Square Ratio
Cluster 7	ln_x29 ln_x30	0.04 0.06	ln_x29	Fiscal performance	Lowest R-Square Ratio

*Variable names have been shortened due to visibility constraints.

Cluster	Variables*	$1 - R_{ratio}^2$	Chosen variable	Broad factor of chosen variable	Reason
Cluster 8	Ind_WC ln_x4 ln_x9 ln_x41 ln_x61	0.48 0.20 0.25 0.31 0.59	ln_x61	Economic conditions	Subject knowledge (Broad factor)
Cluster 9	x27_group ln_x28_Zm	0.28 0.28	ln_x28_Zm	Fiscal performance	Lowest R-Square Ratio
Cluster 10	ln_x39	0.00	ln_x39	Fiscal performance	Only one variable - no choice necessary
Cluster 11	Ind_FS	0.00	Ind_FS		Only one variable - no choice necessary
Cluster 12	Ind_Lim	0.00	Ind_Lim		Only one variable - no choice necessary
Cluster 13	Ind_KZN	0.00	Ind_KZN		Only one variable - no choice necessary
Cluster 14	ln_x58 ln_x59	0.01 0.02	ln_x58	Economic conditions	Lowest R-Square Ratio
Cluster 15	Ind_Mpu	0.00	Ind_Mpu		Only one variable - no choice necessary
Cluster 16	Ind_EC	0.00	Ind_EC		Only one variable - no choice necessary
Cluster 17	Ind_NC Ind_x28_Z ln_x36_Zm x52	0.46 0.35 0.66 0.69	x52	Management quality and institutional strength	Subject knowledge (Broad factor)
Cluster 18	ln_x13	0.00	ln_x13	Financial and debt position	Only one variable - no choice necessary
Cluster 19	ln_x14	0.00	ln_x14	Financial and debt position	Only one variable - no choice necessary

Table 6.1: *Variable clustering results of the HT dataset*

This resulted in 19 variables, representing all four broad factors, which will be used for the rest of the analysis.

6.2.2 Ranks of Spearman correlation vs. Hoeffding's D

The Corr procedure of the SAS Institute Inc. (2011) software was used to create a scatter plot of the ranks of the Spearman's correlation coefficients of each independent variable with the dependent variable vs. ranks of Hoeffding's Ds for each independent variable with the dependent variable. This was used to identify irrelevant variables, see Section 5.3.7 for more detail.

The variables indicated in the upper right hand corner, ln_x13 and Indicator_EC, were omitted from further analysis based on the fact that both statistics indicated that they had high ranks and thus low correlations with the dependent variable (Figure 6.1).

The variables in the upper left corner, ln_x64, ln_x61 and ln_x39, required further investigation due to the discrepancy between the low correlations indicated by the high Spearman correlation ranks and the high correlations indicated by the low Hoeffding's D ranks. This may indicate a non-linear relationship, (SAS Institute Inc., 2010). Different transformations were applied to these variables to linearise the possible non-linear relationships, but no effective transformation could be found. These variables were also excluded from the rest of the analysis.

This step decreased the number of possible independent variables to 14.

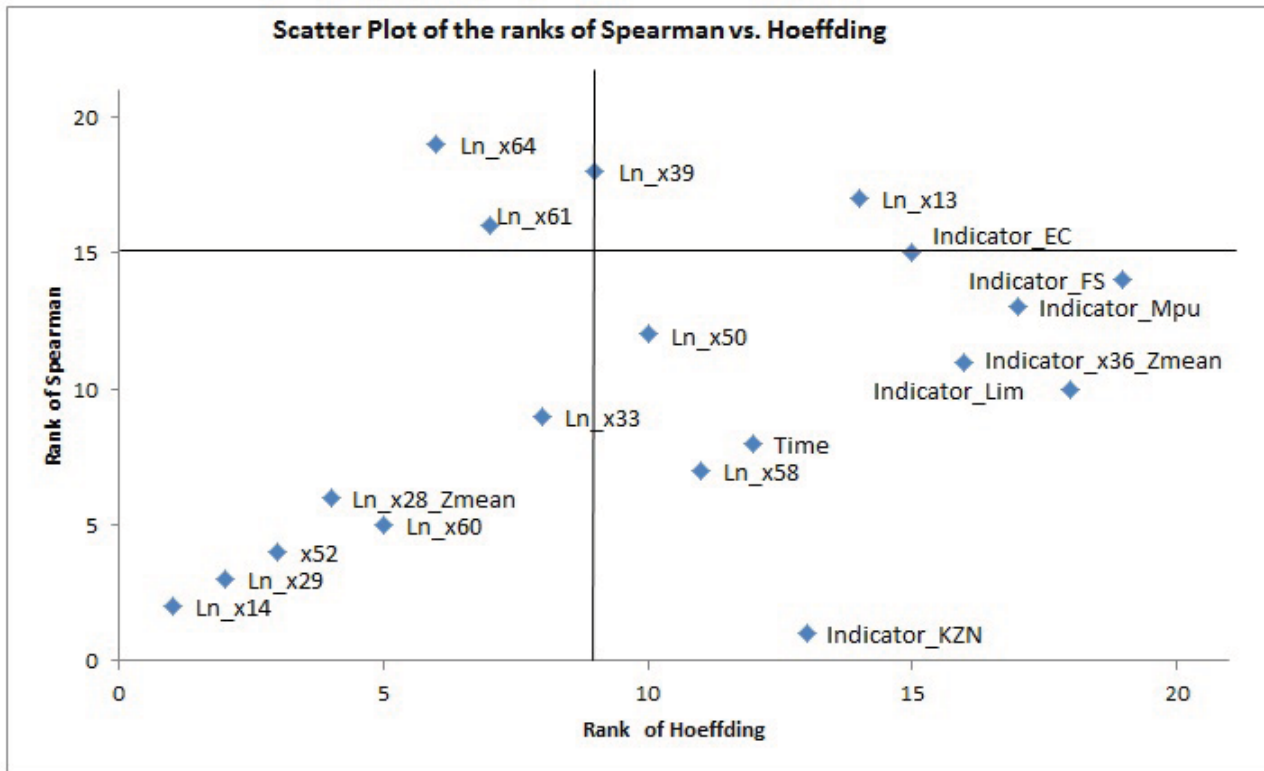


Figure 6.1: Scatterplot of Spearman correlations and Hoeffding's D ranks of the HT dataset

6.2.3 Linear regression models

As discussed in Section 5.3.3, four different variable selection techniques were used to choose the final independent variables from the variables that remained after multicollinearity and irrelevancy were dealt with. The variable selection techniques used were stepwise selection, forward addition, backward elimination and best subset. Note that a significance level of 0.1 was set for these variable selection techniques. The analyses were performed by using the Reg procedure of the SAS Institute Inc. (2011) software.

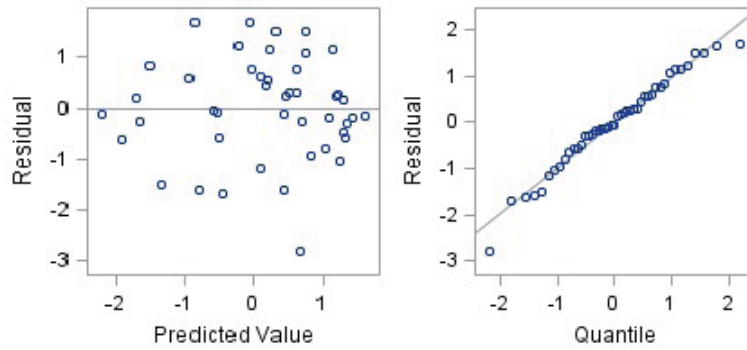
The dependent variable is a proxy of payment behaviour and is expressed as a ratio of accruals in excess of 30 days, divided by total expenditure. A high value indicates bad payment behaviour since it points to a large portion of total expenditure that is still outstanding after 30 days. The lower the value of this ratio, the better the payment behaviour since, this indicates that the accruals 30 days plus is proportionally lower than the total expenditure. An increase in this ratio indicates worsening payment behaviour and a decrease indicates improving payment behaviour, see Section 5.4 for more detail on the dependent variable.

In the case of the HT dataset the four variable selection techniques resulted in exactly the same model. The details of this model is discussed next.

Stepwise, forward, backward and best subset

R-Square	0.51
Adjusted R-Square	0.45

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	-1.06	0.00	0.30	0.00
Indicator_KZN	1 = KwaZulu-Natal, 0 = all other provinces	-2.74	-0.62	<.0001	1.09
ln_x28_Zmean	ln (departmental own revenue to total departmental revenue) (missing mean)	0.34	0.31	0.01	1.14
Indicator_Mpu	1 = Mpumalanga, 0 = all other provinces	-1.32	-0.30	0.01	1.09
Indicator_Lim	1 = Limpopo, 0 = all other provinces	-1.18	-0.27	0.03	1.08
ln_x58	ln (provincial GDP per capita growth)	0.90	0.24	0.04	1.02

Table 6.2: *Linear regression results of the HT dataset*Figure 6.2: *Scatter plot and normality plot of the residuals of the HT dataset's linear regression model*

This resulted in the following model:

$$\begin{aligned}
 \hat{Y}_i = & -1.06 - 2.74(\text{Indicator_KZN}_i) + 0.34(\ln_x28_Zmean_i) \\
 & -1.32(\text{Indicator_Mpu}_i) - 1.18(\text{Indicator_Lim}_i) \\
 & + 0.09(\ln_x58_i)
 \end{aligned} \tag{6.1}$$

(where $i = 1, 2, \dots, 9$)

The model has an R^2 of 0.51, thus it explains 51% of the variance of the dependent variable. The R^2 adjusted for the number of parameters within the model is 0.45 (Table 6.2).

The independent variables, excluding the intercept, are sorted according to importance based on the absolute values of the standardised parameter estimates. The most influential variable is Indicator_KZN.

All the p-values of the five independent variables chosen for this model are below 0.1.

The VIFs of the variables range between 1.02 and 1.09, well below the guideline value of 10 suggested by Hair et al. (2006) as discussed in Section 5.3.6.

The interpretation of the independent variables' effects on the dependent variable is documented next. This is based on their parameter estimates. An independent variable's parameter estimate indicates the change in the dependent variable per one unit increase of the corresponding independent variable when the other independent variables are held constant (Kutner et al., 2005). Therefore, when explanations are provided for parameter estimates, it will be assumed that all other variables remain constant.

The negative signs of the parameter estimates of Indicator_KZN, Indicator_Mpu and Indicator_Lim indicate that the Health Departments of KwaZulu-Natal, Mpumalanga and Limpopo are better payers than the other provinces' Departments of Health.

As $\ln_x28.Zmean$ (departmental own revenue to total departmental revenue) increases, the payment behaviour of the departments worsen. This is indicated by the parameter estimate of 0.34. A possible explanation is that departmental own revenue is a more volatile source of income than income received directly from national government, depending on the original source of the departmental own revenue. Fitch (2011b) also reviews revenue sources in terms of volatility, diversity and predictability and states that reliance on economically sensitive revenue leads to a credit concern. Thus, if departmental own revenue is generated from an economically sensitive activity, an increase would influence payment behaviour negatively.

The positive parameter estimate of GDP per capita growth ($\ln_x58$) indicates that an increase in GDP per capita growth will worsen payment behaviour when considering this model. This contradicts Moody's (2008a), who states that a high regional GDP per capita is considered a credit positive. However, the growth in GDP can be caused by a decrease in the number of residents in the province, thus the tax base or income base is shrinking and less money is available to repay creditors. This is supported by various other authors (Fitch, 2011b; S&P, 2010; AustraliaRatings, 2014).

The normality, linearity and homoscedasticity assumptions of a linear regression model can be tested by means of a scatterplot and a normality plot of the residuals. Refer to Section 5.3.8 for a detailed discussion on the assumptions of linear regression modelling. It is evident from Figure 6.2 that the linear regression model resulting from the HT dataset met the assumptions.

6.3 Health without time dataset (H)

The H data comprise 45 data points, but one less independent variable than the previous dataset since the time variable was excluded from the H dataset. Thus, 40 independent variables were available for modelling purposes.

6.3.1 Variable clustering

Variable clustering was used to deal with multicollinearity among the 40 independent variables. The variable clustering results of the H dataset, the variable chosen, the factor it represents and the reason for choosing the specific variable are presented in Table 6.3.

Cluster	Variables*	$1 - R_{ratio}^2$	Chosen variable	Broad factor of chosen variable	Reason
Cluster 1	Ind_WC ln_x4 ln_x9 ln_x41	0.43 0.18 0.28 0.39	ln_x4	Fiscal performance	Lowest R-Square Ratio
Cluster 2	ln_x32 ln_x36_Zm ln_x64	0.29 0.60 0.36	ln_x64	Economic conditions	Subject knowledge (Broad factor)
Cluster 3	ln_x3 ln_x8 ln_x33 ln_x34	0.06 0.54 0.06 0.06	ln_x33	Fiscal performance	Lowest R-Square Ratio
Cluster 4	ln_x63 ln_x65	0.01 0.01	ln_x65	Economic conditions	Subject knowledge (Broad factor)
Cluster 5	ln_x48 ln_x49 ln_x50	0.00 0.00 0.00	ln_x50	Fiscal performance	Lowest R-Square Ratio
Cluster 6	Ind_NW Ind_x36_Z	0.06 0.06	Ind_x36_Z	Fiscal performance	Lowest R-Square Ratio
Cluster 7	ln_x58 ln_x59	0.01 0.02	ln_x58	Economic conditions	Lowest R-Square Ratio
Cluster 8	ln_x29 ln_x30 ln_x31	0.24 0.01 0.72	ln_x30	Fiscal performance	Lowest R-Square Ratio
Cluster 9	Ind_Mpu ln_x13 ln_x14	0.44 0.39 0.34	ln_x14	Financial and debt position	Lowest R-Square Ratio
Cluster 10	Ind_Gau ln_x57 ln_x60 ln_x61	0.44 0.31 0.16 0.71	ln_x60	Economic conditions	Lowest R-Square Ratio
Cluster 11	Ind_KZN	0.00	Ind_KZN		Only one variable - no choice necessary
Cluster 12	Ind_EC	0.00	Ind_EC		Only one variable - no choice necessary
Cluster 13	Ind_Lim	0.00	Ind_Lim		Only one variable - no choice necessary
Cluster 14	ln_x28_Zm	0.00	ln_x28_Zm	Fiscal performance	Only one variable - no choice necessary
Cluster 15	x27_group	0.00	x27_grouped	Fiscal performance	Only one variable - no choice necessary
Cluster 16	ln_x39	0.00	ln_x39	Fiscal performance	Only one variable - no choice necessary
Cluster 17	Ind_FS	0.00	Ind_FS		Only one variable - no choice necessary
Cluster 18	Ind_NC Ind_x28_Z x52	0.42 0.30 0.61	x52	Management quality and institutional strength	Subject knowledge (Broad factor)

Table 6.3: Variable clustering results of the H dataset

This resulted in 18 variables that will be used for the rest of the analysis.

6.3.2 Ranks of Spearman correlation vs. Hoeffding's D

The scatter plot of the ranks of the Spearman's correlation coefficients vs. Hoeffding's Ds for each of the remaining 18 independent variables with the dependent variable is shown in Figure 6.3. This was used to deal with irrelevant independent variables.

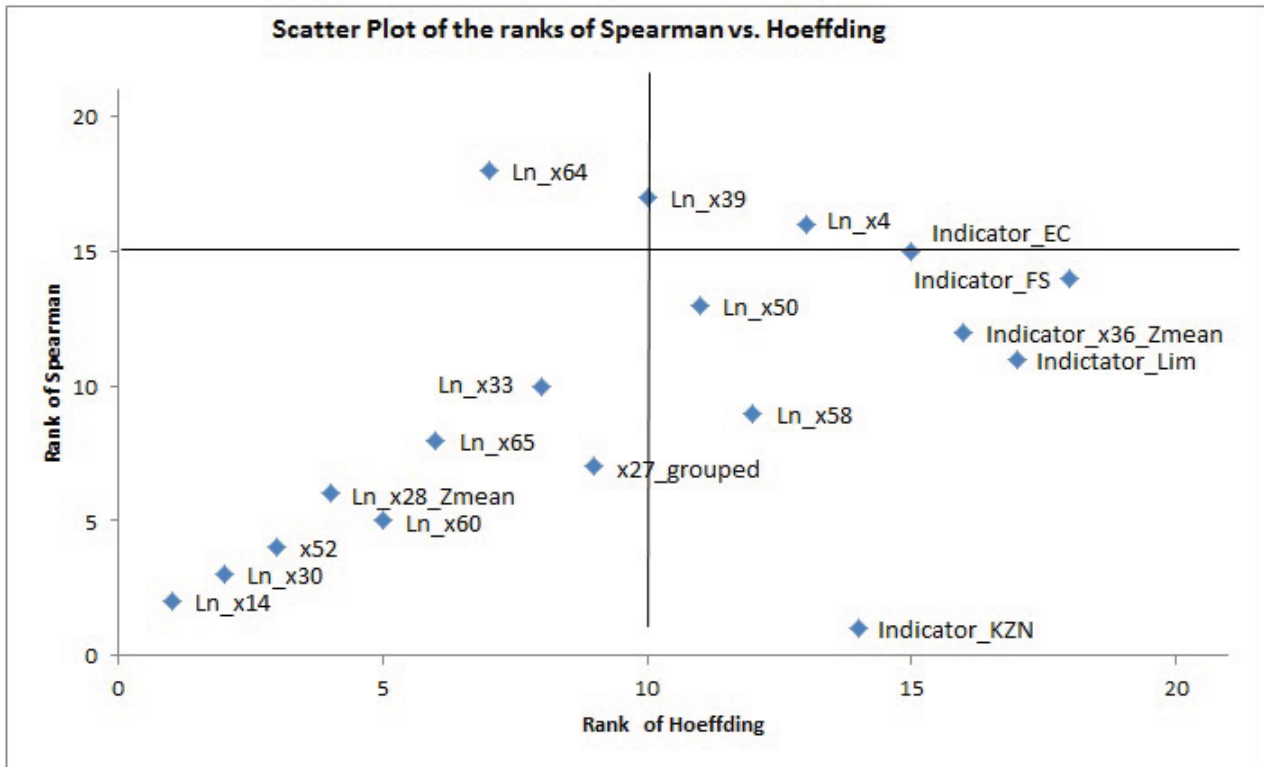


Figure 6.3: Scatterplot of Spearman correlation and Hoeffding's D ranks of the H dataset

Variables `ln_x4` and `Indicator_EC` were omitted from further analysis based on the fact that both statistics indicated that they had high ranks and thus low correlations with the dependent variable.

When considering the scatterplot the variables in the upper left corner, `ln_x64` and `ln_x39`, required further investigation due to the discrepancy of low correlations indicated by the high Spearman ranks and the high correlations indicated by the low Hoeffding's D ranks, as this may indicate a non-linear relationship. None of the transformations that were applied to linearise these possible non-linear relationships were effective. These variables will also be excluded going forward.

This decreased the number of independent variables available for modelling purposes to 14.

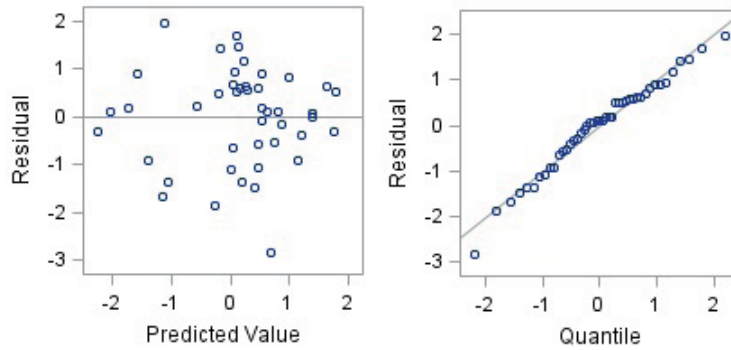
6.3.3 Linear regression models

The stepwise and forward selection techniques resulted in the same linear regression model and the other two methods resulted in another regression model. The details of these two models are discussed next.

Stepwise and forward

R-Square	0.49
Adjusted R-Square	0.44

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	-2.33	0.00	0.16	0.00
Indicator_KZN	1 = KwaZulu-Natal, 0 = all other provinces	-2.59	-0.58	<.0001	1.13
x27_grouped	departmental annual appropriation of revenue to total departmental revenue (grouped)	-0.56	-0.33	0.01	1.11
Indicator_Lim	1 = Limpopo, 0 = all other provinces	-1.35	-0.30	0.01	1.08
ln_x14	ln (departmental capital expenditure to total provincial capital expenditure)	0.88	0.22	0.08	1.12

Table 6.4: *Stepwise and forward regression model of the H dataset*Figure 6.4: *Dataset H's stepwise and forward model's residual plots*

The equation of this model is:

$$\hat{Y}_i = -2.33 - 2.59(\text{Indicator_KZN}_i) - 0.56(\text{x27_grouped}_i) - 1.35(\text{Indicator_Lim}_i) + 0.88(\ln_x14_i) \quad (6.2)$$

The R^2 of 0.49 indicates that the model explains 49% of the variance of the dependent variable. The R^2 adjusted for the number of parameters within the model is lower at 0.44.

When considering the absolute values of the standardised parameter estimates, the independent variable Indicator_KZN is the most influential variable (Table 6.4). This corresponds to the results of the HT dataset.

The highest p-value (ignoring the intercept) is 0.08 and the highest VIF is 1.13, well below the guideline values of 0.1 and 10 respectively.

The interpretation of independent variables and their effect on the dependent variable are documented next. Again, one variable at a time will be explained and it will be assumed that the other variables remain constant.

The parameter estimates of variables `Indicator_KZN` and `Indicator_Lim`, -2.59 and -1.35 respectively, indicate that these provinces' Departments of Health are better payers than the other provinces.

As departmental annual appropriation of revenue to total departmental revenue (`x27_grouped`) increases the payment behaviour of the department improves. This is indicated by the negative parameter estimate of -0.56. One explanation is that revenue received directly from national government is unwavering, as opposed to some sources of own departmental revenue. As stated earlier, Fitch (2011b) also takes the volatility, diversity and predictability of revenue sources into account, since overdependence on a volatile source would influence payment behaviour in a negative manner. Consequently, a higher proportion of departmental annual appropriation of revenue would influence payment behaviour in a positive manner since it is considered an unwavering source of revenue.

An increase in the ratio departmental capital expenditure to total provincial expenditure, `ln_x14`, leads to a deterioration of payment behaviour. One possible reason for the increase in the ratio is an increase in the department's capital expenditure. If this is the case, payment behaviour could be affected negatively since capital expenditure is a long term commitment and therefore may have an undesirable impact on future expenditure flexibility.

The random and evenly dispersed points on the scatter plot indicate that the model met the underlying assumptions of linearity and homoscedasticity. The residuals are normally distributed (Figure 6.4).

Backward and best subset

R-Square	0.54
Adjusted R-Square	0.48

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	0.07	0.00	0.92	0.00
Indicator_KZN	1 = KwaZulu-Natal, 0 = all other provinces	-2.43	-0.55	<.0001	1.17
x27_grouped	departmental annual appropriation of revenue to total departmental revenue (grouped)	-0.69	-0.41	<0.01	1.13
Indicator_Lim	1 = Limpopo, 0 = all other provinces	-1.22	-0.27	0.02	1.02
Indicator_x36_Z	0 if departmental net assets = 0, 1 if departmental net assets >0	-1.11	-0.27	0.03	1.15
x52	quality of department's financial reports	0.48	0.24	0.04	1.14

Table 6.5: *Backward and best subset regression model of the H dataset*

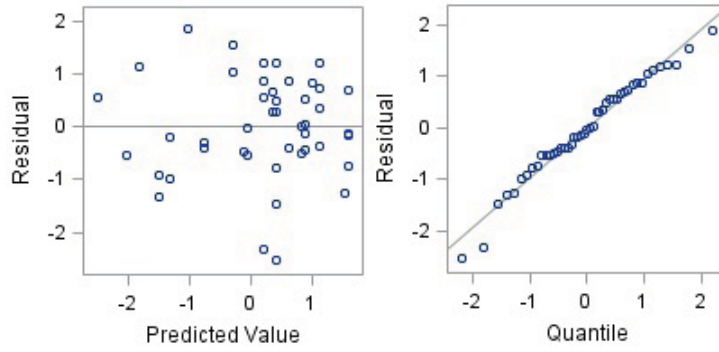


Figure 6.5: *Residual plots of the H dataset's backward and best subset model*

This resulted in the following model:

$$\begin{aligned} \hat{Y}_i = & 0.07 - 2.43(\text{Indicator_KZN}_i) - 0.69(x27_grouped_i) - \\ & 1.22(\text{Indicator_Lim}_i) - 1.11(\text{Indicator_x36_Zmean}_i) + 0.48(x52_i) \end{aligned} \quad (6.3)$$

The R^2 and adjusted R^2 of this model are marginally higher, at 0.54 and 0.48, than the previous model's. This is to be expected since this model includes five independent variables as opposed to the four of the previous model.

Indicator_KZN is the most influential variable included in this model as well.

All the p-values are below the cut-off of 0.1. The low VIFs indicate that no multicollinearity exist among the five independent variables.

As in the previous model, the variables Indicator_KZN and Indicator_Lim are included in the final model. Although the parameter estimates, -2.43 and -1.22, differ slightly from the previous model's, the interpretations stays the same. These provinces' Departments of Health are better payers than the other provinces'.

The same logic applies for the parameter estimate and interpretation of x27.grouped, which was also included in the previous model. As departmental annual appropriation of revenue to total departmental revenue increases, the payment behaviour of the department improves.

The negative parameter estimate of Indicator_x36_Z reflects that departments with net assets are better payers than departments without net assets. Generally the existence of net assets, i.e. assets exceed liabilities, indicates good financial management and thus departments with net assets will be in a better position to do repayments in a timely manner. AustraliaRatings (2014) also review assets management as part of their financial management strategy assessment.

The parameter estimate of 0.48 of x52 (quality of department's financial reports) shows that as the quality of financial reporting worsens, the departments payment behaviour also worsens (1 = clean audit, 2 = financially unqualified audit opinion, 3 = qualified audit opinion or 4 = adverse audit opinion and disclaimer of audit opinion). Good financial reporting indicates good financial management. Three other rating agencies also examine the quality, transparency, level of detail, timeliness, frequency and audit opinion of a subnational's financial reports (Moody's, 2008a; S&P, 2010; DBRS, 2011).

It is evident from Figure 6.5 that this model adheres to the underlying assumptions of linear regression modelling.

6.4 Education with time dataset (ET)

The ET data contain 45 data points and 41 independent variables, the same as the HT dataset. The number of independent variables will decrease once multicollinearity and irrelevancy have been dealt with.

6.4.1 Variable clustering

Refer to Table 6.6 for the results of the ET dataset's variable clustering. One variable was chosen from each cluster of variables as the cluster representative based on lowest R^2 ratio or subject knowledge. The only exception was the time variable. The time variable was chosen as the cluster representative regardless of the other variables R^2 ratios and broad factors.

Cluster	Variables*	1 – R^2_{ratio}	Chosen variable	Broad factor of chosen variable	Reason
Cluster 1	ln_x4 ln_x9 ln_x31 ln_x41 ln_x57 ln_x60 ln_x61	0.16 0.26 0.51 0.53 0.35 0.42 0.50	ln_x57	Economic conditions	Subject knowledge (Broad factor)
Cluster 2	time ln_x63 ln_x64 ln_x65	0.53 0.07 1.34 0.09	time		Education with time model
Cluster 3	ln_x48 ln_x49 ln_x50	0.00 0.00 0.00	ln_x50	Fiscal performance	Lowest R Square Ratio
Cluster 4	ln_x3 ln_x8 ln_x33 ln_x34	0.14 0.46 0.11 0.09	ln_x34	Fiscal performance	Lowest R Square Ratio
Cluster 5	Ind_Mpu ln_x29 ln_x36_Zm	0.19 0.73 0.40	ln_x36_Zm	Fiscal performance	Subject knowledge (Broad factor)
Cluster 6	ln_x14 ln_x32	0.16 0.12	ln_x14	Financial and debt position	Subject knowledge (Broad factor)
Cluster 7	Ind_NW Ind_x28_Z	0.41 0.35	Ind_x28_Z		Lowest R Square Ratio
Cluster 8	ln_x58 ln_x59	0.01 0.01	ln_x58	Economic conditions	Lowest R Square Ratio
Cluster 9	Ind_FS	0.00	Ind_FS		Only one variable - no choice necessary
Cluster 10	Ind_EC x52	0.32 0.34	x52	Management quality and institutional strength	Subject knowledge (Broad factor)
Cluster 11	Ind_KZN	0.00	Ind_KZN		Only one variable - no choice necessary
Cluster 12	x27_group ln_x28_Zm	0.42 0.36	ln_x28_Zm	Fiscal performance	Lowest R Square Ratio
Cluster 13	Ind_x36_Z	0.00	Ind_x36_Z	Fiscal performance	Only one variable - no choice necessary
Cluster 14	ln_x13	0.00	ln_x13	Financial and debt position	Only one variable - no choice necessary

Cluster	Variables*	$1 - R_{ratio}^2$	Chosen variable	Broad factor of chosen variable	Reason
Cluster 15	Ind_NC	0.00	Ind_NC		Only one variable - no choice necessary
Cluster 16	Ind_Gau	0.00	Ind_Gau		Only one variable - no choice necessary
Cluster 17	Ind_WC	0.00	Ind_WC		Only one variable - no choice necessary
Cluster 18	ln_x30	0.00	ln_x30	Fiscal performance	Only one variable - no choice necessary
Cluster 19	Ind_Lim	0.00	Ind_Lim		Only one variable - no choice necessary
Cluster 20	ln_x39	0.00	ln_x39	Fiscal performance	Only one variable - no choice necessary

Table 6.6: Variable clustering results of the ET dataset

Variable clustering resulted in 20 independent variables that represent all four broad factors (Table 6.6). These 20 variables will be used for the rest of the analysis.

6.4.2 Ranks of Spearman correlation vs. Hoeffding's D

Figure 6.6 presents the results of the scatter plot of the ranks of the Spearman's correlation coefficients of each independent variable with the dependent variable vs. ranks of Hoeffding's Ds for each independent variable with the dependent variable.

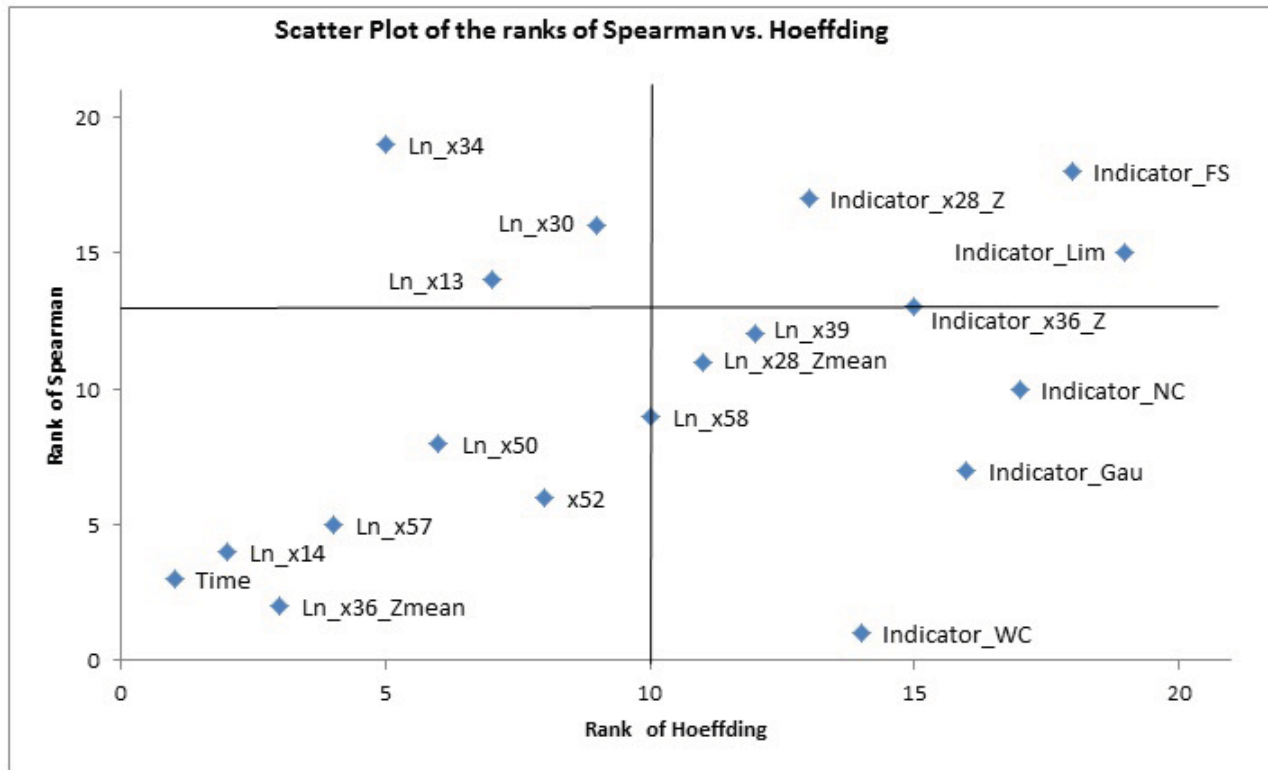


Figure 6.6: Scatterplot of Spearman correlation and Hoeffding's D ranks of the ET dataset

Based on both statistics showing that variables Indicator_FS, Indicator_x28.Z, Indicator_Lim and Indicator_x36.Z had high ranks and thus low correlations with the dependent variable, they were excluded from further analysis.

Variable $\ln_x34$, $\ln_x30$ and $\ln_x13$ required further investigation due to the possible non-linear relationships with the dependent variable. Different transformations were applied to linearise the possible non-linear relationships, but no effective transformation could be found. These variables were also omitted from the rest of the analysis.

This step decreased the number of possible independent variables to 13.

6.4.3 Linear regression models

In the case of the ET dataset the four variable selection techniques resulted in exactly the same model. The detail of this model is discussed next.

Stepwise, forward, backward and best subset

R-Square	0.48
Adjusted R-Square	0.43

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	12.77	0.00	0.03	0.00
Indicator_Gau	1 = Gauteng, 0 = all other provinces	1.76	0.46	<0.01	1.46
$\ln_x36_Zmean$	$\ln$ (departmental net assets to departmental total expenditure) (missing mean)	-0.72	-0.42	<0.01	1.11
$\ln_x57$	$\ln$ (provincial GDP per capita)	-1.34	-0.38	0.02	1.82
time	time	-0.21	-0.25	0.06	1.31

Table 6.7: *Linear regression model resulting from the ET dataset*

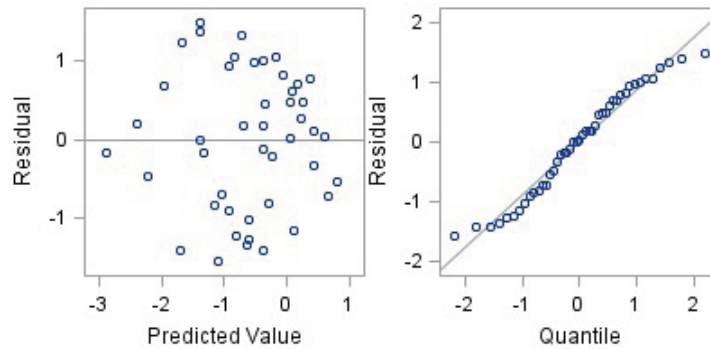


Figure 6.7: *The residual plots of the ET dataset's linear regression model*

This resulted in the following model:

$$\begin{aligned}\hat{Y}_i = & 12.77 + 1.76(Indicator_Gau_i) - 0.72(\ln_x36_Zmean_i) - \\ & 1.34(\ln_x57_i) - 0.21(time_i)\end{aligned}\quad (6.4)$$

(where $i = 1, 2, \dots, 9$)

The model has an R^2 of 0.48, which means that it explains less than 50% of the variance of the dependent variable. The R^2 adjusted for the number of parameters within the model is 0.48.

As before, the independent variables, excluding the intercept, are sorted according to importance based on the absolute values of the standardised estimates. The most important variable is the indicator used to identify Gauteng's Department of Education (Table 6.7).

The highest p-value of the independent variables chosen for this model is 0.06. The VIFs of the variables all are below two, thus well below the guideline of 10.

It is assumed that all other variables remain constant when a specific independent variable's effect on the dependent variable is explained.

The positive parameter estimate of 1.76 indicates that the Department of Education of Gauteng's payment behaviour are worse than the other provinces' Departments of Education.

The negative parameter estimate of -0.72 of $\ln_x36_Zmean$ illustrates that an increase in the ratio of departmental net assets to departmental total expenditure leads to better credit repayment. Assuming that the increase in this ratio is caused by an increase in net assets, this phenomenon can be explained by the reasoning that good asset and liability management indicates good financial management. As was stated previously, AustraliaRatings (2014) also review assets management as part of their financial management strategy assessment.

An increase in GDP per capita ($\ln_x57$) will improve payment behaviour since this will lead to an increase in revenue, which could be used to repay creditors. This is confirmed by Moody's (2008a) who states that a high regional GDP per capita is considered a credit positive. However, this contradicts the effect of the GDP per capita growth variable ($\ln_x58$) included in the HT (Section 6.2) and C models (Section 6.7) where an increase in GDP per capita leads to worsening payment behaviour. The latter can be explained by a decreasing number of residents in the province instead of an increase in GDP. The smaller number of residents will lead to a smaller income base available to repay creditors.

When considering this model, payment behaviour improves as time passes. A possible explanation is that the departments learned from past mistakes and subsequently improved their financial management over time, including repayment of creditors. In Chapter 5 it was stated that the time variable will be added to the dataset and that normal linear regression modelling will be used instead of time series analysis. In the case of the ET dataset the time variable is included in the final linear regression model, but it is the least influential variable. In the next section (Table 6.9) a model will be developed without the time variable. This model's R^2 is 0.45, so a different set of independent variables (without time) can still explain 45% of the variance of the dependent variable.

Based on the overall shape of the scatterplot of the residuals and the closely aligned observed and expected values of the normality plot, it can be assumed that this model does meet the assumptions of linearity, homoscedasticity and normality (Figure 6.7).

6.5 Education without time dataset (E)

The E dataset comprise of 45 data points, but one less independent variable than the previous dataset since the time variable was excluded from the E dataset. Forty independent variables were available to develop a payment behaviour model.

6.5.1 Variable clustering

Variable clustering was used to deal with multicollinearity. The variable clustering results of the E dataset, the variable chosen, the factor it represents and the reason for choosing the specific variable are presented in Table 6.8.

Cluster	Variables*	1 – R^2_{ratio}	Chosen variable	Broad factor of chosen variable	Reason
Cluster 1	ln_x4 ln_x9 ln_x31 ln_x41 ln_x57 ln_x60 ln_x61	0.15 0.26 0.51 0.59 0.35 0.32 0.65	ln_x60	Economic conditions	Subject knowledge (Broad factor)
Cluster 2	ln_x3 ln_x8 ln_x33 ln_x34	0.14 0.50 0.11 0.09	ln_x34	Fiscal performance	Lowest R Square Ratio
Cluster 3	ln_x48 ln_x49 ln_x50	0.00 0.00 0.00	ln_x50	Fiscal performance	Lowest R Square Ratio
Cluster 4	ln_x14 ln_x32 ln_x64	0.28 0.13 0.27	ln_x14	Financial and debt position	Subject knowledge (Broad factor)
Cluster 5	ln_x63 ln_x65	0.00 0.00	ln_x65	Economic conditions	Subject knowledge (Broad factor)
Cluster 6	Ind_Mpu ln_x29 ln_x36_Zm	0.19 0.73 0.40	ln_x36_Zm	Fiscal performance	Subject knowledge (Broad factor)
Cluster 7	Ind_NW Ind_x28_Z	0.30 0.35	Ind_x28_Z	Fiscal performance	Subject knowledge (Broad factor)
Cluster 8	ln_x58 ln_x59	0.01 0.01	ln_x58	Economic conditions	Lowest R Square Ratio
Cluster 9	Ind_Gau Ind_x36_Z	0.32 0.29	Ind_x36_Z	Fiscal performance	Lowest R Square Ratio
Cluster 10	Ind_FS	0.00	Ind_FS		Only one variable - no choice necessary
Cluster 11	Ind_Lim	0.00	Ind_Lim		Only one variable - no choice necessary
Cluster 12	Ind_EC x52	0.32 0.34	x52	Management quality and institutional strength	Subject knowledge (Broad factor)
Cluster 13	ln_x13	0.00	ln_x13	Financial and debt position	Only one variable - no choice necessary
Cluster 14	Ind_NC	0.00	Ind_NC		Only one variable - no choice necessary
Cluster 15	Ind_WC	0.00	Ind_WC		Only one variable - no choice necessary
Cluster 16	x27_group ln_x28_Zm	0.42 0.36	ln_x28_Zm	Fiscal performance	Lowest R Square Ratio
Cluster 17	Ind_KZN	0.00	Ind_KZN		Only one variable - no choice necessary
Cluster 18	ln_x30	0.00	ln_x30	Fiscal performance	Only one variable - no choice necessary
Cluster 19	ln_x39	0.00	ln_x39	Fiscal performance	Only one variable - no choice necessary

Table 6.8: Variable clustering results of the E dataset

This resulted in 19 variables that will be used for the rest of the analysis.

6.5.2 Ranks of Spearman correlation vs. Hoeffding's D

The scatter plot of the ranks of the Spearman's correlation coefficients vs. Hoeffding's Ds for each of the remaining 19 independent variables with the dependent variable is shown in Figure 6.8. This was used to identify irrelevant variables.

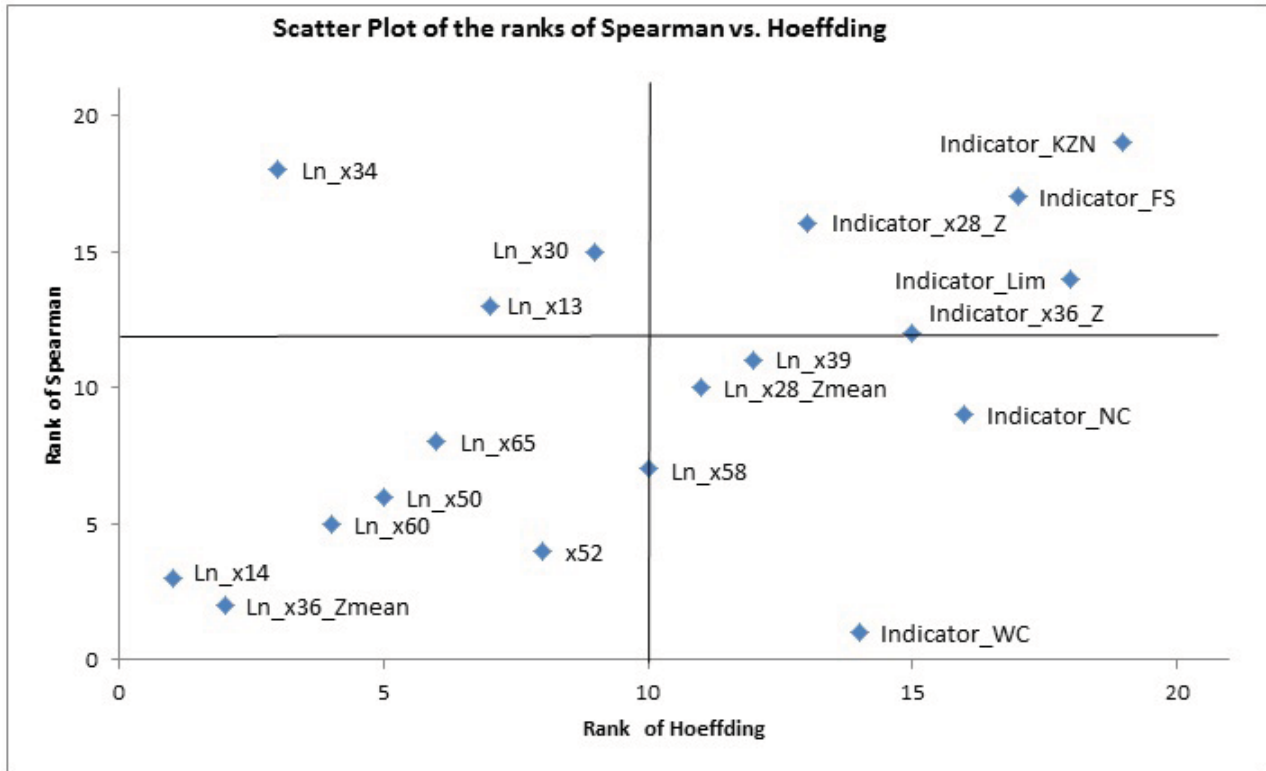


Figure 6.8: Scatterplot of Spearman correlation and Hoeffding's D ranks of the E dataset

Five independent variables were excluded from further analysis due to low correlations with the dependent variables. These were the variables in the upper right hand corner namely: Indicator_KZN, Indicator_FS, Indicator_x28_Z, Indicator_Lim and Indicator_x36_Z.

Variables ln_x34, ln_x30 and ln_x13 were also omitted from the rest of the analysis. Possible non-linear relationships with the dependent variable existed and none of the investigated transformations could rectify it. These variables were omitted from the rest of the analysis.

This left only 11 independent variables for the remaining analysis.

6.5.3 Linear regression models

The four variable selection techniques resulted in exactly the same model. The details of this model is discussed next.

Stepwise, forward, backward and best subset

R-Square	0.45
Adjusted R-Square	0.40

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	-3.75	0.00	0.00	0.00
ln_x36_Zmean	ln (departmental net assets to departmental total expenditure) (missing mean)	-0.87	-0.50	<0.01	1.27
ln_x65	ln (departmental total expenditure per capita)	-2.20	-0.49	<0.01	1.26
x52	quality of department's financial reports	0.52	0.32	0.01	1.08
ln_x14	ln (departmental capital expenditure to total provincial capital expenditure)	0.64	0.26	0.04	1.08

Table 6.9: *Linear regression model of the E dataset*

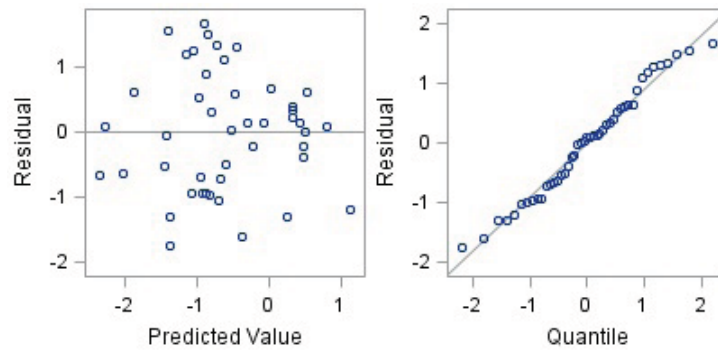


Figure 6.9: *E dataset's model's residual plots*

The formula of this model is:

$$\begin{aligned}\hat{Y}_i = & -3.75 - 0.87(\ln_x36_Zmean_i) - 2.20(\ln_x65_i) + \\ & 0.52(x52_i) + 0.64(\ln_x14_i)\end{aligned}\quad (6.5)$$

For this model the time variable has been omitted from the dataset. Compared to the ET model, this model's R^2 is slightly lower at 0.45 instead of 0.48. Thus this model is explaining 3% less of the variance of the dependent variable. The adjusted R^2 is 0.40 instead of 0.43 (Table 6.9). Note that the chosen independent variables differ considerably, only variable $\ln_36_Zmean$ was included in both models.

$\ln_x36_Zmean$ and $\ln_65$ are almost equally important when considering the absolute values of the standardised parameter estimates of the independent variables.

The p-values of all the independent variables were below 0.1. The two above-mentioned variables had the highest VIF, 1.27 and 1.26. These were still well below the guideline value.

The interpretation of independent variables and their effect on the dependent variable are documented next, one variable at a time, and it will be assumed that the other variables remained constant.

Note that no provincial indicators are included in this model; this indicates that none of the provinces' Departments of Education has been identified as either better or worse creditor repayers than the other provinces'.

As in the case of the previous model, $\ln_x36_Zmean$ is included in the final model. The parameter estimate differs slightly, but the interpretation stays the same. An increase in the ratio of departmental net assets to departmental total expenditure leads to improvement in credit repayment. Assuming that the increase in this ratio is caused by an increase in net assets, this phenomenon can be explained by good asset and liability management that indicates good financial management and thus payment behaviour.

Payment behaviour improves as departmental total expenditure per capita ($\ln_x65$) increases. An increase in total expenditure and a decrease in the number of residents will both lead to an increase in total expenditure per capita. This explanation focuses only on the decreasing number of residents. Literature revealed that an increase in population constitutes an increase in infrastructure needs (S&P, 2010; AustraliaRatings, 2014). Thus a decrease in population will constitute a decrease in infrastructure demands, freeing up some income to repay creditors.

The parameter estimate of 0.52 of $x52$ (quality of department's financial reports) shows that as the quality of financial reporting worsens, the departments payment behaviour also worsens (1 = clean audit, 2 = financially unqualified audit opinion, 3 = qualified audit opinion or 4 = adverse audit opinion and disclaimer of audit opinion). As was mentioned before, good financial reporting indicates good financial management. Thus good payment behaviour can be expected from a department with good quality financial reports.

Although the parameter estimate differs, the interpretation of departmental capital expenditure to total provincial expenditure ($\ln_x14$) stays the same as provided in Section 6.3.3 (stepwise and forward model). An increase in the ratio leads to a deterioration of payment behaviour. One possible reason for the increase in the ratio is an increase in the department's capital expenditure. If this is the case, payment behaviour could be affected negatively since capital expenditure is a long term commitment and therefore may have an undesirable impact on expenditure flexibility.

The linear regression model of the E dataset does not violate any of the linear regression modelling assumptions (Figure 6.9).

6.6 Combined with time dataset(CT)

The two datasets of Health and Education containing the time variable (HT and ET) were combined to form the Combined with time (CT) dataset. An additional indicator variable was added to the dataset, this was used to distinguish between the Department of Health and the Department of Education. Subsequently, this dataset comprises 90 data points and 42 independent variables.

Like with the previous datasets, multicollinearity and irrelevancy were dealt with first. These results are discussed next, followed by the linear regression results.

6.6.1 Variable clustering

Table 6.10 shows the CT dataset's variable clustering results. As previously, one variable was chosen from each cluster of variables as the cluster representative based on lowest R^2 ratio or subject knowledge. Again, the only exception was the time variable. The time variable was chosen as the cluster representative regardless of any other considerations.

Cluster	Variables*	1 – R^2_{ratio}	Chosen variable	Broad factor of chosen variable	Reason
Cluster 1	Ind_Dep ln_x4 ln_x9 ln_x29 ln_x30	0.07 0.33 0.08 0.11 0.13	Ind_Dep		Lowest R Square Ratio
Cluster 2	Ind_Gau ln_x57 ln_x60	0.39 0.33 0.09	ln_x60	Economic conditions	Lowest R Square Ratio
Cluster 3	ln_x48 ln_x49 ln_x50	0.00 0.00 0.00	ln_x50	Fiscal performance	Lowest R Square Ratio
Cluster 4	ln_x63 ln_x65	0.01 0.01	ln_x65	Economic conditions	Lowest R Square Ratio
Cluster 5	ln_x8 ln_x33 ln_x34	0.77 0.42 0.44	ln_x33	Fiscal performance	Lowest R Square Ratio
Cluster 6	Ind_Mpu ln_x36_Zm	0.30 0.33	ln_x36_Zm	Fiscal performance	Subject knowledge (Broad factor)
Cluster 7	Ind_WC ln_x41 ln_x61	0.36 0.24 0.50	ln_x61	Economic conditions	Subject knowledge (Broad factor)
Cluster 8	ln_x14 ln_x32 ln_x64	0.35 0.41 0.21	ln_x14	Financial and debt position	Subject knowledge (Broad factor)
Cluster 9	Ind_FS Ind_x28_Z	0.35 0.39	Ind_x28_Z		Subject knowledge (Broad factor)
Cluster 10	Ind_NC	0.00	Ind_NC		Only one variable - no choice necessary
Cluster 11	Ind_KZN	0.00	Ind_KZN		Only one variable - no choice necessary
Cluster 12	ln_x3	0.00	ln_x3	Fiscal performance	Only one variable - no choice necessary
Cluster 13	Ind_NW	0.00	Ind_NW		Only one variable - no choice necessary
Cluster 14	Ind_EC x52	0.34 0.37	x52	Management quality and institutional strength	Subject knowledge (Broad factor)
Cluster 15	ln_x58	0.00	ln_x58	Economic conditions	Only one variable - no choice necessary
Cluster 16	ln_x13	0.00	ln_x13	Financial and debt position	Only one variable - no choice necessary
Cluster 17	ln_x31	0.00	ln_x31	Fiscal performance	Only one variable - no choice necessary
Cluster 18	Ind_Lim	0.00	Ind_Lim		Only one variable - no choice necessary

Cluster	Variables*	$1 - R_{ratio}^2$	Chosen variable	Broad factor of chosen variable	Reason
Cluster 19	Ind_x36_Z	0.00	Ind_x36_Z		Only one variable - no choice necessary
Cluster 20	time ln_x59	0.32 5.57	time		Lowest R Square Ratio
Cluster 21	x27_group	0.00	x27_group	Fiscal performance	Only one variable - no choice necessary
Cluster 22	ln_x28_Zm	0.00	ln_x28_Zm	Fiscal performance	Only one variable - no choice necessary
Cluster 23	ln_x39	0.00	ln_x39	Fiscal performance	Only one variable - no choice necessary

Table 6.10: Variable clustering results of the CT dataset

The variable clustering analysis performed on the CT dataset resulted in 23 independent variables.

6.6.2 Ranks of Spearman correlations vs. Hoeffding's D

The scatter plot of the ranks of the Spearman's correlation coefficients vs. Hoeffding's Ds for each of the remaining independent variables with the dependent variable is shown in Figure 6.10. This was used to deal with irrelevancy among the independent variables.

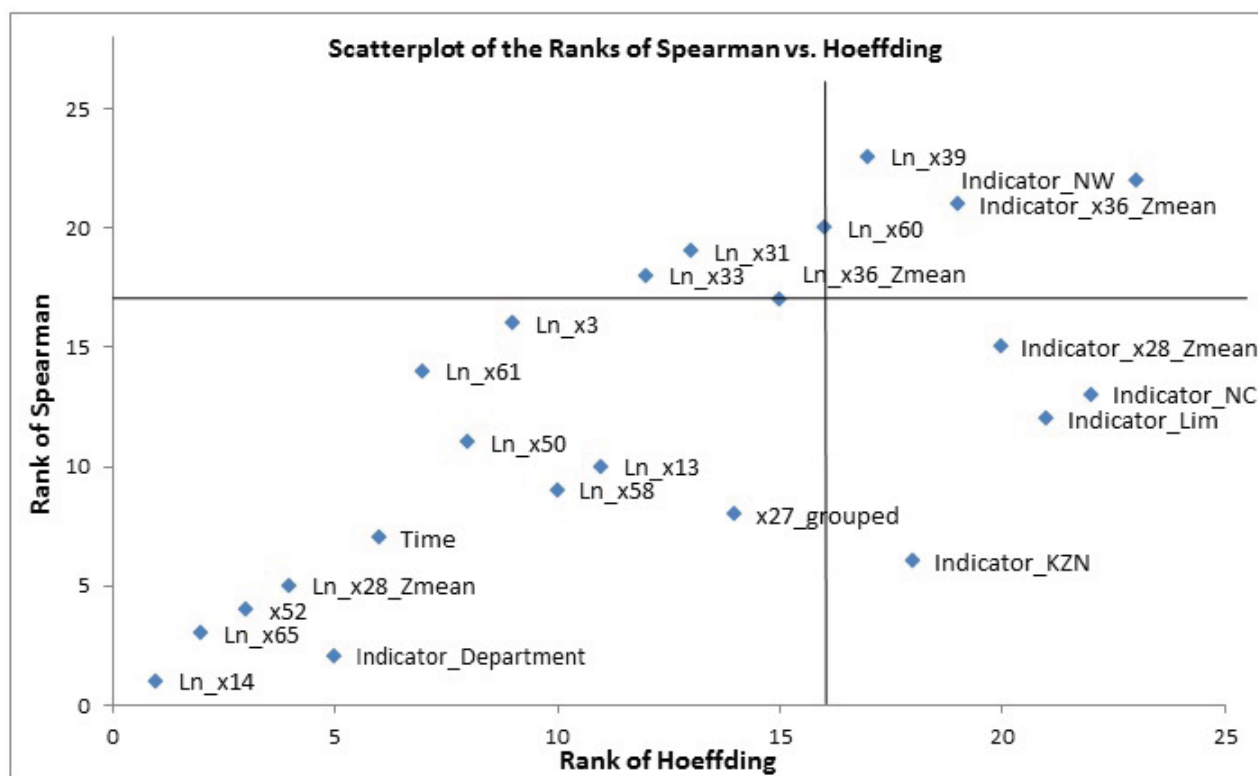


Figure 6.10: Scatterplot of Spearman correlation and Hoeffding's D ranks of the CT dataset

Based on the low correlations indicated by both measures, variables ln_x39, Indicator_NW and Indicator_x36_Zmean were omitted from the rest of the analysis.

Transformations were applied to independent variables $\ln_X60$, $\ln_x36_Zmean$, $\ln_x31$ and $\ln_x33$ to linearise the possible non-linear trends indicated by the high Spearman correlation ranks vs. low Hoeffding's D ranks. None of the applied transformations were effective. These variables were excluded from the rest of the analysis.

This step reduced the number of possible independent variables by 7, leaving a total number of 16 possible independent variables for further analysis.

6.6.3 Linear regression models

The stepwise, forward selection and backward elimination techniques resulted in the same linear regression model and the best subset method resulted in another very similar regression model.

Stepwise, forward and backward

R-Square	0.49
Adjusted R-Square	0.45

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	-4.96	0.00	<.0001	0.00
ln_x14	ln (departmental capital expenditure to total provincial capital expenditure)	1.31	0.45	<.0001	1.13
Indicator_KZN	1 = KwaZulu-Natal, 0 = all other provinces	-1.54	-0.36	<.0001	1.20
Indicator_Lim	1 = Limpopo, 0 = all other provinces	-1.49	-0.35	<.0001	1.13
x27_grouped	departmental annual appropriation of revenue to total departmental revenue (grouped)	-0.49	-0.30	<0.01	1.35
x52	quality of department's financial reports	0.47	0.25	<0.01	1.06
time	time	-0.15	-0.16	0.07	1.19

Table 6.11: *Stepwise, forward and backward regression model of the CT dataset*

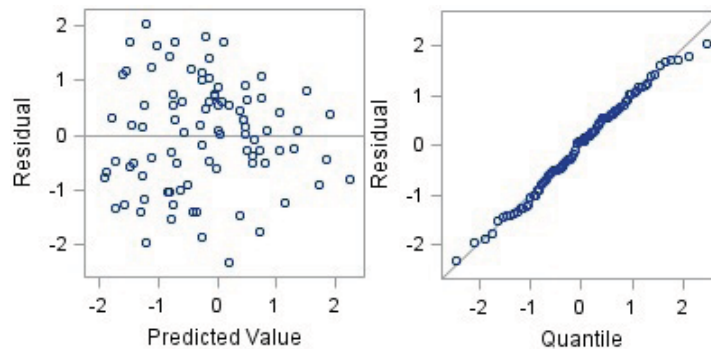


Figure 6.11: *Residual plots of the CT dataset's stepwise, forward and backward model*

The resulting model can also be expressed as follow:

$$\begin{aligned}\hat{Y}_i = & -4.96 + 1.31(\ln_x14_i) - 1.54(Indicator_KZN_i) - \\ & 1.49(Indicator_Lim_i) - 0.49(x27_grouped_i) + \\ & 0.47(x52_i) - 0.15(time_i)\end{aligned}\tag{6.6}$$

(where $i = 1, 2, \dots, 18$)

The model has an R^2 of 0.49, which means that it explains 49% of the variance of the dependent variable. The adjusted R^2 is 0.45 (Table 6.11).

Based on the absolute values of the standardised estimates, the most important independent variable is $\ln_x14$.

As was the case with the ET dataset, the time variable is included in the final linear regression model, but it is the least influential variable. Three models without the time variable were developed in Section 6.7.3. These models' R^2 s ranged between 0.50 and 0.52, thus a different set of independent variables can still explain 50% or more of the variance of the dependent variable.

The p-values of all six chosen independent variables are below 0.1, the highest being 0.07. The VIFs of the variables ranged between 1.06 and 1.35.

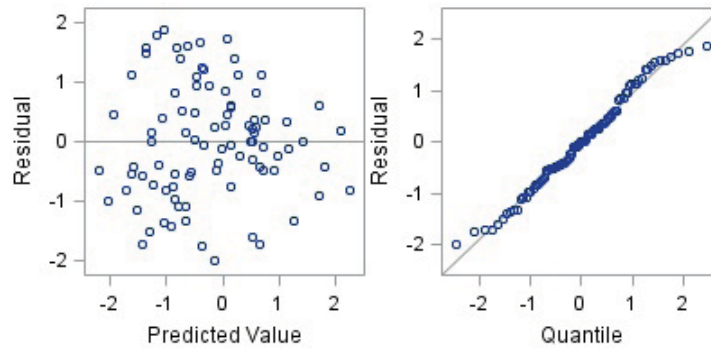
All the independent variables included in this model featured in previously documented models. Although the parameter estimates differ slightly, the interpretations stay the same. As variable $\ln_x14$ (departmental capital expenditure to total provincial capital expenditure) increase, payment behaviour worsens. As previously mentioned, a negative parameter estimate indicates that the specific province's departments are considered to have better payment behaviour than the other provinces' departments, therefore KwaZulu-Natal and Limpopo are the better payers when this model is considered. The payment behaviour will improve as the independent variable $x27_grouped$ (departmental annual appropriation of department to total departmental revenue) increases. Good quality financial reporting implies good creditor repayment; this is indicated by the positive parameter estimate of $x52$. Payment behaviour improves as time passes.

The random and evenly dispersed points on the scatter plot of the residuals shows that the linearity and homoscedasticity assumptions are met. The fairly linear relationship of the normality plot shows that the normality assumption is met (Figure 6.11).

Best subset

R-Square	0.52
Adjusted R-Square	0.47

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	-2.51	0.00	0.19	0.00
ln_x13	ln (departmental capital expenditure to departmental adjusted budget)	-0.61	0.45	0.11	1.09
time	time	-0.19	-0.36	0.03	1.23
Indicator_KZN	1 = KwaZulu-Natal, 0 = all other provinces	-1.55	-0.35	<0001	1.22
ln_x14	ln (departmental capital expenditure to total provincial capital expenditure)	1.33	-0.26	<.0001	1.14
Indicator_x28_Z	0 if departmental own revenue = 0, 1 if departmental own revenue >0	0.42	0.25	0.10	1.20
x52	quality of department's financial reports	0.47	0.18	<0.01	1.08
x27_grouped	departmental annual appropriation of revenue to total departmental revenue (grouped)	-0.40	0.15	0.01	1.49
Indicator_Lim	1 = Limpopo, 0 = all other provinces	-1.46	-0.12	<0.01	1.17

Table 6.12: *Results of the best subset regression model of the CT dataset*Figure 6.12: *CT dataset's best subset model's residual plots*

This resulted in the following model:

$$\begin{aligned}
\hat{Y}_i = & -2.51 - 0.61(\ln_x13_i) - 0.19(time_i) - \\
& 1.55(Indicator_KZN_i) + 1.33(\ln_x14_i) + \\
& 0.42(Indicator_x28_Z_i) + 0.47(x52_i) - \\
& 0.40(x27_grouped_i) - 1.46(Indicator_Lim_i)
\end{aligned} \tag{6.7}$$

This model is similar to the previously reported model. This model includes two additional independent variables, namely `ln_x13` and `Indicator_x28_Z`. The inclusion of the additional independent variables increased the R^2 to 0.52 and the adjusted R^2 to 0.47 (Table 6.12).

The absolute values of the standard estimates indicate that the additional variable, `ln_x13`, is the most important independent variable.

The p-values of all eight independent variables included in the model are below 0.1, two were even lower than 0.0001. The VIFs of the variables were well below the guideline value of 10, the highest being 1.49.

Again, this model is very similar to the stepwise, forward and backward model discussed in the previous section, therefore only the interpretations of the additional variable are provided below.

The negative parameter estimate of departmental capital expenditure to departmental adjusted budget (`ln_x13`) indicates that an increase in this ratio will result in better payment behaviour. A ratio close to 100% indicates that the department's actual and budgeted capital expenditure match up. This demonstrates good budgeting capability, which is considered a financial management strength according to AustraliaRatings (2014).

The parameter estimate of 0.42 associated with `Indicator_x28_Z` indicates that departments with their own departmental revenue is considered to have worse payment behaviour compared to departments who do not generate own revenue. Own departmental revenue is a volatile source of income. Fitch (2011b) also reviews revenue sources in terms of volatility, diversity and predictability and states that reliance on economically sensitive revenue leads to a credit concern.

This model adheres to the assumptions of linear regression modelling (Figure 6.12).

6.7 Combined without time dataset(C)

The two datasets of Health and Education without the time variable (H and E) were combined to form the Combined without time (C) dataset. In this case the additional indicator variable was also added to the dataset to distinguish between the Department of Health and the Department of Education. Subsequently, this dataset comprises 90 data points and 41 independent variables.

As per the previous datasets, multicollinearity and irrelevancy were dealt with using cluster analysis and scatterplots of the correlation coefficient ranks. These results are discussed next, followed by the linear regression results.

6.7.1 Variable clustering

Variable clustering was used to deal with multicollinearity among the 41 independent variables. The results are documented in Table 6.13.

Cluster	Variables*	$1 - R_{ratio}^2$	Chosen variable	Broad factor of chosen variable	Reason
Cluster 1	Ind_Dep ln_x4 ln_x9 ln_x29 ln_x30	0.07 0.33 0.08 0.11 0.13	Ind_Dep		Lowest R Square Ratio
Cluster 2	Ind_Gau ln_x57 ln_x60	0.39 0.33 0.09	ln_x60	Economic conditions	Lowest R Square Ratio
Cluster 3	ln_x48 ln_x49 ln_x50	0.00 0.00 0.00	ln_x50	Fiscal performance	Lowest R Square Ratio
Cluster 4	ln_x8 ln_x33 ln_x34	0.77 0.42 0.44	ln_x33	Fiscal performance	Lowest R Square Ratio
Cluster 5	ln_x14 ln_x32 ln_x64	0.35 0.41 0.21	ln_x14	Financial and debt position	Subject knowledge (Broad factor)
Cluster 6	Ind_Mpu ln_x36_Zm	0.30 0.33	Ind_Mpu		Lowest R Square Ratio
Cluster 7	Ind_WC ln_x41 ln_x61	0.36 0.24 0.50	ln_x41	Fiscal performance	Lowest R Square Ratio
Cluster 8	ln_x63 ln_x65	0.01 0.01	ln_x65	Economic conditions	Subject knowledge (Broad factor)
Cluster 9	Ind_NC	0.00	Ind_NC		Only one variable - no choice necessary
Cluster 10	Ind_KZN	0.00	Ind_KZN		Only one variable - no choice necessary
Cluster 11	Ind_FS	0.00	Ind_FS		Only one variable - no choice necessary
Cluster 12	ln_x3	0.00	ln_x3	Fiscal performance	Only one variable - no choice necessary
Cluster 13	Ind_x28_Z	0.00	Ind_x28_Z	Fiscal performance	Only one variable - no choice necessary
Cluster 14	Ind_EC x52	0.34 0.37	x52	Management quality and institutional strength	Subject knowledge (Broad factor)
Cluster 15	ln_x58	0.00	ln_x58	Economic conditions	Only one variable - no choice necessary
Cluster 16	ln_x13	0.00	ln_x13	Financial and debt position	Only one variable - no choice necessary
Cluster 17	ln_x31	0.00	ln_x31	Fiscal performance	Only one variable - no choice necessary
Cluster 18	Ind_Lim	0.00	Ind_Lim		Only one variable - no choice necessary
Cluster 19	Ind_NW	0.00	Ind_NW		Only one variable - no choice necessary
Cluster 20	Ind_x36_Z	0.00	Ind_x36_Z	Fiscal performance	Only one variable - no choice necessary
Cluster 21	x27_group	0.00	x27_group	Fiscal performance	Only one variable - no choice necessary
Cluster 22	ln_x28_Zm	0.00	ln_x28_Zm	Fiscal performance	Only one variable - no choice necessary
Cluster 23	ln_x59	0.00	ln_x59	Economic conditions	Only one variable - no choice necessary
Cluster 24	ln_x39	0.00	ln_x39	Fiscal performance	Only one variable - no choice necessary

Table 6.13: *Variable clustering results of the C dataset*

There were 24 possible independent variables left after multicollinearity was dealt with. These 24 independent variables represent all four of the broad factors.

6.7.2 Ranks of Spearman correlations vs. Hoeffding's D

Irrelevancy was dealt with by means of a scatterplot of the Spearman correlations vs. Hoeffding's D ranks of each independent variable with the dependent variable (Figure 6.13).

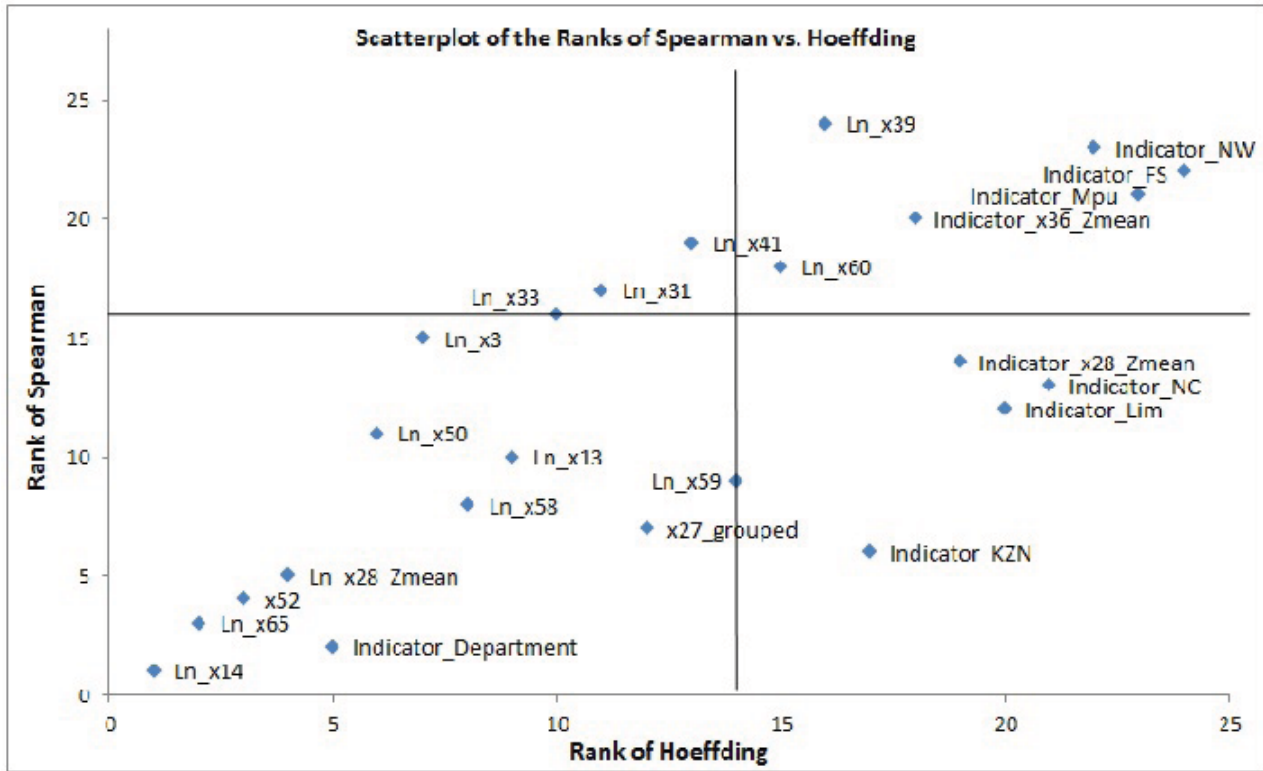


Figure 6.13: Scatterplot of Spearman correlation and Hoeffding's D ranks of the C dataset

The variables in the upper right hand corner were excluded from further analysis since both measures indicate low correlations with the dependent variable.

The variables in the upper left hand corner, $\ln_x41$, $\ln_x31$ and $\ln_x33$, required further investigation due to a possible non-linear relationship indicated by the discrepancy of low correlations. This is evident from the high Spearman correlation ranks and the high correlations indicated by the low Hoeffding's D ranks. Different transformations were applied to these variables to linearise the possible non-linear relationships, but no effective transformation could be found. These variables were also excluded from the rest of the analysis.

There were 15 possible independent variables left once multicollinearity and irrelevancy had been dealt with.

6.7.3 Linear regression models

Three different linear regression models resulted from the C dataset. The stepwise and forward selection techniques resulted in one model and the backward and best subset techniques in two other models. The backward and best subset models are very similar; the only difference is one extra variable in the best subset model. The details of all of these models are discussed next.

Stepwise and forward

R-Square	0.49
Adjusted R-Square	0.45

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	-4.74	0.00	<.0001	0.00
ln_x14	ln (departmental capital expenditure to total provincial capital expenditure)	1.17	0.40	<.0001	1.17
Indicator_KZN	1 = KwaZulu-Natal, 0 = all other provinces	-1.55	-0.36	<.0001	1.20
x27_grouped	departmental annual appropriation of revenue to total departmental revenue (grouped)	-0.54	-0.32	<0.01	1.23
Indicator_Lim	1 = Limpopo, 0 = all other provinces	-1.39	-0.32	<0.01	1.15
x52	quality of department's financial reports	0.51	0.28	<0.01	1.06
ln_x65	ln (departmental total expenditure per capita)	-0.63	-0.15	0.09	1.15

Table 6.14: *Linear regression model of the C dataset resulting from the stepwise and forward variable selection procedures*

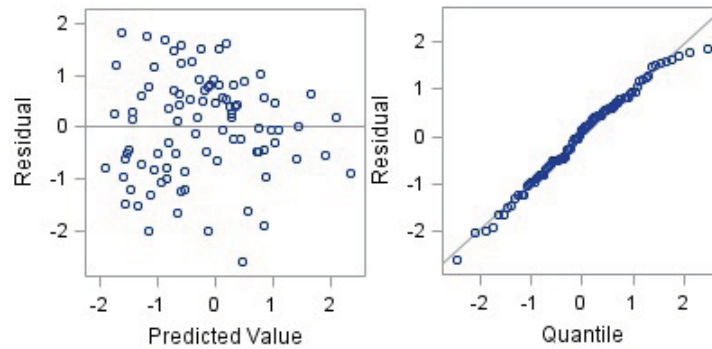


Figure 6.14: *Residual plots of the stepwise and forward model of the C dataset*

The formula of this model is:

$$\begin{aligned}
 \hat{Y}_i = & -4.71 + 1.17(\ln_x14_i) - 1.55(Indicator_KZN_i) - \\
 & 0.54(x27_grouped_i) - 1.39(Indicator_Lim_i) + \\
 & 0.51(x52_i) - 0.63(\ln_x65_i)
 \end{aligned} \tag{6.8}$$

The independent variables included in this model explain 49% of the variance of the dependent variable. The adjusted R^2 is 0.45 (Table 6.14).

The most influential independent variable is $\ln_x14$ (departmental capital expenditure to total provincial capital expenditure).

The p-values and VIFs of all 6 independent variables are all below the 0.1 and 10 cut-off values respectively.

Although the parameter estimate of $\ln_x14$ differs, the interpretation of $\ln_x14$ stays the same as documented in Section 6.3.3, the H stepwise and forward selection model. An increase in variable indicates worsening payment behaviour. Again, the negative parameter estimates of the provincial indicators indicate that these provinces are considered to have better payment behaviour than the other provinces. The payment behaviour will improve as the independent variable $x27$ increase. Good quality financial reporting implies good creditor repayment (indicated by the positive parameter estimate of $x52$). As was mentioned previously, an increase in departmental total expenditure in capita ($\ln_x65$) will result in improved payment behaviour. This can be explained by assuming that the increase is caused by a decrease in the number of residents in the province, which leads to a decrease in infrastructure demands and thus more available income.

It is evident from Figure 6.14 that the assumptions of linear regression modelling are adhered to by the model resulting from the stepwise and forward variable selection techniques.

Backward

R-Square	0.50
Adjusted R-Square	0.46

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	-7.03	0.00	<.0001	0.00
$\ln_x14$	$\ln$ (departmental capital expenditure to total provincial capital expenditure)	1.27	0.44	<.0001	1.13
Indicator_KZN	1 = KwaZulu-Natal, 0 = all other provinces	-1.59	-0.37	<.0001	1.22
Indicator_Lim	1 = Limpopo, 0 = all other provinces	-1.59	-0.37	<.0001	1.15
$x27_grouped$	departmental annual appropriation of revenue to total departmental revenue (grouped)	-0.44	-0.27	<0.01	1.40
$x52$	quality of department's financial reports	0.48	0.26	<0.01	1.07
$\ln_x58$	provincial GDP per capita growth	0.61	0.16	0.05	1.13
Indicator_x28_Z	0 if departmental own revenue = 0, 1 if departmental own revenue >0	0.44	0.15	0.09	1.21

Table 6.15: *Backward model of the C dataset*

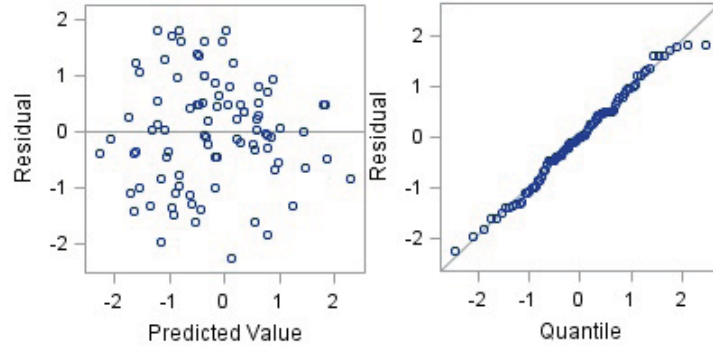


Figure 6.15: *Backward's model of the C dataset's residual plots*

This resulted in the following model:

$$\begin{aligned} \hat{Y}_i = & -4.71 + 1.17(\ln_x14_i) - 1.55(Indicator_KZN_i) - \\ & 0.54(x27_grouped_i) - 1.39(Indicator_Lim_i) + \\ & 0.51(x52_i) - 0.63(\ln_x65_i) \end{aligned} \quad (6.9)$$

This model explains 50% of the variance of the dependent variable. The R^2 adjusted for the number of parameters within the model is 0.46 (Table 6.15).

Based on the standardised parameter estimates the most influential variable is $\ln_x14$ (departmental capital expenditure to total provincial capital expenditure) and the second most influential are $Indicator_KZN$ and $Indicator_Lim$. The latter are almost equally important.

The p-values of the above-mentioned two most influential variables are below 0.0001. The highest VIF of 1.40, the VIF of independent variable $x27_grouped$, is well below the guideline value of 10.

As mentioned before, it is assumed that all other independent variables remain constant when interpreting the effect of a specific independent variable's effect on the dependent variable. These effects are based on the parameter estimates.

Payment behaviour will improve as $x27_grouped$ (departmental annual appropriation of revenue to total departmental revenue) increases.

Good quality financial reports (indicated by independent variable $x52$) indicates good payment behaviour.

An increase in $\ln_x58$ (provincial GDP per capita growth) indicates worsening payment behaviour. Again, the explanation focuses on the growth caused by a decrease in the number of residents in the province. This will lead to a smaller income base and thus less money to repay creditors.

The positive parameter estimate of $Indicator_x28_Z$ indicates that departments generating their own departmental revenue is considered to have worse payment behaviour compared to departments who do not generate own revenue.

Based on the scatter plot of the residuals' overall shape and the fairly linear trend of the normality plot, it can be assumed that the backward model of the C dataset adheres to the underlying assumptions (Figure 6.15).

Best subset

R-Square	0.52
Adjusted R-Square	0.47

Parameter Estimates					
Variable	Description	Parameter Estimate	Standardised Estimate	p-value	VIF
Intercept	Intercept	-4.70	0.00	0.02	0.00
ln_x14	ln (departmental capital expenditure to total provincial capital expenditure)	1.30	0.45	<.0001	1.13
Indicator_KZN	1 = KwaZulu-Natal, 0 = all other provinces	-1.55	-0.36	<.0001	1.22
Indicator_Lim	1 = Limpopo, 0 = all other provinces	-1.51	-0.35	<.0001	1.18
x27_grouped	departmental annual appropriation of revenue to total departmental revenue (grouped)	-0.44	-0.26	<0.01	1.40
x52	quality of department's financial reports	0.46	0.25	<0.01	1.09
ln_x58	provincial GDP per capita growth	0.67	0.18	0.03	1.15
Indicator_x28_Z	0 if departmental own revenue = 0, 1 if departmental own revenue >0	0.45	0.15	0.08	1.21
ln_x13	departmental capital expenditure to departmental adjusted budget	-0.56	-0.12	0.13	1.07

Table 6.16: *Best subset model of the C dataset*

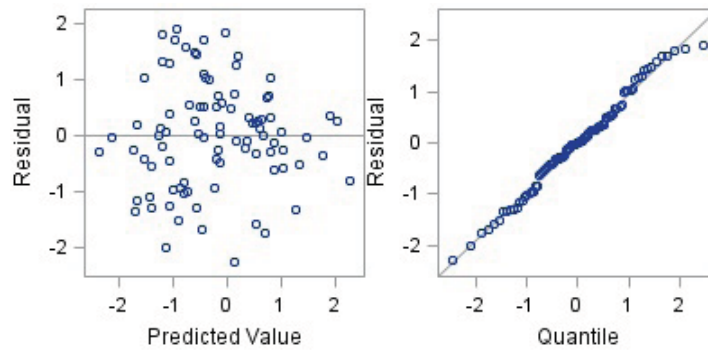


Figure 6.16: *Best subset model of the C dataset's residual plots*

The resulting model can also be expressed as follows:

$$\begin{aligned}
 \hat{Y}_i = & -4.70 - 1.55(Indicator_KZN_i) - 1.51(Indicator_Lim_i) - \\
 & 0.44(x27_grouped_i) + 0.51(x52_i) + 0.67(ln_x58_i) + \\
 & 0.45(Indicator_x28_Z_i) - 0.65(ln_x13_i)
 \end{aligned} \tag{6.10}$$

The best subset variable selection technique resulted in the same model as the model resulting from the backward elimination variable selection technique, with the exception of one additional independent variable, namely $\ln_x13$. The addition of the extra independent variable increased the R^2 and adjusted R^2 to 0.52 and 0.47 respectively (Table 6.16).

Only the effect of $\ln_x13$, the additional variable, is explained. An increase in variable $\ln_x13$ (departmental capital expenditure to departmental adjusted budget) will improve payment behaviour. One possible explanation is that a ratio close to 100% indicates that a department applies good budgeting practices, which in turn is considered a financial management strength.

It is evident from Figure 6.16 that the model met the assumptions of linear regression modelling.

A total number of 10 linear regression models were developed for the six datasets. The next section concludes the chapter by summarising the results of the models documented in Sections 6.2.3 to 6.7.3.

6.8 Summary and conclusions

In this chapter payment behaviour models were developed via linear regression modelling for six datasets. Accruals in excess of 30 days (as a percentage of expenditure) were used as a proxy for payment behaviour.

The ultimate aim of these models is not to predict a department's numerical value of the dependent variable, but to rank the departments' expected future payment behaviours with regard to each other based on the predicted values.

In order to develop the linear regression models the following steps were followed. Firstly, variable clustering was performed to deal with multicollinearity among the independent variables. The next step was to deal with irrelevant independent variables by using scatterplots of Spearman correlation vs. Hoeffding's D ranks. Lastly, linear regression modelling based on four different variable selection techniques were used to develop the payment behaviour models. The results of each dataset were documented separately in Sections 6.2 to 6.7.

In certain instances some of the variable selection techniques resulted in the same final linear regression models. Only one unique model resulted from the HT, ET and E datasets. Two final models resulted from the H and CT datasets and three models from the C dataset. In total ten unique linear regression models resulted from the datasets.

A summary of the independent variables included in the ten models are tabled below. Table 6.17 indicates the R^2 of each model, the total number of terms included in the model, the number of fields that have to be updated when using the model and the number of broad factors represented by the independent variables included in each model. Table 6.18 includes the independent variables included in each model, the descriptions and broad factors of each variable. The variables included in the models are reflected by arrows indicating the effects on payment behaviour. Independent variables with negative parameter estimates have an improving effect on payment behaviour, this is indicated by an up arrow ($\uparrow$). Down arrows ($\downarrow$) are used to indicate the detrimental effect that independent variables with positive parameters have on payment behaviour. This can be thought of as an thumbs up thumbs down approach.

When considering the HT and H models' R^2 s, the backward and best subset model of the H dataset explains the highest percentage of the variation of the dependent variable at 54%. The independent variables included in all the final linear regression models of the Health datasets represented only two of the broad factors, thus no distinction between the models can be made based on the number of factors represented. All the models based on the Education datasets' R^2 s were below 0.5. The best subset model of the C dataset had one of the highest R^2 at 0.52. The eight independent variables included in the model represent all four broad factors.

The next chapter serves as a continuation of this chapter. The models presented in this chapter are investigated further. This investigation was conducted in order to improve the R^2 s, thus to improve the variance of the dependent variable explained by each model.

In Chapter 8 the models developed will be compared and recommendations with regard to model usage in future will be provided.

Dataset	Model	R^2	Number of terms	Fields to be updated	Number of broad factors
HT	Stepwise, forward, backward and best subset	0.51	5	2	2
H	Stepwise and forward	0.49	4	2	2
	Backward and best subset	0.54	5	3	2
ET	Stepwise, forward, backward and best subset	0.48	4	2	2
E	Stepwise, forward, backward and best subset	0.45	4	4	4
CT	Stepwise, forward and backward	0.49	6	3	3
	Best subset	0.52	8	5	3
C	Stepwise and forward	0.49	6	4	4
	Backward	0.50	7	5	4
	Best subset	0.52	8	6	4

Table 6.17: *Summary of the model information of the developed payment behaviour models*

Variable information												
Name*	Description	Broad factor	HT	Stepwise and forward	H	ET	E	Stepwise, forward and backward	C'T	Stepwise and forward	C	Best subset
			Stepwise, forward and best subset									
time	time					↑		↑				
Ind_Gau	1 if Gauteng, 0 if other					↓						
Ind_KZN	1 if KwaZulu-Natal, 0 if other		↑	↑	↑			↑	↑	↑	↑	↑
Ind_Lim	1 if Limpopo, 0 if other		↑	↑	↑			↑	↑	↑	↑	↑
Ind_Mpu	1 if Mpumalanga, 0 if other		↑									
ln_x13	ln (departmental capital expenditure to departmental adjusted budget)	Financial and debt position							↑			↑
ln_x14	ln (departmental capital expenditure to total provincial capital expenditure)	Financial and debt position		↓			↓	↓	↓	↓	↓	↓
x27_group	departmental annual appropriation of revenue to total departmental revenue (grouped)	Fiscal performance		↑	↑			↑	↑	↑	↑	↑
ln_x28_Zm	ln (departmental own revenue to total departmental revenue) (missing mean)	Fiscal performance	↓									
Ind_x28_Z	0 if departmental own revenue = 0, 1 if departmental own revenue >0	Fiscal performance							↓		↓	↓
ln_x36_Z	ln (departmental net assets to departmental total expenditure) (missing mean)	Fiscal performance				↑	↑					
Ind_x36_Z	0 if departmental net assets = 0, 1 if departmental net assets >0	Fiscal performance			↑							

*Variable names have been shortened for due to visibility constraints.

Variable information											
Name*	Description	Broad factor	HT	H		ET	E	C'T		C	
			Stepwise, forward, backward and best subset	Stepwise and forward	Backward and best subset	Stepwise, forward, backward and best subset	Stepwise, forward, backward and best subset	Stepwise, forward and backward	Best subset	Stepwise and forward	Backward
x52	quality of department's financial reports		Stepwise, forward, backward and best subset		↓		↓	↓	↓	↓	
		Management quality and institutional strength									
ln_x57	ln (provincial GDP per capita)	Economic conditions				↑					
ln_x58	ln (provincial GDP per capita growth)	Economic conditions	↓								
ln_x65	ln (departmental total expenditure per capita)	Economic conditions					↑			↑	

Table 6.18: Summary of variables included in the ten payment behaviour models

Chapter 7

INVESTIGATION OF MODEL ADVANCEMENTS

7.1 Introduction

This chapter serves as a continuation of the previous chapter since it investigates whether certain model advancements can improve the R^2 values of the linear regression models presented previously.

In order to improve the linear regression models, four advancements methods were investigated, namely using an alternative dependent variable, using subject knowledge as a variable selection method, including interactions between the independent variables in the models and excluding outliers from the datasets. These methods were only applied to the linear regression models that resulted from the stepwise variable selection procedures. The data analysis and output was generated using the SAS Institute Inc. (2011) software.

The results of these investigations are documented in the remainder of this chapter. This chapter's layout corresponds to the previous chapter's layout. Sections 7.2 to 7.3 contain the results of the two Health datasets, Sections 7.4 to 7.5 contain that of the Education datasets and Sections 7.6 to 7.7 contain the results of the Combined datasets. Section 7.8 provides an overview of the results and concludes the chapter.

7.2 Health with time dataset (HT)

The results of the alternative dependent variable, using subject knowledge as a variable selection method, outlier and interaction testing of the HT dataset are presented next. Unless stated otherwise, model results are documented in Appendix B.

7.2.1 Alternative dependent variable

National Treasury suggested an adjustment to the proxy for the payment behaviour where compensation to employees should be excluded from the total expenditure part of the ratio (National Treasury, 2012b). Thus, the alternative dependent variable is:

$$Y = \ln\left(\frac{\text{accruals in excess of 30 days}}{\text{total expenditure} - \text{compensation to employees}}\right)$$

The reason for this alternative dependent variable is that governmental departments would rarely fall into arrears on compensation of employees as these are salaries and would have serious consequences, for example strikes, should it not be paid on time.

The R^2 of the payment behaviour model based on this alternative dependent variable is 0.48, which is lower than the R^2 of 0.51 of the model based on the original dependent variable. The adjusted R^2 decreased from 0.45 to 0.41. This minor change in the model's prediction power could be expected as the two dependent variables are highly correlated. The decision was made to rather use the original dependent variable.

7.2.2 Subject knowledge as variable selection method

The four variable selection techniques discussed in Section 5.3.3 are based on the statistical properties of the independent variables. In other words, variables were selected based on their predictive power (measured in terms of significance levels) with regard to the dependent variable. Alternatively, variables selection can be done by manually entering some independent variables selected by the researcher based on past work or subject knowledge (Field, 2005; Osborne, 2008).

As previously mentioned, for the purpose of this study subject knowledge is based on including independent variables that represent all four broad factors identified by the literature in the final models. The model advancement method investigated in this case ensures that independent variables from all four broad factors were included in the stepwise models.

Although this did result in an improvement in terms of R^2 , 0.51 to 0.53, this lead to a deterioration of prediction accuracy. The improvement in R^2 should be considered in conjunction with the deterioration in prediction accuracy when deciding if the improvement is worthwhile, this discussion can be found in Section 8.3.1.

7.2.3 Outliers

The treatment of outliers depends on the reason for the resulting outlier. If it is due to an error during the data capturing phase, it should be corrected or deleted from the dataset. If the outlier is valid, but is explainable by an exceptional situation, it should only be deleted if there are no independent variables in the model that can explain the exceptional situation. If there is no explanation available for an outlier, the analyses should be done with the outlier included and excluded since neither the inclusion or exclusion can be warranted (Hair et al., 2006).

Identified outliers were treated in two ways in this thesis. Firstly, identified outliers were investigated during the data compilation phase as well as during the model building phase. If these outliers were caused by data capturing errors, they were corrected. If they involved special circumstances, they were left unchanged.

Secondly, during the model advancement phase, the M Estimation and LTS procedures of the SAS Institute Inc. (2011) software is used to identify outliers. The M Estimation procedure focuses on outliers in the dependent variable and the LTS procedure on outliers in the independent variables. Since no reason to delete these data points could be found, models were developed with the outliers included and excluded. The results of the models including the identified outliers were documented in Chapter 6 and the results of the models excluding outliers are presented in this chapter. Note that the process followed for models excluding outliers are as follows: once outliers were identified they were deleted from the datasets and the parameter estimates were recalculated.

Data point 29 was identified as an outlier in the dependent variable when the M Estimation procedure was applied. The deletion of this point improves the R^2 of the model from 0.51 to 0.58 and the adjusted R^2 from 0.45 to 0.53.

The LTS technique indicated data points 15, 23, 29 and 32 as outliers as far as the independent variables are concerned. The deletion of these points improved the model's R^2 to 0.65 and the adjusted R^2 to 0.60.

The effect of the deletion of the outliers on the parameter estimates has to be assessed once the parameter estimates have been recalculated. This could be done by tabulating the different parameter estimates, see for example Table 7.1. Similar parameter estimates resulted in these cases.

Variable	Stepwise	Stepwise without dependent outliers	Stepwise without independent outliers
Indicator_KZN	-2.7	-2.9	-2.8
Indicator_Lim	-1.2	-1.2	-0.1
Indicator_Mpu	-1.3	-1.4	-1.8
ln_x28_Zmean	0.3	0.4	0.3
ln_x58	0.9	0.8	0.4

Table 7.1: *Parameter estimates of the different Stepwise models of the HT dataset*

The number of data points deleted has to be taken into account when one considers the improvement of a model by deleting outliers. In this case it is debatable whether the loss of four data points, thus 9% of the data, is worth the model improvement of 27.45%, expressed in terms of the R^2 .

7.2.4 Interaction effects

Another way of improving a linear regression model is to add interaction effects to the model. The specific interaction terms that formed part of this investigation were two-way interactions and polynomials of the second degree.

The results of adding interaction effects to the stepwise model of the HT dataset are presented in Table 7.2. The consequential model contains only interaction variables, except for the intercept, and the R^2 improved notably to 0.74.

Kutner et al. (2005) state that models that include interaction terms are considered to be complex models and SAS Institute Inc. (2010) states that the inclusion of polynomial terms complicates interpretation. Therefore, only high-level descriptions of the effects of the interaction terms on the dependent variable are provided (Table 7.3). The table contains the parameter estimates (in red) and descriptions of the effects. It will be assumed that all other interaction effects remain constant.

R-Square	0.74
Adjusted R-Square	0.68

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	1.03	0.00	<.0001	0.00
Indicator_WC_ln_x49	-19.85	-0.32	<0.01	1.11
x27_grouped_Indicator_x36_Z	-0.62	-0.33	<0.01	1.26
Indicator_Lim_ln_x36_Zmean	0.60	0.37	<0.01	1.18
Indicator_KZN_ln_x48	-32.18	-0.60	<0.0001	1.12
Indicator_Mpu_ln_x57	-0.15	-0.36	<0.01	1.13
Indicator_Lim_ln_x50	-65.09	-0.35	<0.01	1.13
Indicator_FS_ln_x33	-22.70	-0.18	0.05	1.06
x27_grouped_ln_x34	-13.93	-0.29	<0.01	1.22

Table 7.2: *Linear regression model with interaction effects of the HT dataset*

7.2.5 Combining the effect of interaction effects and outliers

A test was conducted to determine the effect of outliers on the model with interaction effects included. When applying the M Estimation method, one data point was indicated as an outlier. The application of the LTS method identified five data points as outliers. The deletion of these data points resulted in models with R^2 s of 0.80 and 0.90 respectively. The adjusted R^2 increased to 0.76 and 0.88.

The resulting models are very similar to the previously discussed model. The deletion of the five outliers indicated by the LTS method resulted in noteworthy changes in the parameter estimates of the independent variables Indicator_Lim_ln_x50 and Indicator_FS_ln_x33 included in the interaction model without independent outliers (compare Tables 7.2.4, B.5 and B.6).

Table 7.3 contains the descriptions of the interaction terms included in all three models on the dependent variable (the interaction model without dependent outliers' in black and interaction model without independent outliers' in blue).

Variable:	Indicator_WC_ln_x49
Variable description:	ln_x49 = ln (provincial surplus/deficit to provincial payments)
Parameter estimate:	(-19.85) (-19.71) (-18.54)
Description of effect:	The negative parameter estimate shows that an increase in ln_x49 (provincial surplus/deficit to provincial payments) leads to an improvement in payment behaviour where Western Cape is concerned.
Variable:	x27_grouped_Indicator_x36_Z
Variable description:	x27_grouped = departmental annual appropriation of revenue to total departmental revenue (grouped) Indicator_x36_Z = 0 if departmental net assets = 0 Indicator_x36_Z = 1 if departmental net assets >0
Parameter estimate:	(-0.62) (-0.66) (-0.58)
Description of effect:	An increase in departmental annual appropriation of revenue to total departmental revenue will lead to an improvement in payment behaviour, provided that the department's assets exceeds liabilities.
Variable:	Indicator_Lim_ln_x36_Zmean
Variable description:	ln_x36_Zmean = ln (departmental net assets to departmental total expenditure) (missing mean)
Parameter estimate:	(0.60) (0.59) (0.93)
Description of effect:	An increase in ln_x36_Zmean will lead to a deterioration of payment behaviour for the Limpopo province.
Variable:	Indicator_KZN_ln_x48
Variable description:	ln_x48 = ln (provincial surplus/deficit to provincial receipts)
Parameter estimate:	(-32.18) (-31.99) (-30.85)
Description of effect:	KwaZulu-Natal's payment behaviour will improve if the province's surplus/deficit to provincial receipts ratio increase.
Variable:	Indicator_Mpu_ln_x57
Variable description:	ln_x57 = ln (provincial GDP per capita)
Parameter estimate:	(-0.15) (-0.20) (-0.15)
Description of effect:	An increase in provincial GDP per capita will be beneficial with regard to Mpumalanga Department of Health's payment behaviour.
Variable:	Indicator_Lim_ln_x50
Variable description:	ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-65.09) (-66.26) (-128.57)
Description of effect:	An increase in ln_x50 will lead to better payment behaviour; this only applies to the Limpopo province.
Variable:	Indicator_FS_ln_x33
Variable description:	ln_x33 = ln (departmental surplus/deficit to departmental total revenue)
Parameter estimate:	(-22.70) (-22.00) (-34.79)
Description of effect:	Free State's Department of Health's payment behaviour will improve if its surplus/deficit to total revenue increase.
Variable:	x27_grouped_ln_x34
Variable description:	x27_grouped = departmental annual appropriation of revenue to total departmental revenue (grouped) ln_x34 = ln (departmental surplus/deficit to departmental total expenditure)
Parameter estimate:	(-13.93) (-15.10) (-13.69)
Description of effect:	Payment behaviour will improve as ln_x34 increases, provided that x27 has high values (group = 1). In the case where x27 has low values (group = -1) an increase in departmental surplus/deficit to departmental total expenditure will lead to worsening payment behaviour. The remainder of the values of x27 (group = 0) will have no effect due to the multiplication with zero.

Table 7.3: Descriptions of the interaction effects of the HT dataset (the interaction model's parameter estimates are indicated in red, the interaction model without dependent outliers' in black and interaction model without independent outliers' in blue)

7.3 Health without time (H)

The stepwise model of the H dataset was used to test for improvements in the model if another dependent variable is specified, using subject knowledge as a variable selection method, if interaction effects are added to the model and if outliers are deleted from the dataset. These results are presented next, model results not documented in this section can be found in Appendix B instead.

7.3.1 Alternative dependent variable

As stated previously, the alternative dependent variable is highly correlated to the original dependent variable, $r = 0.99$ and thus similar results are expected.

The R^2 of the model based on the alternative dependent variable are marginally lower at 0.46 than the original R^2 of 0.49. The adjusted R^2 decreased from 0.44 to 0.41. The decision was made to use the original dependent variable.

7.3.2 Subject knowledge as variable selection method

Subject knowledge with regard to the number of broad factors represented by the independent variables included in the final stepwise model was also tested in the case of the H dataset. The model including variables representing all four broad factors' R^2 improved from 0.49 to 0.53 but the prediction accuracy deteriorated (refer to Section 8.3.1).

7.3.3 Outliers

The same procedures as for the HT dataset were used to test for the effect of outliers. These procedures are the M Estimation procedure which focus on outliers in the dependent variable and the LTS procedure, which focus on outliers in the independent variables.

Three data points were identified as outliers in the dependent variable. The R^2 of the model improved by 0.19 from 0.49 to 0.68 and the adjusted R^2 from 0.44 to 0.65 when these data points were deleted.

The LTS technique indicated four data point as outliers. The deletion of these data points improved the model's R^2 and adjusted R^2 even more to 0.72 and 0.69 respectively. The model improved notably, measured in terms of the increase in the R^2 , by 39% and 46% respectively. However the loss of data, 7% and 9%, has to be taken into account too. Again, the parameter estimates did not change much.

7.3.4 Interaction effects

The test done to determine whether the inclusion of interaction effects will improve the model was repeated for the H dataset. The results are presented in Table 7.4.

As in the case of the HT dataset, the resulting model contains only interaction variables, except for the intercept. The R^2 improved substantially from 0.49 to 0.62.

Again, only high-level descriptions are provided, seeing that the inclusion of interaction terms resulted in a complicated model (Table 7.5 (parameter estimates displayed in red)). These descriptions are based on the assumption that all other variables stay constant.

R-Square	0.62
Adjusted R-Square	0.56

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	0.91	0.00	.0001	0.00
x27_grouped_ln_x57	-0.05	-0.32	<0.01	1.08
Indicator_KZN_ln_x49	-34.78	-0.65	<.0001	1.08
Indicator_Lim_ln_x36_Zmean	0.63	0.39	<0.01	1.12
Indicator_Mpu_ln_x58	-0.51	-0.27	0.01	1.06
Indicator_WC_ln_x13	-0.30	-0.31	0.01	1.06
Indicator_Lim_ln_x50	-53.33	-0.29	0.01	1.07

Table 7.4: *Model including interaction effects of the H dataset*

7.3.5 Combining the effect of interaction effects and outliers

When applying the M Estimation method six data points were indicated as outliers. The application of the LTS method identified four data points as outliers.

The R^2 of the model increased from the original 0.62 to 0.85 once the data points with the dependent variable outliers were deleted. The R^2 increased from the original 0.62 to 0.82 when the four data points with outliers in the independent space were deleted.

These models are similar to the interaction model. Once again the parameter estimate of the independent variable Indicator_Lim_ln_x50 included in the interaction model without independent outliers showed a large change (compare Tables 6.4, B.11 and B.12). Therefore, the outliers did have a noteworthy effect in this model. This relates to the HT interaction model without independent outliers.

Table 7.5 contains the high-level descriptions of the interaction terms, indicated by the parameter estimates on the dependent variable. The interaction model without dependent outliers' parameter estimates is indicated in black and the interaction model without independent outliers in blue.

Variable:	x27_grouped_ln_x57
Variable description:	x27_grouped = departmental annual appropriation of revenue to total departmental revenue (grouped) ln_x57 = ln (provincial GDP per capita)
Parameter estimate:	(-0.05) (-0.05) (-0.04)
Description of effect:	Payment behaviour will improve as ln_x57 increases, provided that x27 has high values (group = 1). In the case where x27 has low values (group = -1) an increase in provincial GDP per capita will lead to worsening payment behaviour. The remainder of the values of x27 (group = 0) will have no effect due to the multiplication with zero.
Variable:	Indicator_KZN_ln_x49
Variable description:	ln_x49 = ln (provincial surplus/deficit to provincial payments)
Parameter estimate:	(-34.78) (-31.05) (-32.06)
Description of effect:	The negative parameter estimate shows that an increase in ln_x49 (provincial surplus/deficit to provincial payments) leads to an improvement in payment behaviour where KwaZulu-Natal is concerned.
Variable:	Indicator_Lim_ln_x36_Zmean
Variable description:	ln_x36_Zmean = ln (departmental net assets to departmental total expenditure) (missing mean)
Parameter estimate:	(0.63) (0.59) (1.08)
Description of effect:	An increase in ln_x36_Zmean will lead to a deterioration of payment behaviour for the Limpopo province.
Variable:	Indicator_Mpu_ln_x58
Variable description:	ln_x58 = ln (provincial GDP per capita growth)
Parameter estimate:	(-0.51) (-0.63) (-0.76)
Description of effect:	An increase in provincial GDP per capita growth will be beneficial with regard to Mpumalanga Department of Health's payment behaviour.
Variable:	Indicator_WC_ln_x13
Variable description:	ln_x13 = ln (departmental capital expenditure to departmental adjusted budget)
Parameter estimate:	(-0.30) (-0.35) (-0.33)
Description of effect:	An increase in ln_x13 leads to an improvement of payment behaviour for the Western Cape.
Variable:	Indicator_Lim_ln_x50
Variable description:	ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-53.33) (-44.66) (-121.13)
Description of effect:	An increase in ln_x50 will result in better payment behaviour; this only applies to the Limpopo province.

Table 7.5: *Descriptions of interaction terms included in the H dataset (the interaction model's parameter estimates are indicated in red, the interaction model without dependent outliers' in black and interaction model without independent outliers' in blue)*

7.4 Education with time (ET)

The results of the model advancement tests of the ET dataset are presented next, model results not found in this section are reported in Appendix B.

7.4.1 Alternative dependent variable

The R^2 of the payment behaviour model based on the alternative dependent variable is very similar, at 0.49, to the R^2 of 0.48 of the model based on the original dependent variable. Both models' adjusted R^2 s are 0.43. As was explained in Section B.1, this is to be expected as the two dependent

variables are highly correlated. The same decision as in the cases of the previous tests was made, i.e. to use the original dependent variable.

7.4.2 Subject knowledge as variable selection method

Opposed to the HT and H models, the model including independent variables that represent all four broad factors' R^2 and prediction accuracy (documented in Section 8.4.1) improved marginally.

7.4.3 Outliers

No outliers were indicated by either the M Estimation or the LTS procedure.

7.4.4 Interaction effects

An investigation was conducted to determine whether the inclusion of two-way interactions and polynomials of the second degree will improve the ET dataset's linear regression model's prediction power.

The consequential model contains only interaction variables (excluding the intercept) and the R^2 improved from 0.48 to 0.70 (Table 7.6). This is considered to be a substantial improvement.

R-Square	0.70
Adjusted R-Square	0.63

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	94.22	0.00	<.0001	0.00
ln_x57_ln_x60	-1.38	-0.72	<.0001	1.49
time_Indicator_NC	0.24	0.21	0.04	1.15
ln_x29_ln_x29	-2.08	-0.44	<.0001	1.20
Indicator_Mpu_ln_x50	-75.76	-0.31	<0.01	1.10
Indicator_EC_Indicator_x36_Z	-1.04	-0.22	0.07	1.64
Indicator_Lim_ln_x50	-42.72	-0.27	0.01	1.01
x27_grouped_ln_x50	-18.18	-0.36	<0.01	1.32
time_Indicator_Gau	0.40	0.35	<0.01	1.09

Table 7.6: *Interaction model of ET dataset*

Table 7.7 contains high-level descriptions of the effects of the interaction terms on the dependent variable, parameter estimates are shown in red. Again, it is assumed that all other interaction effects remain constant.

7.4.5 Combining the effect of interaction effects and outliers

No outliers in the independent variable were identified when applying the M Estimation method to the ET dataset. Data point 44 was identified as an outlier when applying the LTS method. The deletion of data point 44 resulted in a model with a R^2 of 0.74 and an adjusted R^2 of 0.68. The deletion of 1 data point (2.22% of the data) lead to an improvement of 5.87% in terms of R^2 . The parameter estimates changed only slightly in comparison with the original models’.

Refer to Table B.15 in Appendix B for detailed results of the model itself and Table 7.7 for the parameter estimates (in blue) and descriptions of the effects.

Variable:	ln_x57_ln_x60
Variable description:	ln_x57 = ln (provincial GDP per capita) ln_x60 = ln (provincial dependent population to total population)
Parameter estimate:	(-1.38) (-1.39)
Description of effect:	Payment behaviour improves as ln_x60 increases. The interaction between these two variables makes intuitive sense since an increase in total population will ultimately lead to an increase in GDP. This in turn will lead to an increase in revenue, which could be used to support the dependent population within the province. Considering the two variables separately, an increase in GDP per capita (ln_x57) will improve payment behaviour since this will lead to an increase in revenue available to repay creditors (as seen in the ET without interactions model as well). An increase in the proportional dependent population within a province (ln_x60) will lead to an increasing demand for public services and thus less available revenue to repay creditors.
Variable:	time_Indicator_NC
Parameter estimate:	(0.24) (0.03)
Description of effect:	The payment behaviour of the Department of Education of the Northern Cape worsens as time goes by.
Variable:	ln_x29_ln_x29
Variable description:	ln_x29 = ln (departmental personnel expenditure to departmental total current expenditure)
Parameter estimate:	(-2.08) (-2.12)
Description of effect:	An increase in ln_x29 will lead to an improvement in payment behaviour.
Variable:	Indicator_Mpu_ln_x50
Variable description:	ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-75.76) (-75.45)
Description of effect:	Mpumalanga’s payment behaviour will improve if the provincial total receipts to provincial total payments ratio increases.
Variable:	Indicator_EC_Indicator_x36_Z
Variable description:	Indicator_x36_Z = 0 if departmental net assets = 0 Indicator_x36_Z = 1 if departmental net assets >0
Parameter estimate:	(-1.04) (-1.10)
Description of effect:	Department of Education of Eastern Cape’s payment behaviour is better when assets exceed liabilities.
Variable:	Indicator_Lim_ln_x50
Variable description:	ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-42.72) (-75.45)
Description of effect:	An increase in ln_x50 will lead to better payment behaviour; this only applies to the Limpopo province.

Variable:	x27_grouped_ln_x50
Variable description:	x27_grouped = departmental annual appropriation of revenue to total departmental revenue (grouped) ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-18.18) (-18.30)
Description of effect:	Payment behaviour will improve as ln_x50 increases, provided that x_27 is high (group = 1). In the case of low values of x27 (group = -1) an increase in ln_x50 will lead to a worsening in payment behaviour.
Variable:	time_Indicator_Gau
Parameter estimate:	(0.40) (0.39)
Description of effect:	The payment behaviour of the Department of Education of Gauteng worsens as time goes by.

Table 7.7: *Descriptions of the interaction effects included in the ET dataset's model (the interaction model's parameter estimates are indicated in red and the interaction model without independent outliers' in blue, no dependent outliers identified)*

7.5 Education without time (E)

The model advancement tests of the E dataset were also based on the stepwise model. Unless stated differently, model results are documented in Appendix B.

7.5.1 Alternative dependent variable

The R^2 of the model based on the original and alternative dependent variables are 0.45 and the adjusted R^2 is 0.39. It was also decided to use the original dependent variable in this case.

7.5.2 Subject knowledge as variable selection method

The model resulting from the subject knowledge variable selection method was the same as the original model.

7.5.3 Outliers

No outliers were indicated by either the M Estimation or the LTS procedure.

7.5.4 Interaction effects

As was mentioned in Section 7.2.4, two-way interactions and polynomials of the second degree were added to the model to test for an improvement in terms of the variance of the dependent variable explained by the model. The results are documented in Table 7.8.

Parameter estimates and the effects of the interaction terms on the dependent variable are documented in Table 7.9 (this model's parameter estimates are indicated in red).

R-Square	0.71
Adjusted R-Square	0.65

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	46.77	0.00	0.00	0.00
ln_x8_ln_x8	2.54	0.44	<0.01	2.11
ln_x29_ln_x29	-2.81	-0.60	<.0001	1.30
ln_x57_ln_x60	-1.17	-0.61	<.0001	1.15
Indicator_x28_Z_ln_x33	31.91	0.64	<.0001	2.15
Indicator_NC_ln_x14	0.37	0.20	0.04	1.16
Indicator_Mpu_ln_x50	-51.88	-0.21	0.03	1.04
Indicator_Lim_ln_x50	-37.05	-0.23	0.01	1.02

Table 7.8: *Model including two-way interactions and polynomials of the second degree of the E dataset*

7.5.5 Combining the effect of interaction effects and outliers

As before, a test was conducted to determine the effect of outliers on the interaction model by identifying outliers via the M Estimation and LTS methods. Once the outliers were detected they were deleted from the dataset and the parameter estimates were recalculated.

When applying the M Estimation method, five data points were indicated as outliers. The application of the LTS method identified only data point 44 as an outlier.

The R^2 s of the models increased to 0.86 and 0.75 respectively. The detailed results of the interaction model without dependent outliers are documented in Table B.17 and the model without independent outliers in Table B.18 in Appendix B. The subsequent model contains only interaction variables. The R^2 improved substantially from 0.45 to 0.71 and R^2 adjusted for the number of independent variables from 0.39 to 0.65.

Again, only slight modifications are evident when comparing the resulting parameter estimates to those of the original models.

Possible high-level descriptions of the effects of the interaction terms on the dependent variable, and thus on payment behaviour, are provided in Table 7.9 (parameter estimates displayed in black and blue respectively).

Variable:	ln_x8_ln_x8
Variable description:	ln_x8 = ln(departmental personnel expenditure to departmental adjusted budget)
Parameter estimate:	(2.54) (3.15) (2.69)
Description of effect:	The positive parameter estimate of 2.54 indicates that payment behaviour will worsen as ln_x8 increases.
Variable:	ln_x29_ln_x29
Variable description:	ln_x29 = ln (departmental personnel expenditure to departmental total current expenditure)
Parameter estimate:	(-2.81) (-2.96) (-2.88)
Description of effect:	Payment behaviour is expected to improve if the ratio of departmental personnel expenditure to departmental total current expenditure increases.
Variable:	ln_x57_ln_x60
Variable description:	ln_x57 = ln (provincial GDP per capita) ln_x60 = ln (provincial dependent population to total population)
Parameter estimate:	(-1.17) (-1.14) (-1.20)
Description of effect:	Payment behaviour improves as this term increases. The interaction between these two variables makes intuitive sense since an increase in total population will ultimately lead to an increase in GDP. This in turn will lead to an increase in revenue, which could be used to support the dependent population within the province. Considering the two variables separately, an increase in GDP per capita (ln_x57) will improve payment behaviour, since this will lead to an increase in revenue available to repay creditors (as seen in the ET without interactions model as well). An increase in the proportional dependent population within a province (ln_x60) will lead to an increasing demand for public services and thus less available revenue to repay creditors.
Variable:	Indicator_x28_Z_ln_x33
Variable description:	Indicator_x28_Z = 0 if departmental own revenue = 0 Indicator_x28_Z = 1 if departmental own revenue > 0 ln_x33 = ln (departmental surplus/deficit to departmental total revenue)
Parameter estimate:	(31.91) (35.63) (31.72)
Description of effect:	A department's payment behaviour will worsen as variable ln_x33 increases, provided that the specific department generates its own revenue (Indicator_x28_Z = 1).
Variable:	Dummy_NC_ln_x14
Variable description:	ln_x14 = ln (departmental capital expenditure to total provincial capital expenditure)
Parameter estimate:	(0.37) (0.13) (0.14)
Description of effect:	The Department of Education of the Northern Cape's payment behaviour will worsen if its departmental capital expenditure to total provincial capital expenditure ratio increases.
Variable:	Indicator_Mpu_ln_x50
Variable description:	ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-51.88) (-49.69) (-52.15)
Description of effect:	Mpumalanga's payment behaviour will improve if the province's total receipts to provincial total payments ratio increases.
Variable:	Indicator_Lim_ln_x50
Variable description:	ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-37.05) (-35.74) (-36.34)
Description of effect:	An increase in ln_x50 leads to better payment behaviour, this only applies to the Limpopo province.

Table 7.9: Descriptions of the model including interaction effects of the E dataset (the interaction model's parameter estimates are indicated in red, the interaction model without dependent outliers' in black and interaction model without independent outliers' in blue)

7.6 Combined with time (CT)

The results model advancement investigations of the CT dataset are presented in this section. Unless stated otherwise, the details of the model results are documented in Appendix B.

7.6.1 Alternative dependent variable

The stepwise linear regression based on the alternative dependent variable of the CT dataset contains the same independent variables as the model based on the original dependent variable. The only exception is the time variable. This variable did not form part of the variables selected in this case. This resulted in a notably lower R^2 , it decreased from 0.49 to 0.39.

In previous tests (HT, H, ET and E datasets' tests) the same independent variables were selected by the stepwise procedure for both models, this explains the similar results in terms of R^2 s.

7.6.2 Subject knowledge as variable selection method

The model including independent variables from all four broad factors' R^2 remained unchanged at 0.49, but the prediction accuracy deteriorated (refer to Section 8.5.1).

7.6.3 Outliers

No outliers were indicated by the M Estimation procedure.

The LTS procedure identified only data point 5 as an outlier. The deletion of this outlier resulted in a minor improvement of R^2 , 0.50 instead of 0.49. This resulted in minor changes of the parameter estimates.

7.6.4 Interaction effects

The results of the model including interaction effects are documented next. The R^2 improved marginally from 0.49 to 0.55 (Table 7.10).

Table 7.11 contains high-level descriptions of the effects of the interaction terms on the dependent variable. It is assumed that all other interaction effects remain constant.

R-Square	0.55
Adjusted R-Square	0.49

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-1.04	0.00	0.00	0.00
Indicator_Gau_ln_x58	0.90	0.45	<.0001	1.35
ln_x32_x52	0.23	0.38	<.0001	1.12
Indicator_FS_ln_x33	-30.26	-0.19	0.02	1.13
Indicator_Lim_ln_x50	-55.32	-0.31	<0.01	1.18
Indicator_FS_Indicator_x28_Z	1.55	0.20	0.01	1.10
time_ln_x61	-0.19	-0.24	0.01	1.34
Indicator_Lim_x27_grouped	-0.87	-0.20	0.02	1.26
Indicator_Lim_ln_x36_Zmean	0.43	0.22	0.01	1.19
x27_grouped_ln_x50	-8.64	-0.15	0.08	1.26

Table 7.10: *Results of the model including interaction effects of the CT dataset*

7.6.5 Combining the effect of interaction effects and outliers

No outliers were indicated by any of the two methods.

Variable:	Indicator_Gau_ln_x58
Variable description:	ln_x58 = ln (provincial GDP per capita growth)
Parameter estimate:	(0.90)
Description of effect:	An increase in provincial GDP per capita growth will lead to worsening payment behaviour for Gauteng.
Variable:	ln_x32_x52
Parameter estimate:	(0.23)
Variable description:	ln_x32 = ln (departmental capital expenditure to departmental total expenditure) x52 = quality of department's financial reports
Description of effect:	Payment behaviour worsens as the interaction term increases. Same applies for each of the separate independent variables. An increase in departmental capital expenditure to total departmental expenditure (ln_x32) will be detrimental to payment behaviour. As the quality of financial reporting worsens (x52) the department's payment behaviour also worsens.
Variable:	Indicator_FS_ln_x33
Variable description:	ln_x33 = ln (departmental surplus/deficit to departmental total revenue)
Parameter estimate:	(-30.26)
Description of effect:	The payment behaviour of the Free State's Departments of Health and Education will improve if its surplus/deficit to total revenue ratio increases.
Variable:	Indicator_Lim_ln_x50
Variable description:	ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-55.32)
Description of effect:	Limpopo's payment behaviour will improve if the province's total receipts to provincial total payments ratio increases.
Variable:	Indicator_FS_Indicator_x28_Z
Variable description:	Indicator_x28_Z = 0 if departmental own revenue = 0 Indicator_x28_Z = 1 if departmental own revenue >0
Parameter estimate:	(1.55)
Description of effect:	Free State department's payment behaviour is worse when the specific department generates own departmental revenue.

Variable:	time_ln_x61
Variable description:	ln_x61 = ln (provincial dependent population to total population)
Parameter estimate:	(-0.19)
Description of effect:	Payment behaviour improves as the interaction term increases. The same applies for each of the separate independent variables. Payment behaviour improves as time goes by, as well as when the ratio provincial total receipts to provincial total payments increases.
Variable:	Indicator_Lim_x27_grouped
Variable description:	x27_grouped = departmental annual appropriation of revenue to total departmental revenue (grouped)
Parameter estimate:	(-0.87)
Description of effect:	Limpopo will have better payment behaviour when x27 contains high values (group = 1) compared to when x27 contains low values (group = -1).
Variable:	Indicator_Lim_ln_x36_Zmean
Variable description:	ln_x36_Zmean = ln (departmental net assets to departmental total expenditure) (missing mean)
Parameter estimate:	(0.43)
Description of effect:	An increase in ln_x36_Zmean will lead to a deterioration of payment behaviour for the Limpopo province.
Variable:	x27_grouped_ln_x50
Variable description:	x27_grouped = departmental annual appropriation of revenue to total departmental revenue (grouped) ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-8.64)
Description of effect:	Payment behaviour will improve as ln_x50 increases, provided that x.27 is high (group = 1). In the case of low values of x27 (group = -1) an increase in ln_x50 will lead to a worsening in payment behaviour.

Table 7.11: *Descriptions of the model including interaction effects included in the CT dataset's model (the interaction model's parameter estimates are indicated in red, no outliers identified)*

7.7 Combined without time (C)

The model advancement tests of the C dataset were also based on the stepwise model. The results are documented in the remainder of this section.

7.7.1 Alternative dependent variable

The outcome of the alternative dependent variable test is similar to that of the C dataset. The stepwise linear regression based on the alternative dependent variable of the CT dataset contains the same independent variables as the model based on the original dependent variable, with the exception of independent variable ln_x65. This variable did not form part of the variables selected in this case. The R^2 is notably lower; it decreased from 0.49 to 0.39. The adjusted R^2 decreased from 0.45 to 0.35.

Again the same independent variables were selected by the stepwise procedure for both models of the Health and Education datasets, which explains the similar results in terms of R^2 s.

7.7.2 Subject knowledge as variable selection method

The model resulting from the subject knowledge variable selection method was the same as the original model.

7.7.3 Outliers

These results are also very similar to the results of the CT dataset. No outliers were indicated by the M Estimation procedure.

The LTS procedure also identified only data point 5 as an outlier. This did not result in a change in R^2 or the adjusted R^2 . Only minor changes were reported in the parameter estimates of the independent variables included in the model.

7.7.4 Interaction effects

The results of the model including interactions effects are documented next. The R^2 improved from 0.49 to 0.53 and R^2 adjusted for the number of independent variables from 0.45 to 0.48 (Table 7.12).

R-Square	0.53
Adjusted R-Square	0.48

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-1.88	0.00	0.00	0.00
Indicator_KZN_ln_x64	0.65	0.34	<0.01	1.23
Indicator_Department_ln_x49	-5.36	-0.16	0.06	1.16
Indicator_Lim_ln_x59	-0.42	-0.24	0.01	1.25
Indicator_EC_ln_x63	1.42	0.26	<0.01	1.19
Indicator_Gau_ln_x65	1.36	0.14	0.08	1.11
x27_grouped_ln_x65	-0.84	-0.35	<0.01	1.47
Indicator_Lim_ln_x50	-44.85	-0.25	<0.01	1.07
ln_x14_ln_x58	0.28	0.31	<0.01	1.39
Indicator_NC_ln_x34	14.19	0.14	0.07	1.02

Table 7.12: *Model including two-way interactions and polynomials of the second degree of the C dataset*

High-level descriptions of the effects on the interaction terms on the dependent variable, and thus on payment behaviour, are provided in Table 7.13 based on the parameter estimates displayed in red.

7.7.5 Combining the effect of interaction effects and outliers

When applying the M Estimation method, one data point was indicated as an outlier. The application of the LTS method identified two data points as outliers.

The R^2 s of the models increased to 0.57 and 0.59 respectively. The parameter estimates stayed relatively unchanged, thus the deletion of the outliers did not have a noteworthy effect. Again, these models are similar to the interaction model and the detailed model results are documented in Tables B.24 and B.25 in Appendix B. Table 7.13 contains the parameter estimates (in black and blue) and high-level descriptions of the effect on payment behaviour.

Variable:	Indicator_KZN_ln_x64
Variable description:	ln_x64 = ln (departmental capital expenditure per capita)
Parameter estimate:	(0.65) (0.82) (0.81)
Description of effect:	Payment behaviour worsens as departmental capital expenditure per capita of KwaZulu-Natal increases.
Variable:	Indicator_Department_ln_x49
Variable description:	0 = Health, 1 = Education ln_x49 = ln (provincial surplus/deficit to provincial payments)
Parameter estimate:	(-5.36) (-6.65) (-7.14)
Description of effect:	The negative parameter estimate shows that an increase in ln_x49 (provincial surplus/deficit to provincial payments) leads to an improvement in payment behaviour where the Department of Education is concerned.
Variable:	Indicator_Lim_ln_x59
Variable description:	ln_x59 = ln (provincial GDP growth)
Parameter estimate:	(-0.42) (-0.41) (-0.31)
Description of effect:	Limpopo's payment behaviour will improve if provincial GDP growth increases.
Variable:	Indicator_EC_ln_x63
Variable description:	ln_x63 = ln (departmental total revenue per capita)
Parameter estimate:	(1.42) (1.45) (1.44)
Description of effect:	The positive parameter estimate indicates that payment behaviour will worsen if ln_x63 increases.
Variable:	Indicator_Gau_ln_x65
Variable description:	ln_x65 = ln (departmental total expenditure per capita)
Parameter estimate:	(1.36) (1.32) (1.32)
Description of effect:	The positive parameter estimate indicates that payment behaviour will worsen if the departmental total expenditure per capita of Gauteng increases.
Variable:	x27_grouped_ln_x65
Variable description:	x27_grouped = departmental annual appropriation of revenue to total departmental revenue (grouped) ln_x65 = ln (departmental total expenditure per capita)
Parameter estimate:	(-0.84) (-0.87) (-0.83)
Description of effect:	Payment behaviour will improve as ln_x65 increases, provided that x.27 is high (group = 1). In the case of low values of x27 (group = -1) an increase in ln_x65 will lead to a worsening in payment behaviour.
Variable:	Indicator_Lim_ln_x50
Variable description:	ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(-44.85) (-44.73) (-45.22)
Description of effect:	An increase in ln_x50 will lead to better payment behaviour, this only applies to the Limpopo province.
Variable:	ln_x14_ln_x58
Variable description:	ln_x14 = ln (departmental capital expenditure to total provincial capital expenditure) ln_x58 = ln (provincial GDP per capita growth)
Parameter estimate:	(0.28) (0.26) (0.27)
Description of effect:	Payment behaviour worsens as the interaction term increases. Same applies for each of the separate independent variables. An increase in departmental capital expenditure to total provincial capital expenditure (ln_x14), as well as provincial GDP per capita growth (ln_x58) will be detrimental to payment behaviour.
Variable:	Indicator_NC_ln_x34
Variable description:	ln_x50 = ln (provincial total receipts to provincial total payments)
Parameter estimate:	(14.19) (13.71) (13.58)
Description of effect:	An increase in ln_x34 will lead to worse payment behaviour, this only applies to the Northern Cape.

Table 7.13: Descriptions of the interaction effects of the C dataset's model (the interaction model's parameter estimates are indicated in red, the interaction model without dependent outliers' in black and interaction model without independent outliers' in blue)

7.8 Summary and conclusions

In Chapter 6 various linear regression models were built to predict future payment behaviour. In this chapter, various ways to improve these models were investigated. Firstly, using an alternative dependent variables was tested. Also, subject knowledge as variable selection method were compared with the more traditional methods namely stepwise, forward, backward. Thirdly possible interaction terms were added to see if the R^2 s could be improved. Lastly, the effect outliers were investigated. The investigation was necessitated since higher R^2 s are preferred. The results of each dataset's model advancement investigations were documented separately in Sections 7.2 to 7.6.

Only in the case of the E dataset did the alternative dependent variable result in an improvement of R^2 . However this improvement was minor. In all the other cases the R^2 either remained constant or worsened. Thus, in all cases the decision was made not to use the alternative dependent variable. Due to this decision these models will not be discussed in the next chapter.

The inclusion of additional independent variables based on the subject knowledge variable selection method improved the R^2 s of the models, but in 91.6% of the cases the prediction accuracies remained constant or worsened.

The inclusion of interaction effects improved the models in terms of R^2 in all cases. However, these models are complex. In the next chapter the models documented in Chapters 6 and 7 will be compared and recommendations will be provided as to which models should be used in future.

Lastly, outliers were identified, deleted and the parameter estimates were recalculated. This always resulted in an increase in R^2 . However, the loss of data should be compared to the R^2 improvement to determine if the improvement is worth the loss of data. Again the results of Chapter 8 have to be taken into account to make such a decision.

As mentioned above, the next chapter will compare the linear regression models presented previously. These results, together with the results presented previously, will be used to decide if the complexity of the interaction models and the loss of data due to outliers are worthwhile.

Chapter 8

MODEL COMPARISONS AND RECOMMENDATIONS

8.1 Introduction

The aim of the models developed in Chapters 6 and 7 was to rank South African subnationals (specifically the Department of Health and the Department of Education) in terms of future payment behaviour based on quantitative information. The aim of this chapter is to test the appropriateness of the developed models, i.e. to decide on a payment behaviour model to be used in future to predict payment behaviour. Note that the rankings resulting from the developed models can also be used to assign RAG (Red, Amber or Green) statuses. Red indicates bad payment behaviour, Amber indicates average payment behaviour and Green indicates good payment behaviour.

Testing the appropriateness of the models includes comparisons of all the Health models (models resulting from the HT and H datasets), the Education models (models resulting from the ET and E datasets) and the Combined models (models resulting from the CT and C datasets). The comparisons include the R^2 s of the models, the number of data points deleted, the number of terms and independent variables included in the models, the number of data sources needed to update the models, the number of factors represented by the independent variables and the number of correctly predicted RAG statuses.

These comparisons are used to provide recommendations with regard to which models should be used in future to rank the departments in terms of expected payment behaviour. Once model recommendations are made available, two models (one for the Department of Health and one for the Department of Education) are used for illustrative purposes. These two models are used to compare the RAG statuses predicted by the models with the actual RAG statuses of the financial year 2012/13. These are illustrated graphically by means of maps of South Africa, coloured according to the predicted and actual RAG status.

Lastly, case studies are provided. These illustrate how the RAG statuses predicted by the models based on quantitative information (equating to 30% of final ranking or RAG status) can be overlaid with some more recent qualitative information (equating to 70% of final ranking or RAG status) to derive a final RAG status. Dashboards were constructed to illustrate this.

Note that the specifications regarding South African subnationals' borrowing discussed in Chapter 4 should be taken into account when deciding to extend credit to a provincial department (based on a ranking or RAG status resulting from the developed models), since non-adherence could lead to unenforceable loan arrangements. An example of such a specification is that the issuing of guarantees by the national government is usually not permitted.

The models resulting from the Health datasets are discussed in Section 8.3 and then the Education datasets' in Section 8.4. Section 8.5 documents the model comparison and recommendations of the Combined datasets. Section 8.6 concludes the chapter.

8.2 Validation

To compare the models developed in Chapters 6 and 7 and to make recommendations with regard to future usage, the model's applicability beyond the dataset it was originally developed on has to be assessed first. This can also be referred to as model validation, as stated by Kutner et al. (2005).

There are three ways to validate a model (Kutner et al., 2005). One can collect new data and re-apply the model to verify the model's predictive ability in this manner. Another method is to compare the results with theoretical expectation, earlier empirical results and simulation results. The last method discussed is the use of a holdout sample to verify the model and its predictive ability.

The first method, i.e. the collection of new data, is recommended by Kutner et al. (2005). This was also the method used to validate the linear regression models developed in Chapters 6 and 7. The data from the same sources as discussed in Chapter 5 were used, but for the latest available financial years. Thus, the 2011/12 financial year's data were used for the independent variables to predict the values of the dependent variable for 2012/13. The newly available 2012/13 financial year's data are used for comparison purposes.

The ultimate aim of the developed models is not to predict a department's numerical value of the dependent variable, but to rank the departments expected future payment behaviours with regard to each other. The rankings are based on the predicted values of the proxy for payment behaviour, thus the ratio of accruals in excess of 30 days to total expenditure. Accrual in excess of 30 days is of importance since provincial departments are expected to repay creditors within 30 days of the receipt of the invoice. This is stipulated by the PFMA documented in Section 4.2.1.

The rankings based on the proxy for payment behaviour can either be one to nine, or a RAG status can be assigned to each of the nine provinces' departments. The following procedure was used to allocate the RAG statuses: bottom third (bad payment behaviour based on high values of the payment behaviour proxy) are assigned red statuses, middle third (average payment behaviour) are assigned amber statuses and the top third (good payment behaviour based on low values of the payment behaviour proxy) are assigned green statuses.

For explanatory purposes the HT interaction model without dependent outliers is applied to indicate how the RAG statuses were derived, the details of the model can be found in Section 7.2.5.

The following formula relates to this model:

$$\begin{aligned}\hat{Y}_3 = & 1.04 - 19.71(Indicator_WC_3 \times ln_x49_3) - 0.66(x27_grouped_3 \times Indicator_x36_Z_3) \\ & + 0.59(Indicator_Lim_3 \times ln_x36_Zmean_3) - 31.99(Indicator_KZN_3 \times ln_x48_3) \\ & - 0.20(Indicator_Mpu_3 \times ln_x57_3) + 66.26(Indicator_Lim_3 \times ln_x50_3) \\ & - 22.00(Indicator_FS_3 \times ln_x33_3) - 15.10(x27_grouped_3 \times ln_x34_3)\end{aligned}\quad (8.1)$$

(where $i = 3$, which is the case number of the Gauteng Department of Health)

Applying Equation 8.1 to the Department of Health of Gauteng's data from 2011/12 results in the following:

$$\begin{aligned}\hat{Y}_3 = & 1.04 - 19.71(0 \times 10) - 0.66(-1 \times 1) \\ & + 0.59(0 \times -1.57) - 31.99(0 \times 0.10) \\ & - 0.20(0 \times 11.39) + 66.26(0 \times 0.02) \\ & - 22.00(0.01) - 15.10(-1 \times 0.01)\end{aligned}\quad (8.2)$$

$$\hat{Y}_3 = 1.86$$

Table 8.1 indicates the predicted values of the dependent variable, the proxy for payment behaviour, when applying the formula to all provinces' Departments of Health information for 2011/12.

Province	Predicted Y
Limpopo	-3.27
KwaZulu-Natal	-1.77
Western Cape	-1.51
Mpumalanga	-1.16
Northern Cape	0.41
Eastern Cape	0.46
Free State	0.60
North West	0.95
Gauteng	1.86

Table 8.1: *Predicted values of the dependent variable when applying the HT interaction model without dependent outliers*

The ranking of the departments' expected future payment behaviours with regard to each other are indicated in Table 8.2, as well as the RAG statuses relating to these rankings. In this case Gauteng's Department of Health is ranked ninth and its RAG status is red.

Province	Predicted Y	Predicted Rank	Predicted RAG
Limpopo	-3.27	1	G
KwaZulu-Natal	-1.77	2	G
Western Cape	-1.51	3	G
Mpumalanga	-1.16	4	A
Northern Cape	0.41	5	A
Eastern Cape	0.46	6	A
Free State	0.60	7	R
North West	0.95	8	R
Gauteng	1.86	9	R

Table 8.2: *Illustration: assigning ranks and RAG statuses*

These predicted RAG status were used as part of the method to test the appropriateness of the linear regression models documented previously. The RAG statuses predicted were compared to the actual RAG statuses based on the newly available data of 2012/13 and the number of correctly assigned RAG statuses was counted as a measure of the model's predictive ability.

8.3 Health with and without time (HT and H)

The validation results are included in the model comparison of the linear regression models resulting from the HT and H datasets. These are provided next. This comparison is followed by recommendations with regard to which models to use in future. The predicted vs. actual ranks and RAG statuses of one the developed models are also documented. Lastly, a case study is provided to illustrate how the models can be used in future.

8.3.1 Model comparison

Table 8.3 compares the 16 models resulting from the HT and H datasets in terms of R^2 , the number of data points deleted, the number of terms and independent variables included in the models, the number of data sources needed to update the models, the number of factors represented by the independent variables and the number of correctly predicted RAG statuses.

In the case of the 16 models represented in Table 8.3, the models with the highest R^2 s are the five interaction models without outliers. Considering the data loss compared to the improvement in terms of R^2 , all data losses are considered to be worthwhile. The highest loss of data is 13.3%, but it yields an improvement of 73.5% (H interaction model without dependent outliers). The minimum number of terms included in the Health models is four and the maximum is ten. The number of data sources needed to update the HT models are three and five and the number of data sources of the H models range from three to six. The number of broad factors represented by the independent variables included in the models are two to four. The interaction models are the models that predicted the most RAG statuses correctly.

Data-set	Model	R^2	Data deleted	Number of terms	Number of independent variables	Number of data sources	Number of factors	Number of correct RAG statuses
HT	Stepwise, forward, backwards and best subset	0.51		5	2	3	2	2
	Stepwise with subject knowledge selection	0.53		7	4	5	4	1
	Stepwise without dependent outliers	0.58	1	5	2	3	2	2
	Stepwise without independent outliers	0.65	4	5	2	3	2	3
	Interaction model	0.74		8	10	4	2	7
	Interaction model without dependent outliers	0.80	1	8	10	4	2	7
	Interaction model with subject knowledge selection but without dependent outliers	0.80	1	10	12	6	4	7
	Interaction model without independent outliers	0.90	5	8	10	4	2	6
H	Stepwise and forward	0.49		4	2	2	2	5
	Backwards and best subset	0.54		5	3	2	2	5
	Stepwise with subject knowledge selection	0.53		6	4	5	4	3
	Stepwise without dependent outliers	0.69	3	4	2	2	2	5
	Stepwise without independent outliers	0.72	4	4	2	2	2	5
	Interaction model	0.62		6	7	5	3	6
	Interaction model without dependent outliers	0.85	6	6	7	5	3	6
	Interaction model without independent outliers	0.82	4	6	7	5	3	5

Table 8.3: Comparison of payment behaviour models developed for the HT and H datasets

8.3.2 Model recommendation

Deciding on which model to use in future depends on the reason for using the model. For example, if the model is used for explanation purposes, the model explaining most of the dependent variable's variance, thus the model with the highest R^2 , will be chosen. If the model is used to predict the future payment behaviour, the model with the best prediction power will be chosen, thus the model with the highest number of correctly predicted RAG statuses. However, the other aspects discussed, such as the number of terms included in the model and the number of broad factors represented by the independent variables included in the model, should also be taken into account.

The purpose of this chapter is to test the appropriateness of the developed models, i.e. to decide on a payment behaviour model to predict future payment behaviour, focussing on the RAG statuses. As can be seen from Table 8.3, three of the models predicted seven out of the nine (77.78%) statuses correctly. Between these models the HT interaction models without dependent outliers had the highest R^2 s at 0.80. However, the model based on subject knowledge requires six data sources to update the model as opposed to the four data sources of the other model. One of these models (HT interaction model without dependent outliers) will be used for the illustrations provided next.

8.3.3 Predicted vs. actual ranks and RAG statuses

In the first illustration, the model is used to compare the predicted vs. actual ranks and RAG statuses with each other.

The ranks and RAG statuses of the provinces' Departments of Health predicted by the HT interaction model without dependent outliers are shown in Table 8.4. As mentioned previously, the predicted values for 2012/2013 are based on the information of the independent variables contained in the data of the financial year 2011/12. Refer to Section 8.2 for the explanation of how these ranks and RAG statuses were derived. The actual values is the ranks and RAG statuses based on the true outcomes of the dependent variable as documented in the newly available annual reports of the financial year 2012/2013.

Province	Predicted Rank	Predicted RAG	Province	Actual Rank	Actual RAG
Limpopo	1	G	Western Cape	1	G
KwaZulu-Natal	2	G	KwaZulu-Natal	2	G
Western Cape	3	G	Eastern Cape	3	G
Mpumalanga	4	A	Limpopo	4	A
Northern Cape	5	A	Mpumalanga	5	A
Eastern Cape	6	A	Northern Cape	6	A
Free State	7	R	North West	7	R
North West	8	R	Free State	8	R
Gauteng	9	R	Gauteng	9	R

Table 8.4: *Predicted ranks and RAG statuses resulting from the example payment behaviour model vs. the actual ranks and statuses*

Only two provinces' RAG statuses were predicted incorrectly, namely Limpopo and the Eastern Cape. In Figure 8.1 the predicted vs. actual RAG statuses for each provinces' Department of Health are graphically represented.

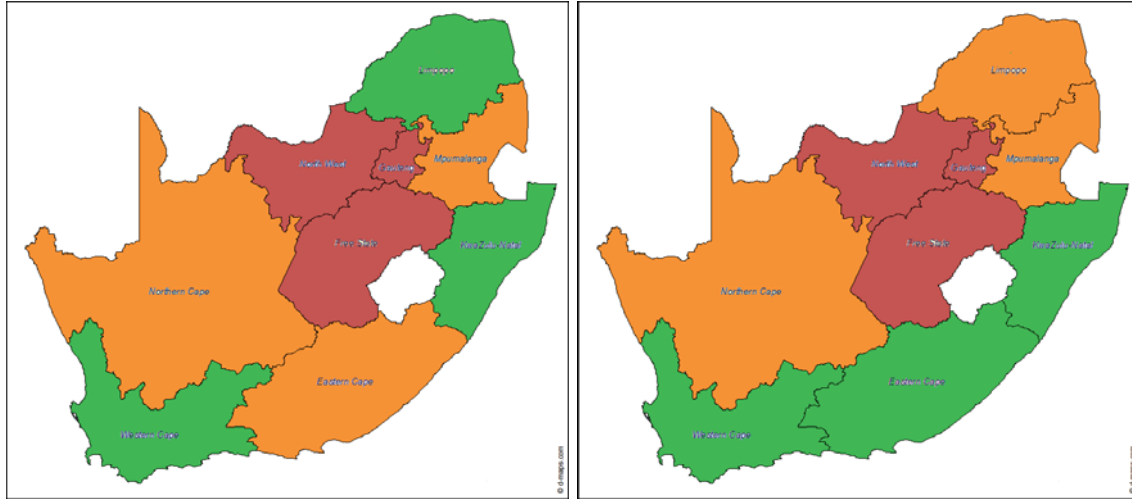


Figure 8.1: *The predicted (left) vs. actual (right) RAG statuses of the provinces' Departments of Health*

8.3.4 Case study: deriving the final ranking of Gauteng's Department of Health

A case study is provided next to demonstrate how the developed models could be used in future.

As explained in Chapters 3 and 5, credit rating methodologies are normally based on a combination of quantitative and qualitative factors since the qualitative information will be assessed by a team of analysts and then used as input in the model. Typically, credit rating methodologies for developing countries comprise 30% quantitative factors and 70% qualitative factors.

The models resulting from Chapters 6 and 7 can be viewed as the quantitative part of a credit rating methodology since it contains only quantitative information. The qualitative information therefore has to be taken into account as an intuitive overlay. Examples of qualitative information that should be considered are information such as management sophistication and budgeting practices. This information relates to the broad factor management quality and institutional strength.

Documented next is a case study that illustrates how a predicted ranking, resulting from the HT interaction model without dependent outliers, overlaid with some qualitative information can be used to derive a final ranking. The case study concentrates on Gauteng's Department of Health.

The predicted ranking with regard to the other provinces was nine; see Section 8.2 for the explanation of this calculation. Again, this is considered to be the quantitative part of the final ranking, thus equating to 30% of the final ranking. Note that this ranking is based on the 2011/12 data and predicts a payment behaviour ranking for 2012/13.

However, the latest qualitative information (2014) should also be taken into account. An example of qualitative information that should form part of the intuitive overlay is the news article issued by

SABC News on 30 April 2014. This article states that the Zola-Jabulani Hospital building project was finished five years later than planned and the actual costs were three times higher than what was budgeted (Anon., 2014a). This might indicate a lack of management sophistication and poor financial planning. Another example of inadequate management and financial planning is provided by a press release issued by the Gauteng Department of Health (2014). The department states that they did experience challenges of late or non-payment in the past, but they are rectifying the problem. Also, the department's annual report of 2012/13 reported that a turnaround strategy has been deployed focusing, among other things, on financial management. The figures reported in this annual report did in fact illustrate an improvement in the debt repayment numbers. The ratio accruals in excess of 30 days to total expenditure improved from 10.05% to 4.49% from 2011/12 to 2012/13. However, it is yet to be seen if this improvement is sustainable.

Typically, the above-mentioned information, as well as any other available qualitative information, will be reviewed by a team of analysts. The analysts will then rank Gauteng's Department of Health's expected payment behaviour with regard to the other provinces by taking into account their qualitative information too. However, this case study focuses only on Gauteng and therefore the other provinces' qualitative information is not provided. For illustrative purposes it will be assumed that Gauteng has an average red status, thus a ranking of eight, based on provided qualitative information. This ranking can be viewed as the qualitative part of the final ranking and therefore will equate to 70% of the final ranking.

Taking both the quantitative and qualitative rankings into account, the final ranking of Gauteng's Department of Health is about eighth. This is derived as follows: $30\% \times 9 + 70\% \times 8 = 8.3$. Thus, the RAG statuses based on the quantitative (ranking = 9) and qualitative information (ranking = 8,) as well as the final RAG status (ranking = 8), were red. In this case, the qualitative information reinforced the red status that was assigned based on the quantitative information. See Figure 8.2 for a graphical illustration in terms of a dashboard.



Figure 8.2: *Illustration combining a predicted ranking with a qualitative overlay to derive a final ranking*

8.4 Education with and without time (ET and E)

A model comparison of the developed models of the ET and E datasets is provided next, as well as some recommendations with regard to which models to use in future. Also, a review of the predicted vs. actual ranks and RAG statuses of one of the developed models is made available. Lastly, a case study of the Department of Education of Limpopo is provided to illustrate how the models can be used in future.

8.4.1 Model comparison

Nine unique linear regression or payment behaviour models resulted from the ET and E datasets. Table 8.5 contains a comparison of the models.

The models with the highest R^2 s are the interaction models without outliers. The interaction model without dependent outliers of the E dataset has the highest R^2 at 0.86 and the highest loss of data at five data points. In all cases the data loss compared to the improvement in terms of R^2 seems to be worthwhile. The minimum number of terms included in the Education models is four and the maximum is ten. The number of independent variables included range between three and nine. The number of data sources needed to update the ET models range between three and six and the number of data sources needed for the E models are four and five. The four independent variables included in the stepwise, forward, backwards and best subset model of the E dataset represent all four broad factors. The two interaction models without independent outliers of the ET dataset predicted seven of the nine (77.78%) RAG statuses correctly.

8.4.2 Model recommendation

As mentioned in Section 8.3.2, the decision of which model to use in future depends on the reason for using the model. The model with the highest R^2 will be chosen if the goal is to explain the variance of the dependent variable, but the model with the highest number of correctly predicted RAG statuses will be chosen if the goal is to predict. Again, some other aspects, such as the data points deleted and the number of data sources needed to update the models, should also be taken into account.

The purpose of this chapter is to decide on a payment behaviour model to predict future payment behaviour, focussing on the RAG statuses. The two interaction models without independent outliers of the ET dataset predicted seven out of the nine (77.78%) statuses correctly. The model based on subject knowledge requires two additional data sources to be updated. The ET interaction model without independent outliers would rather be used for the illustrations provided in the remainder of this section.

Data-set	Model	R^2	Data deleted	Number of terms	Number of independent variables	Number of data sources	Number of factors	Number of correct RAG statuses
ET	Stepwise, forward, backwards and best subset	0.48		4	3	3	2	4
	Stepwise with subject knowledge selection	0.49		6	5	5	4	5
	Interaction model	0.70		8	7	4	2	5
	Interaction model without independent outliers	0.74	1	8	7	4	2	7
	Interaction model with subject knowledge selection but without independent outliers	0.77	1	10	9	6	4	7
E	Stepwise, forward, backwards, best subset and stepwise with subject knowledge selection	0.45		4	4	4	4	3
	Interaction model	0.71		7	8	5	3	5
	Interaction model without dependent outliers	0.86	5	7	8	5	3	5
	Interaction model without independent outliers	0.75	1	7	8	5	3	5

Table 8.5: *Comparison of payment behaviour models developed for the ET and E datasets*

8.4.3 Predicted vs. actual ranks and RAG statuses

The ranks and RAG statuses of the provinces' Departments of Education predicted by model used for illustrative purposes are shown in Table 8.6.

Again, the predicted values for 2012/2013 are based on the information of the independent variables contained in the data of the financial year 2011/12 and the actual values are the true outcomes based on the new data documented in the annual reports of the financial year 2012/2013. Refer to Section 8.2 for an example of the calculations of the predicted ranks and RAG statuses.

Province	Predicted Rank	Predicted RAG	Province	Actual Rank	Actual RAG
North West	1	G	Western Cape	1	G
Western Cape	2	G	Mpumalanga	2	G
Limpopo	3	G	North West	3	G
Mpumalanga	4	A	Limpopo	4	A
Eastern Cape	5	A	Eastern Cape	5	A
Northern Cape	6	A	Northern Cape	6	A
Free State	7	R	Gauteng	7	R
KwaZulu-Natal	8	R	KwaZulu-Natal	8	R
Gauteng	9	R	Free State	9	R

Table 8.6: *Predicted ranks and RAG statuses resulting from the example payment behaviour model vs. the actual ranks and statuses*

The two provinces' whose RAG statuses were inaccurately forecasted by the ET interaction model without dependent outliers are Limpopo and Mpumalanga. Figure 8.3 provides a graphical representation of the predicted vs. actual statuses per province.

8.4.4 Case study: deriving the final ranking of Limpopo's Department of Education

A case study focussing on Limpopo's Department of Education is provided next to demonstrate how the developed models could be used.

The previously developed models can be viewed as the quantitative part of a credit rating methodology, since it contains only quantitative information. Therefore, qualitative information such as a subnational's infrastructure needs and the political stability within the province should be taken into account as a superimposed overlap.

This case study illustrates how a predicted ranking, resulting from the linear regression model, overlaid with some qualitative information, can be used as a final ranking. The case study concentrates on Limpopo's Department of Education.

The predicted ranking with regard to the other provinces resulting from the ET interaction model without independent outliers was three. Thus a green RAG status was assigned. This ranking is

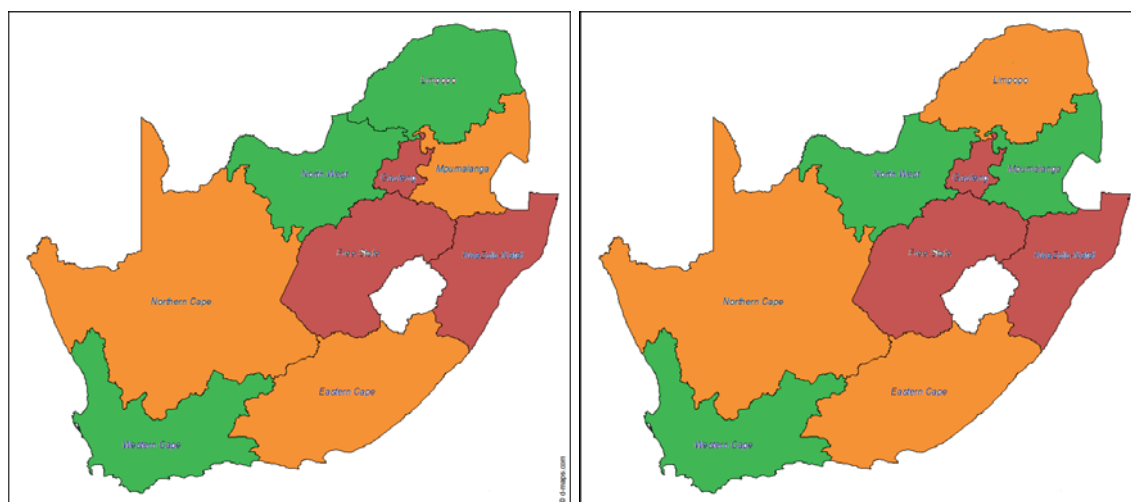


Figure 8.3: *The predicted (left) vs. actual (right) RAG statuses of the provinces' Departments of Education*

based on the 2011/12 data and predicts a payment behaviour ranking for 2012/13. This ranking can be viewed as representing the 30% quantitative factors of the final credit rating. Section 8.2 contains an example of the calculation.

Some examples of recently available qualitative information are reviewed next to illustrate the superimposed overlap. In 2012 the Department of Education of the Limpopo province failed to deliver textbooks by June (Anon., 2014c) and 70% of the grade 10 pupils at 25 schools in Limpopo failed the June exams as a result (Anon., 2012). In March 2014 it was reported that 23 schools again needed 18 000 textbooks (Anon., 2014c). At first, the department blamed a system malfunction for these late deliveries and refused to apologise to pupils who were affected (Ngobeni, 2014). In May 2014 it was reported that textbooks had indeed been delivered to all schools in Limpopo, but some principals had failed to report shortages in time and that books are being delivered to schools who did report shortages (Anon., 2014b). Meaney (2014) reported that over and above the textbook delivery issues, the province also battled with sanitation problems and dilapidated infrastructure. The above-mentioned information points to service delivery issues, lack of management sophistication and an infrastructure need. These issues can also lead to political instability in future.

Typically, the above-mentioned information and any other qualitative information available will be reviewed by a team of analysts. The analysts will then rank the Department of Education of Limpopo's expected payment behaviour with regard to that of the other provinces. This will be done by also taking the qualitative information of the Departments of Education from other provinces into account. However, this case study focuses only on Limpopo and therefore the other provinces' qualitative information is not provided. Thus, for illustrative purposes it will be assumed that Limpopo has an average red RAG status, thus a ranking of 8, based on provided qualitative information. This ranking can be viewed as the qualitative part of the final ranking and will equate to 70% of the resulting ranking.

When both the quantitative and qualitative rankings of the Department of Education of Limpopo are taken into account, the final ranking is about sixth. This is derived as follows: $30\% \times 3 + 70\% \times 8 = 5.6$. Thus the RAG status based on the quantitative information was green (ranking = 3), the RAG status based on the qualitative information was red (ranking = 8) and the final RAG status is amber (ranking = 6) (Figure 8.4). In this case study the qualitative information altered the green status to an amber status.

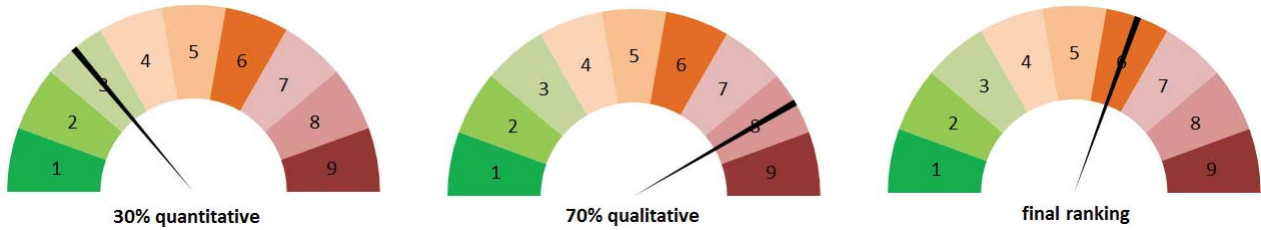


Figure 8.4: *Dashboard illustrating combining a predicted ranking with a qualitative overlay to derive a final ranking*

8.5 Combined with and without time (CT and C)

This section provides a model comparison of the payment behaviour models resulting from the Combined with and without time datasets (CT and C) and model recommendations.

8.5.1 Model comparison

Table 8.7 compares all 12 models developed for the Combined datasets. The table contains the R^2 s, number of data points deleted, number of terms and independent variables included in the models, number of data sources needed to update the models, number of factors represented by the independent variables and the number of correctly predicted RAG statuses.

The R^2 s of the developed models range from 0.49 to 0.59. The maximum number of data points deleted, thus two data points, corresponds to the highest R^2 of 0.59. In this case the improvement in terms of R^2 of 20.2% outweighs the loss of data of 2.2%. The number of terms included in the CT, as well as the C models, ranged between six and nine. In both cases the number of independent variables included ranged from four to ten. The number of broad factors represented by the independent variables included in the models are three and four. These models are based on the Combined dataset, thus the total number of predicted RAG statuses are 18. Taking this into account the best performing model, CT interaction model, predicted only 50% (9 out of 18) of the statuses correctly.

Data-set	Model	R^2	Data deleted	Number of terms	Number of independent variables	Number of data sources	Number of factors	Number of correct RAG statuses
CT	Stepwise, forward and backwards	0.49		6	4	3	3	8
	Best subset	0.52		8	6	3	3	6
	Stepwise with subject knowledge selection	0.49		7	5	5	4	7
	Stepwise without independent outliers	0.50	1	6	4	3	3	8
	Interaction model	0.55		9	10	5	3	9
C	Stepwise, forward and stepwise with subject knowledge selection	0.49		6	4	4	4	8
	Backwards	0.50		7	5	5	4	7
	Best Subset	0.52		8	6	5	4	7
	Stepwise without independent outliers	0.49	1	6	4	4	4	8
	Interaction model	0.53		9	10	5	3	4
	Interaction model without dependent outliers	0.57	1	9	10	5	3	6
	Interaction model without independent outliers	0.59	2	9	10	5	3	6

Table 8.7: Comparison of payment behaviour models developed for the CT and C datasets

8.5.2 Model recommendation

It is recommended that these models should not be used for future predictions, but to rather use one of the models developed based on the data specifically compiled for the Department of Health or Education (whichever department's behaviour needs to be predicted). The discussion below explains the reasoning behind this recommendation.

The payment behaviour models resulting from the Health and Education datasets performed better in terms of predicting new data than the models resulting from the Combined datasets. The Combined models predicted a maximum of 50% of the new cases correctly as opposed to the Health and Education models' 78%. Note that this evaluation is based on the number of RAG statuses predicted correctly.

The recommendation is also supported by the information documented in Section 5.5. It was noted that the models developed based on the Combined datasets were done for completeness sake only and that the department-specific models should be used instead. The reason is that some of the independent variables included in the Combined datasets were structured according to departments. This was due to the aggregation of the Department of Health and Education datasets to form the Combined datasets.

In Chapter 3 some generic and country specific subnational credit rating methodologies were documented. Literature revealed that models tailored for specific populations outperform generic models (Thomas, 2000; Anderson, 2007). It is also true in this case, as can be seen from comparing the validation results of the models resulting from the different datasets. The models resulting from the Combined datasets (i.e. generic models) predicted a maximum of 50% of new cases correctly, as opposed to the 78% prediction accuracies of the models resulting from the Health and Education datasets (i.e. specific models). One possible explanation is the difference in the functions that the departments perform. In essence, this equates to two different types of populations and causes different information to be important for the different departments. Thus different independent variables (and therefore models) are needed to predict the payment behaviour of the different departments.

For example, in order for the Departments of Health to deliver the required health services, sophisticated medical equipment is needed. In this case independent variables containing surplus/deficit information is of importance since surpluses could be used to purchase the needed medical equipment. The Departments of Education on the other hand has to ensure that compensation to employees do not fall into arrears to avoid political unrest. Therefore personnel expenditure information is of interest.

However, the independent variables containing surplus/deficit information and the independent variables containing personnel expenditure information represents the same broad factor; fiscal performance. The broad factors, identified by literature in Section 3.4.4, is also applicable for the departmental level models, even though different independent variables are included in the different departments' models.

As an illustration of the difference of the importance of the independent variables, the developed models are assessed. This assessment is based on the linear regression models used for the previous illustrations too, thus HT's interaction model without dependent outliers and ET's interaction model without independent outliers.

The HT interaction model without dependent outliers included four unique independent variables (compared to the ET interaction model without independent outliers). These variables are: $\ln_x33$, $\ln_x34$, $\ln_x48$ and $\ln_x49$. All four of these independent variables contained information regarding either the departments' or the provinces' deficit/surplus ratio. Again, the need for sophisticated medical equipment of health departments may explain the importance of the surplus/deficit ratios, since surpluses could be used for purchasing equipment.

The ET model, however, included three unique independent variables namely: time, $\ln_x29$ ($\ln$ (departmental personnel expenditure to departmental total current expenditure)) and $\ln_x60$ ($\ln$ (provincial dependent population to total population)). As explained previously, personnel expenditure for the Departments of Education is important since accruals can lead to political unrest. The inclusion of $\ln_x60$ ($\ln$ (provincial dependent population to total population)) also make sense in this case since the pupils needing education forms part of the dependent population and therefore any changes to this ratio may affect the future educational needs of the province.

Based on the above, it is recommended that none of the Combined models should be used for future predictions, but that one of the models developed based on the data specific to the relevant department be used.

8.6 Summary

This chapter compared the payment behaviour models presented in Chapters 6 and 7, illustration of actual vs. predicted values and a case study for the models resulting from the Health and Education datasets were given in Sections 8.3 and 8.4. Only the model comparison and recommendations were applicable in the case of the Combined datasets and can be found in Section 8.5.

The aim of this chapter was to recommend a payment behaviour model to predict future payment behaviour, focussing on the RAG statuses. Three of the HT models could be used when assessing a Department of Health since they predicted seven out of the nine (77.78%) statuses correctly. The interaction model without independent outliers was used for the illustrations.

The two interaction models without independent outliers of the ET dataset predicted seven out of the nine (77.78%) statuses correctly. The interaction model without independent outliers of the ET dataset was used for the illustrations provided for the Education datasets.

No model was recommended for the Combined datasets' models, instead it was recommended to use one of the models developed based on the data specific to the Department of Health or Education due to the better prediction powers (78% correctly predicted RAG statuses as opposed to 50%).

Again, it is important to take into account that the predicted RAG statuses should only equate to 30% of the final ranking and that the other 70% of the final ranking should be based on qualitative information, which is taken into account as an intuitive overlay.

Note that the specifications regarding South African subnationals' borrowing discussed in Chapter 4 should be taken into account when deciding to extend credit to a provincial department (based on a ranking resulting from the developed models) since non-adherence could lead to unenforceable loan arrangements. An example of such a specification is that a provincial department may only

enter into a loan agreement in a foreign currency or financial market once written approval has been received from the minister of finance, and the minister must agree that the loan is in the public's interest.

Chapter 9

CONCLUSIONS AND FUTURE RESEARCH

9.1 Introduction

The problem statement of this thesis was to develop linear regression models that best predict future payment behaviour for the Departments of Health and the Departments of Education focusing on quantitative factors.

This was reached by addressing the four different objectives namely to provide a literature review of existing subnational credit rating methodologies, to develop the quantitative parts of credit rating methodologies for South Africa's Departments of Health and Departments of Education, to test the appropriateness of the proposed methodologies and to construct the datasets needed to address these objectives. The first objective was addressed in Chapter 3. The results of the developed methodologies are documented in Chapters 6 and 7. The third objective was addressed in Chapter 8 and the details of the constructed datasets are documented in Chapter 5. The compiled datasets have been made available electronically on a CD inserted at the back of the thesis.

This chapter highlights the key findings and conclusions of the thesis and provides recommendations (Section 9.2) suggestions for future research (Section 9.3).

9.2 Key findings

Chapter 2 provided information regarding South Africa's governing structure, a provincial overview and credit ratings in general. The provincial overview indicated that variations in the discussed measures, among other things, give rise to provincial uniqueness. These distinctions had to be taken into account when developing subnational credit rating methodologies for these provinces' departments.

Chapter 3 documented six examples of subnational credit rating methodologies and other information regarding subnational credit rating methodologies relevant to the study. Insights gained from the discussion include general knowledge regarding typical variables included in subnational credit rating methodologies. This knowledge was used to identify variables that can be used to develop the quantitative parts of credit rating methodologies for South Africa's subnationals, the Department of Health and Department of Education. One of the key findings of this chapter is that the variables used in the discussed subnational credit rating methodologies can be grouped

into five broad factors. These five factors are the subnational's economic conditions, the fiscal performance of the subnational, the financial and debt position of the subnational, the management quality and strength of subnational institutions, as well as the influence of the sovereign factors, intergovernmental relations and fiscal arrangements on the subnational (Liu and Tan, 2009). The inclusion of variables representing the four relevant broad factors (the fifth factor was omitted since all the departments reside within the same country and therefore the outcome of the factor will be the same) were used as subject knowledge in the development of the subnational credit rating methodologies. Another main finding drawn from Chapter 3 relates to the importance of quantitative factors and qualitative factors included in credit rating methodologies used for developing countries. Typically, quantitative factors amounts to 30% of the final credit rating and qualitative factors to 70% (Moody's, 2007).

Chapter 4 reviewed the South African regulatory framework governing South Africa's subnationals' borrowing. This regulatory framework sets the parameters within which subnational borrowing may take place and should therefore be taken into account when entering into a loan agreement with a subnational. Also, most of the data used for the development of the South African credit rating methodologies were sourced from the reports governed by South Africa's National Treasury. These reports were discussed briefly in this chapter.

The data used to develop the quantitative parts of credit rating methodologies were discussed in Chapter 5. Six different types of reports, compiled by four institutions, were used to gather data spanning five years. This equated to 124 different reports and one interactive dataset used to compile six datasets. The constructed datasets were a secondary objective of this thesis. The investigation of available data revealed that the number of departments per provincial government differs. In theory it should be possible to aggregate these data onto a provincial level to develop a provincial level subnational credit rating methodology, but in practice the unequal number of departments will pose difficulty in terms of data aggregation. Another key finding was that most of the data used are only made available once a year. Credit ratings, however, need to be updated on a regular basis to adjust for changing risk situations. The last observation drawn from this investigation was that the formats of some of the reports used change year-on-year, this may pose problems with regard to the future usage of the developed credit rating methodologies. The discussion regarding the data investigation was followed by a theoretical overview of linear regression modelling. Special attention was given to the dependent and independent variables used. The dependent variable used is a proxy for payment behaviour and only quantitative information was included in the datasets as independent variables. The resulting linear regression models were payment behaviour models that can be used to derive the 30% quantitative part of a final ranking or credit rating. Lastly, an explanation as to how linear regression models relate to credit rating methodologies was provided.

Chapter 6 documented the methodology used to develop the linear regression models, or payment behaviour models, as well as the results of the models developed using the six datasets. The models were developed in three steps. Firstly, variable clustering was performed to deal with multicollinearity among the independent variables. Then irrelevant independent variables were dealt with by using scatterplots of Spearman's correlation vs. Hoeffding's D ranks. Lastly, linear regression modelling based on four different variable selection techniques were used to develop the payment behaviour models. In certain instances some of the variable selection techniques resulted in the same final linear regression models. In total, ten unique linear regression models resulted from the datasets. Note that one methodology was used but different models were developed. The aim of the developed models was to rank South Africa's subnationals in terms of future payment

behaviour based on quantitative information.

In Chapter 7 the linear regression models were investigated to improve the R^2 values via four model advancement techniques, namely using an alternative dependent variable, using subject knowledge as a variable selection method, including interactions between the independent variables in the models and excluding outliers from the data. Only in one case did the alternative dependent variable result in an improvement of R^2 - but this improvement was marginal. For this reason the decision was made not to use the alternative dependent variable. The inclusion of additional independent variables, based on the subject knowledge variable selection method, improved the R^2 s of the models, but in 91.6% of the cases the prediction accuracies remained constant or deteriorated. The inclusion of interaction effects and the deletion of outliers improved the models. The complexity of the models including interaction effects and the loss of data when deleting outliers have to be taken into account by assessing the appropriateness of each model, when deciding whether the improvement in R^2 is worthwhile.

In total, 37 payment behaviour models were developed: 16 from the Health datasets, nine from the Education datasets and 12 from the Combined datasets. Chapter 8 tested the appropriateness of the developed models by comparing the models of each department. The comparisons contained the R^2 s of the models, number of data points deleted, number of terms and independent variables included in the models, number of data sources needed to update the models, number of factors represented by the independent variables and the number of correctly predicted RAG statuses. These comparisons were used to provide recommendations with regard to which models should be used in future. It was recommended that the decision (based on the information provided in the comparisons) as to which model to use in future should be based on the purpose for using the model. It was found that department-specific models outperform generic models in terms of prediction accuracy. Also, a comparison of the RAG statuses predicted by the models used for illustrative purposes and the actual RAG statuses were provided. This was followed by case studies illustrating how the predicted RAG statuses (which are based on quantitative information only) can be overlaid with recent qualitative information to derive a final RAG status. The case studies only illustrate how the models could be used but does not represent an actual credit rating methodology.

Note that the developed models could be used by banks, investors and third parties to decide whether they want to conduct business with a specific provincial department. Also, the provincial departments and National Treasury could use this as an aid in order to improve the departments' credibility.

9.3 Recommendations and suggestions for future research

In order to update the credit ratings resulting from the developed subnational credit rating methodologies as often as possible, the data used should be available on a regular basis (for example quarterly). Also, the format of the reports used should preferably stay constant over time. It is recommended that these preferences should be requested from National Treasury if the developed credit rating methodologies are used in future.

This thesis focused on the Departments of Health and Education. Possible future research may involve the application of the knowledge gained from this thesis to collect data for other departments and to develop linear regression models for such departments. By so doing, subnational credit rating methodologies can be developed for other South African provincial departments as well.

Due to the nature of the data used, the subnational credit rating methodologies developed in this thesis assess only quantitative information. However, the subnational credit rating methodologies reviewed in Chapter 3 assessed both quantitative and qualitative information. It is therefore recommended that future research addresses the identification and quantification of qualitative information that could be used to determine the credit quality of South Africa's subnationals.

The management quality and institutional strength, as well as financial and debt position broad factors were represented by only one and two independent variables respectively. The identification of more quantitative information that could represent these two broad factors could also be investigated further in future.

The provincial departments of South Africa use the cash base accounting system, but the accruals base accounting system generates more comprehensive financial statements. Potential research might involve that provincial governments and departments should be requested to make use of the accrual base accounting system instead. This will enable the redevelopment of the credit rating methodologies in future in order to include other data from the more comprehensive financial statements. This request should be presented to the National Treasury.

Chapter 5 asserted that time series analysis could also be used for modelling purposes. It is suggested that this possibility be investigated in future.

APPENDICES

Appendix A

DETAILS OF SUBNATIONAL CREDIT RATING METHODOLOGIES

A.1 International subnational credit rating methodologies

A.1.1 Fitch's international local and regional governments rating criteria outside the US

This section draws from Fitch's international local and regional governments* rating criteria outside the US (Fitch, 2011b), except if stated otherwise.

Fitch assesses the institutional framework within which the subnational government operates, as well as four other principal factors, including debt and other long-term liabilities, finances, management and administration, and the economic status of the subnational government (Figure A.1 and Table A.1). The institutional framework provides the context within which the four other factors interact.

Factor 1: Institutional framework

The institutional framework is assessed in order to understand the country's intergovernmental relations and funding, as well as to provide some insight into the operating environment of the subnational government. The institutional framework of a country influences the subnational's revenues and expenditures, the extent to which it influences depends on the framework. Fitch therefore assesses the revenue structure and flexibility, funding agreements, the subnational's responsibilities, the degree of autonomy in the country and the flexibility of expenditure. Control from the national government can be viewed as either a credit positive or a credit negative, depending on the level of control.

*Due to the generic definition this can theoretically be applied to the provincial governments, departments and municipalities of South Africa.

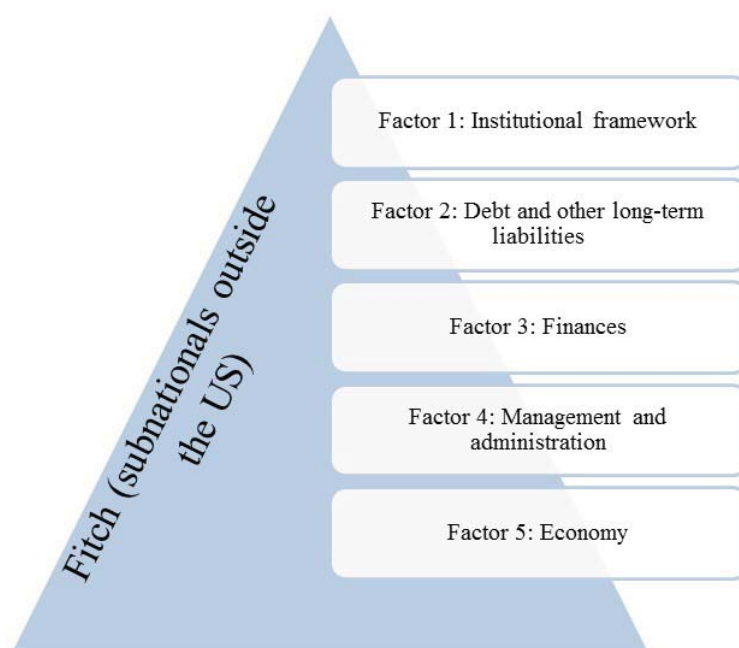


Figure A.1: *The factors used by Fitch to credit rate subnational governments (Adapted from Fitch, 2011b)*

Factor 2: Debt and other long-term liabilities

The debt and other long-term liabilities factor focuses on the extent and nature of liabilities, as well the future outlook of these liabilities by looking at debt ratios and trends, future capital and debt needs, debt structure, pension and other post-employment benefit funding, as well as indirect risks and contingent liabilities.

- **Debt ratios and trends**

A low debt burden is normally seen as a positive contributor to the overall creditworthiness of a subnational government. In order to determine whether or not a subnational has a low debt burden Fitch looks at trends in debt amounts compared to revenue resources because debt growth that is not in line with economic growth might cause future problems.

- **Future capital and debt needs**

Although current debt levels may be low, future infrastructure needs might lead to significant increases in debt ratios. This might have a negative effect on the subnational's future creditworthiness, therefore a thorough and realistic capital plan is viewed as beneficial to the subnational's credit rating.

- **Debt structure**

Debt types, proportions of debt used, the rate of repayment, the percentage of fixed-rate debt and the average life of debt amortisation is considered under this heading. Funds obtained by borrowing not used for capital investment purposes, as well as high levels of short-term and variable-rate debt are considered as weaknesses. Longer periods of average life of debt amortisation have a positive effect on the creditworthiness of a subnational.

Fitch, 2011 International Local and Regional Governments Rating Criteria: Outside the United States	
No	Factor
1	Institutional framework
2	Debt and other long-term liabilities
	Debt ratios and trends
	Future capital and debt needs
	Debt structure
	Pension and other post employment benefit funding
	Indirect risk and contingent liabilities
	Debt and default
3	Finances
	Revenue analysis
	Expenditure analysis
	Operating revenue and expenditure trends
	Fund balance and reserve levels
	Liquidity
4	Management and administration
	Institutionalised policies
	Budgeting practices
	Financial reporting and accounting
	Political, taxpayer and labour environment
	Revenue and spending limitations
5	Economy
	Major economic drivers
	Employment
	Income and wealth
	Other demographic factors
	Tax burden

Table A.1: *Summary of Fitch's international local and regional governments outside the United States rating methodology's factors (Fitch, 2011b)*

- **Pension and other post-employment benefit funding**

Subnationals with well-funded pension plans that are able to fund the yearly requirements will receive a favourable rating on this variable. High or increasing liability levels will impact a subnational's credit rating negatively.

- **Indirect risks and contingent liabilities**

Public entities are used to decentralise overall subnational risk. These entities are also allowed to enter into debt arrangements, their debt arrangements serve as indirect risks or contingent liabilities to subnational governments. These outstanding debts are tracked by Fitch, but are only included in the total tax supported debt calculations. The total tax supported debt includes direct debts from the subnational government itself, debt of public entities that are not self-supporting and unfunded pension commitments. Depending on the possible future impact of contingent liabilities, the effect of these on the subnational's credit rating can either be beneficial or detrimental.

- **Debt and default**

Only defaults that take place in the public markets are taken into account when Fitch determines a subnational's probability of default. Non-payments under swap or derivative contracts are thus not included in these calculations. Therefore this is included as a rating variable, and could either improve or worsen a subnational government's credit rating.

Factor 3: Finances

This factor focuses on the subnational's financial resources and its ability to honour its debt agreements. Financial statements, budget settlements and accounting policies are reviewed and used by Fitch to assess the finances of a subnational. Revenue and expenditure analysis, operating and current margin trends, fund balance and reserve levels, as well as the liquidity position are determined using the above-mentioned information.

- **Revenue analysis**

The volatility, diversity and predictability of revenue resources are assessed under this heading. Diverse revenue resources are normally seen as a credit positive and the reliance on economically sensitive revenue as a credit negative. The ability to control own revenue sources and a diverse revenue system will also improve one's credit rating.

- **Expenditure analysis**

Another important trend analysis is a subnational's expenditure trend analysis. Also examined is the flexibility and the ability to make changes to expenditure behaviour. The ability to maintain a balance is seen as a positive when considering credit strengths.

- **Operating revenue and expenditure trends**

Equally important to revenue and expenditure trends are operating and current margin trends. This compares recurring income with recurring expenditure. It is considered as negative when operating expenditure consistently exceeds operating revenue.

- **Fund balance and reserve levels**

Sufficient fund balances and reserve levels are considered a positive as it can act as a buffer against future revenue and expenditure volatility. Sufficient, however, depends on matters like the economy, revenue and expenditure volatility and the flexibility to alter revenue and spending patterns.

- **Liquidity**

Subnationals that do not depend on external cash flow borrowing are considered to have a strong liquidity position. A subnational's liquidity position takes into account tax collection schedules, timing of transfers to be received and the timing of payments to be made. A strong liquidity position is beneficial to the subnational government's credit rating.

Factor 4: Management and administration

Management can affect a subnational's credit rating, negative or positive, regardless of its stance on any of the other factors. The management and administration of a subnational is measured by its institutionalised policies, budgeting practices, financial reporting and accounting, the political, taxpayer and labour environment, as well as revenue and spending limitations.

- **Institutionalised policies**

The implementation of sound processes and policies for budgeting, debt and financial obligations and the consistent adherence to these policies is considered a credit positive according to Fitch.

- **Budgeting practices**

As part of Fitch's review of a subnational's budget practices it compares revenue and expenditure estimates to actual revenue and expenditure over time. Fitch also reviews the key assumptions these estimates were based on. Conservative estimates have a positive impact on a subnational's creditworthiness.

- **Financial reporting and accounting**

Subnationals with established accounting practices are expected to adhere to them. However, financial statements audited by an independent and reputable accounting firm are preferred. Any additional financial reporting is considered as a credit positive.

- **Political, taxpayer and labour environment**

Key to this variable is the government's ability to make efficient service and spending decisions, as well as the ability to adapt to changes in the economy and financial conditions. Taxpayer dissatisfaction and a difficult labour environment are considered a credit negative. The reason being that it limits the subnational's budgetary options and its ability to address budget shortfalls due to the effect that the dissatisfaction may have on the tax raising ability of the government. Political stability and confidence in the political system is seen as credit positives.

- **Revenue and spending limitations**

Complying with policy guidelines regarding revenue and spending is considered a credit positive. However, the inability to raise revenue or to obtain required funding due to these policies may be considered to have a negative impact on a subnational's credit rating.

Factor 5: Economy

The economy of a subnational government is reviewed to determine the government's ability to support ongoing operations and to repay debt. Key factors considered are the main economic drivers, employment trends, income and wealth levels, other demographics and the tax burden of a subnational government.

- **Main economic drivers**

Excessive dependence on one or a small group of industries is considered a cause for concern, the opposite is true for a diverse and stable economy.

- **Employment trends**

Unemployment trends are considered by taking into account reasons for expansions or contractions by specific employment sectors and labour force changes. Depending on the possible future impact of employment trends, the effect of these on the subnational's credit rating can either be beneficial or detrimental.

- **Income and wealth levels**

Comparing the income levels of the subnational government to other subnational governments and the national governments provides insight into the economic value it creates and also future revenue performance. Low income and wealth levels are detrimental to the subnational's credit rating.

- **Other demographic aspects**

Population trends are considered the most important demographic aspect. Population growth or stability could be considered as credit positives due to the increase in tax base or the fact that service demands and the need for capital investments will not increase in the future. Population declines can be considered as a credit negative because of the negative influence it will have on future revenue due to the shrinking tax base.

- **Tax burden**

As an indication of the competitiveness and the financial flexibility, taxation levels are compared regionally and nationally since these can either enhance or hamper economic development. Thus, it can be either a credit positive or a credit negative.

A.1.2 Moody's regional and local governments outside the US rating methodology

This section is based on Moody's regional and local governments* outside the US updated rating methodology of 2008, cited as (Moody's, 2008a).

Moody's determines the creditworthiness of a subnational by combining two key aspects, namely the standalone credit quality of the subnational and an assessment of the probability of the subnational receiving extraordinary support (i.e. the assistance provided by the national government, any other higher tier of government or the subnational's peers to prevent the subnational from defaulting). The latter criterion reflects the likelihood that the subnational may default in future and therefore might require extraordinary support.** The rest of this section will focus on the first key aspect, the assessment of the fundamental credit quality of the subnational itself.

The creditworthiness of a subnational is determined by evaluating different variables individually. These are then grouped into six factors, namely the operating environment, institutional framework, financial position and performance, debt profile, governance and management factors, and the economic fundamentals of the subnational under review (Figure A.2 and Table A.2). Different weights, allocated according to importance, are assigned to the factors to provide an estimation of the subnational's creditworthiness. The first two factors focus on the national government and the country's management system as a whole, and the other four focus on the subnational itself.

*Due to the generic definition this can theoretically be applied to the provincial governments, departments and municipalities of South Africa.

**Refer to Moody's (2006b) for more information regarding the assessment of the probability of the subnational receiving extraordinary support.

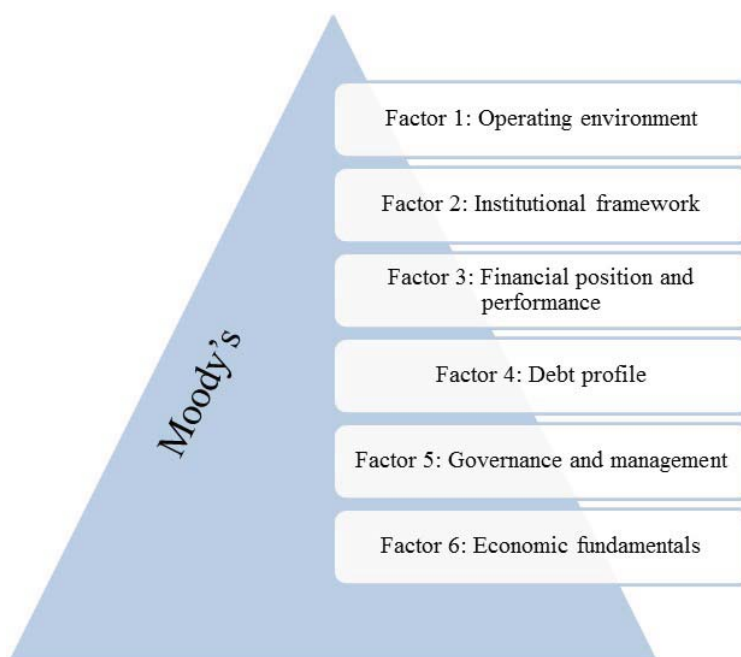


Figure A.2: *The six factors used by Moody's to determine the creditworthiness of a subnational government (Adapted from Moody's, 2008a)*

Factor 1: Operating environment

The operating environment of a subnational government is reviewed since the financial performance of a subnational is restricted by its operating environment. This factor therefore examines national conditions that might have an effect in a national crisis. It also considers the effect that a systemic shock might have on the national government by evaluating its current economic position, economic history, as well its financial history. A strong national operating environment is viewed as a credit positive.

- **GDP per capita**

GDP per capita, in US dollars that is adjusted to reflect purchasing power, is used to indicate the purchasing power of the resources owned by the average individual within the country. This measure provides some insight into the national government's ability to repay debt. An high GDP per capita of the country within which the subnational operates enhances the credit rating of the subnational.

- **GDP volatility**

GDP volatility of the country is assessed since dramatic drops in economic growth may pose a risk to the subnational government. A volatile GDP of the country within which the subnational operates will have an negative impact on the credit quality of the subnational government.

Moody's, 2008 Rating Methodology: Regional and Local Governments Outside the US Developing Countries		
No	Factor	Weighting
1	Operating environment	60.0%
	GDP per capita	50.0%
	GDP volatility	25.0%
	Government effectiveness index	25.0%
2	Institutional framework	10.0%
	Predictability, stability and responsiveness	50.0%
	Fiscal flexibility of own-sources revenues	16.7%
	Fiscal flexibility of spending	16.7%
	Fiscal adequacy of the extent of borrowing	16.6%
3	Financial position and performance	7.5%
	Gross operating balance to operating revenue ratio	25.0%
	Cash financing result to total revenue ratio	25.0%
	Net working capital to total expenditure ratio	25.0%
	Interest payments to operating revenue ratio	25.0%
4	Debt profile	7.5%
	Net direct and indirect debt to operating revenue ratio	50.0%
	Four year trend in net direct and indirect debt to operating revenue ratio	25.0%
	Short-term direct debt to direct debt ratio	25.0%
5	Governance and management factors	7.5%
	Fiscal management	40.0%
	Investment and debt management	20.0%
	Transparency and disclosure	30.0%
	Institutional capacity	10.0%
6	Economic fundamentals	7.5%
	Regional GDP per capita	100.0%

Table A.2: *Summary of Moody's regional and local governments outside the US rating methodology's factors (Moody's, 2008a)*

• Government effectiveness index

The efficiency, stability and receptiveness of the national government also effects an subnational's creditworthiness. Moody's uses the World Bank's government effectiveness index to evaluate a national government's ability to formulate policies and to put these policies into practice. The better the national's government effectiveness, the better the impact on the subnational's credit rating.

Factor 2: Institutional framework

The subnational government's responsibilities and whether or not the government has sufficient fiscal powers to address these responsibilities are measured qualitatively as part of the institutional framework factor. The laws, regulations and practices that influence the subnational's responsibilities and its fiscal powers are assessed, as well as the ways that these might be changed. These need to be examine since the subnational has little to no control over these and thus can be seen as external factors.

- **Predictability, stability and responsiveness**

The current institutional framework is reviewed to determine the operating flexibility within it, the capability to adjust it when required and the way these changes are handled. The greater the flexibility and receptiveness of required changes the better the impact on a subnational's creditworthiness. A change process allowing subnationals to adjust to changes in an organised fashion is favourable to the credit rating of the subnational government under review.

- **Fiscal flexibility of own-source revenue**

The nature and level of taxes that the subnational may enforce are examined. The stability and predictability of fiscal transfers and the equality of resource distributions are also investigated. Equality of resource distributions has an positive effect on the credit quality of a national government and thus also on its subnational governments.

- **Fiscal flexibility of spending**

The impact of spending enforced by the national government and how well revenues match the cost of the service delivery provided by a subnational is assessed under this heading. Flexible requirements and revenue and cost matches will enhance the credit quality of a subnational.

- **Fiscal adequacy of the extent of borrowing**

The degree to which a subnational is allowed to decide on the amount of debt issued and the uses of this incomes are also seen external factors to a subnational's creditworthiness. The greater the need to borrow in order to match typical spending, the lower the credit rating. The effect that this factor may have on a subnational government's credit rating depends on the institutional framework in place.

Factor 3: Financial position and performance

The recent financial position and performance of a subnational is reviewed in order to determine the medium-term forecasts. This is done to determine whether or not revenue generated by the subnational will cover ongoing spending commitments, including expenditures, interest expenses and debt repayments. The existing framework of policies and predicted demographic trends have to be taken into account too. The fiscal balance of a subnational is reviewed by looking at revenues received and generated, expenditures, the result of the revenues and expenditures as well as liquidity.

Moody's examines the taxing powers, the subnational government's effectiveness in exercising these powers and the efficiency of collecting taxes when reviewing the revenues of a subnational. The consistency of fiscal transfers and the acceptable uses of these transfers are also taken into consideration.

Total expenditure, expenditure growth rate and the drivers behind the growth is considered when assessing a subnational's expenditures. The effect of expected demographic trends and the extent to which spending priorities are set by the central government is also taken into account.

The result of revenues and expenditure is measured by combining the view on revenues and expenditures. Thus, the effectiveness of the government to generate sufficient revenues to cover expenditures is assessed.

Liquidity has to be reviewed since certain payments, like employee salaries, have to be settled in cash. The cash balances and access to internal and external sources of liquidity are reviewed as part of the liquidity assessment.

- **Gross operating balance to operating revenue ratio**

The gross operating balance to operating revenue ratio provides information on the subnational's capability to ensure that operating expenditures are lower than the operating revenue generated. It also provides information on the subnational's ability to produce additional revenues needed for debt repayments and capital investments. A high gross operating balance to operating revenue improves a subnational's credit rating.

- **Cash financing result to total revenue ratio**

The cash financing result referred to in this ratio is the cash generated before debt repayment. High levels of recurring cash requirements indicate a fiscal imbalance and increasing levels of debt. Thus this ratio reflects the impact of financial performance on the funding requirements. A high positive cash financing result to total revenue improves the credit quality of the subnational government; a high negative ratio has a negative impact on credit quality.

- **Net working capital to total expenditures ratio**

Net working capital is calculated by the current assets minus current liabilities. The ratio of net working capital to total expenditures is an indicator of the need to borrow money in the near future. A high positive ratio enhances the credit rating of the subnational government; a high negative ratio is detrimental to the credit quality of a subnational government.

- **Interest payment to operating revenue ratio**

The ratio of interest payment to operating revenue indicates the portion of operating revenue that will be needed to fund debt interest payments. A low ratio is considered a credit positive.

Factor 4: Debt profile

Moody's also considers the amount of outstanding debt, the burden of these debts, the debt structure, maturity schedules and the reliance on short-term or variable-rate debt in order to establish a subnational government's debt profile. The government's ability to cover debt repayments from operating revenue and the legal framework for debt are also taken into account. When assessing the legal framework, special attention is paid to limits set on debt amounts and limits set on debt structures, as well as the purposes for which borrowed money may be used.

The reliance on short-term or variable-rate debt has to be assessed since this may introduce market access risk and interest rate risk. Foreign currency risk may also pose counterparty risk and therefore has to be assessed too.

Another important consideration is indirect risk or off-balance sheet transactions. This refers to, among other things, debt guaranteed by the subnational government, debt obligations of enterprises of which the subnational government owns the majority of the enterprise and public-private partnerships. Indirect risk is taken into account when Moody's determine the debt profile of a subnational government.

- **Net direct and indirect debt to operating revenue ratio**

This ratio uses operating revenue as a measure for debt repayment ability. Thus it relates the debt burden and debt repayment ability. A low ratio will have an favourable effect on the credit quality of a subnational government.

- **Four year trend in net direct and indirect debt to operating revenue ratio**

The four year trend in net direct and indirect debt to operating revenue ratio is the four-year trend analysis of the ratio explained above. A positive ratio points out that debt is increasing faster than the ability to repay these debts. A negative ration shows that debt is increasing slower than the ability to repay the debts. Thus the lower this ratio the better the creditworthiness of the subnational government under review.

- **Short-term direct debt to direct debt ratio**

Short-term debt refers to debt with a maturity shorter than one year. Governments are exposed to market access risk and interest rate risks when these debt instruments have to be refinanced. Therefore this ratio indicates market access risk and interest rate risks over the short-term. A low ratio will enhance the credit quality of a subnational.

Factor 5: Governance and management

Maintaining a budgetary balance is viewed as a credit positive. Moody's reviews how realistic a subnational government's budget is, whether or not the subnational government monitors if the budget implementation is effective, whether or not the subnational government makes timely modifications to the budget when necessary. The suitability of the capital plan and whether or not planning for operating and spending happens for periods longer than one year at a time are also reviewed.

Cash, debt and investment management policies are reviewed since the capacity to avoid draw-backs in these are considered a credit positive. The level of management's experience and if they remain in office long enough to put together and complete multi-year fiscal and capital plans are also reviewed under this heading.

The likelihood of changes to the governance and management framework, the speed of such changes and the trends of these changes are considered too.

- **Fiscal management**

This investigates how well a subnational government's real revenues and expenditures meet the forecasted revenues and expenditures. The more often the real revenues and expenditures stay within the forecasted numbers, the better the credit quality of the subnational.

- **Investment and debt management**

Management's adherence to the national government's investment management policy and whether the policy is conservative or lax, is gauged. Adherence to a conservative policy is a stronger credit positive than adhering to a lax policy. The amount of risk that the subnational accepts when making investment decisions are also measured. Accepting nominal risk is preferred above accepting significant risk. Debt management policies that avoid exposure to high or fast changing debt costs, considerable foreign currency or interest rate risk is favoured above taking some of these risks.

- **Transparency and disclosure**

The level of information contained in the subnational's financial statements, the completeness of these statements and the timeliness of submission are investigated. The better the subnational government performs on these three measures, the better the credit quality of the government. Whether or not the government provides consistent independent audited reports and the auditor's opinion on these reports are also reviewed. Providing consistent independently audited reports with no serious qualifications will benefit the subnational's credit rating.

- **Institutional capacity**

The rules used to resolve budgetary and other major policy issues is considered by Moody's to be part of a government's institutional capacity. The clearness of these rules and the process followed to resolve issues is reviewed. The clearer these rules and the more often an orderly process is followed when needed, the better the credit quality of the subnational government.

Factor 6: Economic fundamentals

The economic fundamentals of a subnational government affects its ability to repay debt since it determines the sufficiency and reliability of future revenues needed to repay debts. Moody's considers the economic profile, economic diversity and labour market performance of a subnational government when reviewing its economic fundamentals.

- **Regional GDP**

The GDP per capita, adjusted to reflect purchasing power parity, is used as a single measure to gauge a subnational's economic fundamentals. A high regional GDP per capita is considered a credit positive.

A.1.3 S&P's methodology for rating international local and regional governments

S&P methodology for rating international local and regional governments*, 2010 was used as the base for this section unless stated differently (S&P, 2010).

S&P employs eight main factors to determine the credit quality of a subnational government. The first one, the institutional framework, assesses the institutional and legal background of the subnational government. The remaining seven factors focus on the subnational government itself and are used to determine the standalone credit quality of the subnational. The factors used to determine the subnational's standalone credit quality are its economy, financial management, budgetary flexibility, budgetary performance, liquidity, debt burden and contingent liabilities (Figure A.3 and Table A.3).

Once all eight factors have been assessed the budgetary performance and flexibility are combined into one factor, as well as debt burden and contingent liabilities. Next the institutional framework and the five remaining factors of the standalone credit quality are combined to form the subnational's credit rating. Overriding reasons like the subnational's credit rating is capped by the

*Due to the generic definition this can theoretically be applied to the provincial governments, departments and municipalities of South Africa.

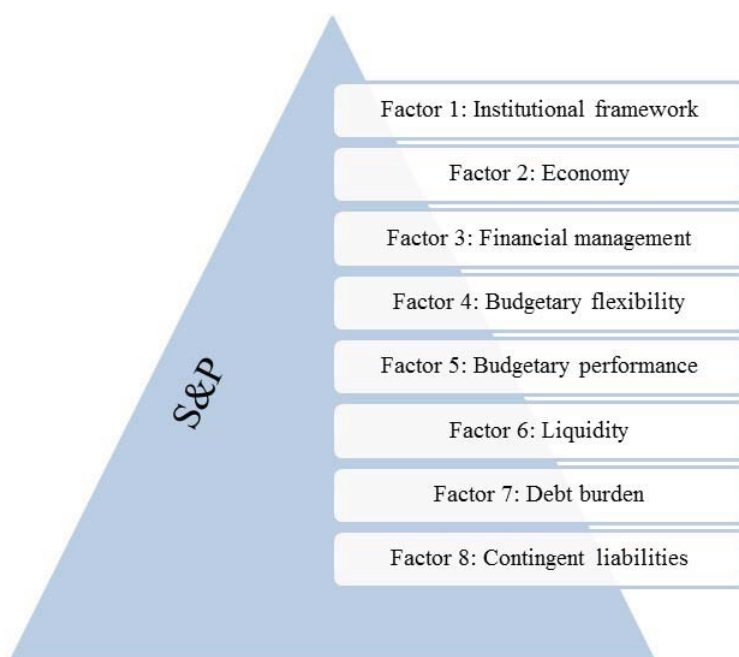


Figure A.3: *The factors used by S&P to determine a subnational government's credit rating (S&P, 2010)*

national government's credit rating, as well as weak liquidity, financial management, debt, contingent liabilities or budgetary performance profiles of the subnational itself can cause a subnational's credit rating to be marginally lower than the credit rating resulting from the combination of the institutional framework and standalone credit quality. On the other hand, if the subnational is expected to benefit from extraordinary support from another government it is possible that its final credit rating might be marginally higher than the one resulting from the combination of the institutional framework and standalone credit quality (Figure A.4).

The remainder of this section will focus on the assessments of the eight main factors used by S&P to determine a subnational's credit rating.

Factor 1: Institutional framework

The institutional framework is assessed on a national level to determine the effect of the institutional framework on the subnationals within the framework. S&P considers the predictability of changes to the framework, the distribution of revenues and expenditures, transparency and accountability of the budget process and financial reporting, as well as support provided by the national government when assessing the institutional framework.

S&P's, 2010 Methodology For Rating International Local and Regional Governments	
No	Factor
1	Institutional framework
	Predictability
	Revenue and expenditure balance
	Transparency and accountability
	System support
2	Economy
	GDP per capita
3	Financial management
	Transparency and disclosure
	Budgeting
	Long-term capital and financial planning
	Revenue and expenditure management
	Debt management
	Reserve and liquidity management
	Management of governmental-related entities
	Political and managerial strength
	External risk management
4	Budgetary flexibility
	Adjustable revenues to adjusted operating revenues ratio
	Capability expenditures to total expenditures ratio
5	Budgetary performance
	Balance after capital accounts to total adjusted revenues ratio
	Operating balance to adjusted operating revenues ratio
6	Liquidity
	Free cash, liquidity assets and committed bank lines to next twelve months' debt services
7	Debt burden
	Tax-supported debt to consolidated operating revenues ratio
	Interest to adjusted operating revenues ratio
8	Contingent liabilities

Table A.3: *Summary of S&P's international and regional governments rating methodology's factors (Adapted from S&P, 2010)*

- **Predictability**

The regularity of changes to the institutional framework and the impact of these changes on the subnationals responsibilities and revenues are considered. A volatile system influences the credit rating of a subnational negatively. Laws like tax flexibility and limitations on debt usage are reviewed to determine the general framework within which the subnational operates. The degree to which a subnational can influence decisions made on a national level is also considered. The higher the ability of the subnationals to influence decisions the better the impact on their credit ratings.

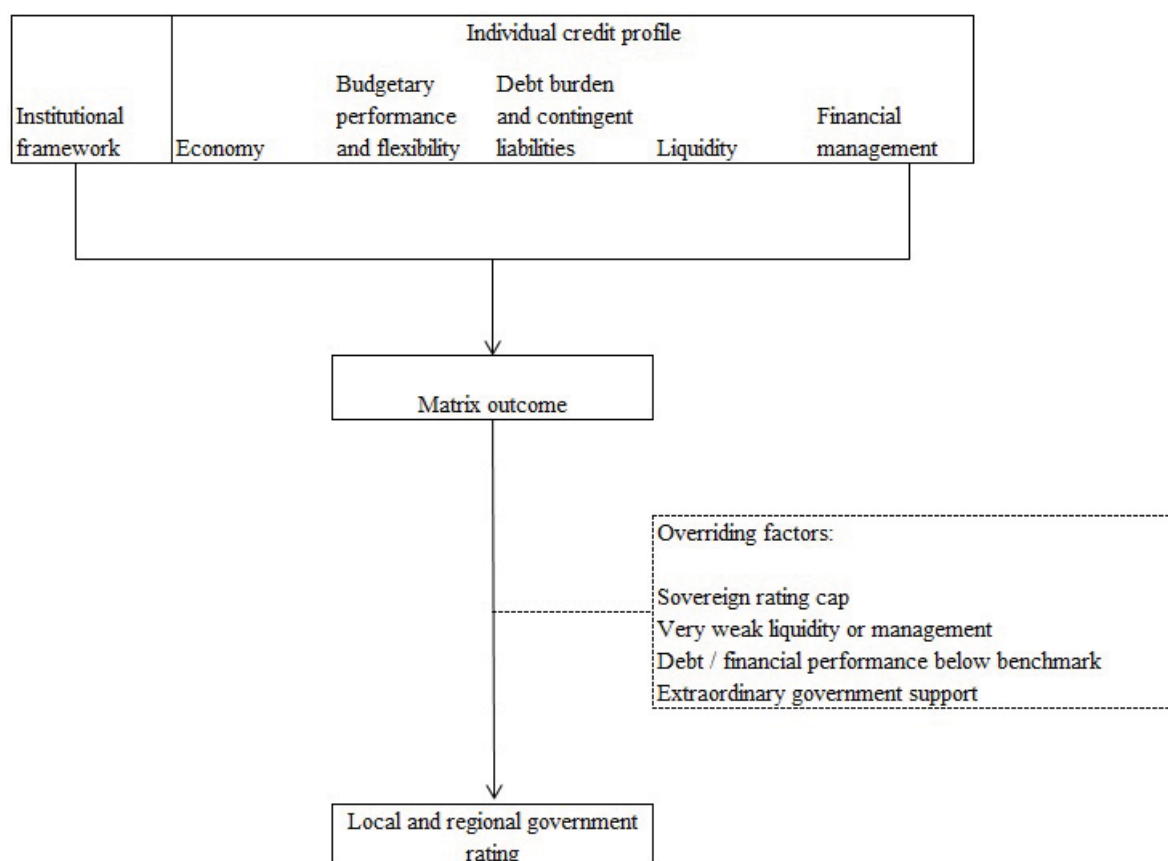


Figure A.4: *S&P's method of combining the institutional framework and the standalone credit quality of a subnational (S&P, 2010)*

- **Revenue and expenditure balance**

In order for a subnational government to sustain a long-term fiscal balance, its revenue generating capacity should match its expenditure responsibilities. S&P considers the fiscal interaction history between the national and the subnational governments, as well as the expected future interactions. Credit positives are seen as predictable transfers that meet the subnational's expenditure needs, subnationals with adequate fiscal powers ensure their expenditures are met by their revenues. The fiscal policy framework are reviewed in terms of rules or laws on the levels of public deficits and debt burden, as well as the usage of derivatives. These may promote budgetary discipline and it may cause the subnational to be aware of debt affordability and excessive indebtedness. The lack of restrictions on public deficits, debt management and liquidity management will be detrimental to the overall creditworthiness of the subnational, as will negligent monitoring of the subnational's financials.

- **Transparency and accountability**

A dependable public financial system is usually associated with high standards for transparency and accountability. High standards for transparency and accountability encourage other good practices like compulsory audits, accrual accounting and consolidated reporting requirements. The reliability of the information provided also has to be assessed. The roles and responsibilities of elected officials who set priorities and the managers who implement these priorities are used to

assess the transparency of the budgetary process. Clearly defined roles are beneficial to the credit profile of a subnational. Accounting standards that are weak and inconsistent and reporting that demands only the minimum information is considered credit weaknesses. Also considered credit weaknesses are if an external audit is not required and the overseeing of legal compliance is only limited to the minimum information.

- **System support**

The level of harmony between the national and its subnational governments are investigated in order to provide some insight regarding the system support of the institutional framework. Noteworthy harmony levels and a national government that bears the responsibility of the system's financial health enhance a subnational's credit profile. An institutional framework that offers only limited extraordinary support may worsen a subnational's credit profile.

Factor 2: Economy

The review of the subnational's economy gives an indication as to how economic factors will influence the subnational's future revenues and expenditures and thus its debt repayment capability. S&P considers four aspects when reviewing a subnational's economy, namely its wealth and income levels, the level of diversification within the economy,* its demographic profile and its economical growth prospects. See Table A.4 for more information regarding the interaction of the four aspects.

- **Wealth and income levels**

The three-year average of GDP per capita in US dollars at market price is used to gauge the wealth and income levels of subnational governments. This gives an indication of the subnational's future income levels. High income levels are associated with low default rates. GDP per capita forms the basis of the economical assessment. A high GDP per capita leads to a better credit rating.

- **Level of diversification within the economy**

A diverse economy is important in terms of credit quality since it influences future revenue and subsequently the repayment of debt. A diverse economy is less exposed and revenue generation is less volatile. A broad and diversified economy will benefit a subnational government's credit rating, whereas a volatile or concentrated economy will have the opposite effect.

- **Demographic profile**

The demographic profile affects future taxes or revenues, the public services that the subnational have to provide and infrastructure needs. A growing population will lead to a bigger tax base and an increase in revenue, but it will also increase the need for services and infrastructure development. A declining population will cause a decline in revenue and a decline in need for services and infrastructure development. A growing dependent population, ages younger than 15 and older than 65, will eventually lead to an increasing need for public services like education and health care, thus it will lead to an increase in expenditure. This might have a negative impact on debt servicing. A growing population, in particular a dependent population, will have a negative impact on a subnational's credit rating.

*The source document refers to the level of diversification within the economy as the diversification of the economic structure.

GDP per capita (nominal US\$)	> 35 000	> 25 000	> 12 000	> 4 000	< 4 000
Score:	1	2	3	4	5
Qualitative factors positively affecting the score include: Above-average growth prospects compared with those for peers in the anchor category, supporting robust revenue growth (for example, expected medium-term trend in real GDP growth in the region of greater than or equal to 3% annually in mature economies and greater than or equal to 6% per year in developing economies). Exceptionally broad and diversified economy compared with peers' in then anchor category (for example, the capital city in a developing economy) providing a strong resilience to economic cycles.	Qualitative factors negatively affecting the score include: Negative budgetary impact from the demographic profile , where a population decrease and/or high share of dependent population (generally greater than 55%) may have a material impact on future revenue growth and expenditure needs. Very volatile and/or concentrated economy , carrying significant exposure to a single vulnerable or cyclical industry (generally greater than 20% of gross value added or employment), and/or to a single tax-payer (generally greater than 20% of tax revenues), leading to potential revenue volatility. Very high unemployment (in the region of greater than or equal to 15%) if it has a material impact on the subnational's budget. Limited growth prospects due to structural economic and/or natural handicaps and/or large infrastructure needs leading to a flat or declining medium-term trend in real GDP growth.				

Table A.4: *The interaction between the four aspects used by S&P's to assess factor 2, the economy of a subnational government (S&P, 2010)*

- **Growth prospects**

S&P takes into account recent and forecasted trends of the employment, productivity and investments to determine growth prospects, but ultimately they focus on the growth in real GDP. The better the medium-term trend of real GDP growth, the better the growth potential and thus the credit rating of the subnational.

Factor 3: Financial management

According to S&P the most important characteristics that determine the credit quality of a subnational is its willingness and capacity to meet its financial obligations. S&P uses nine different aspects to determine a subnational's willingness and capacity to meet its financial obligations.

- **Transparency and disclosure**

The quality, clarity, comprehensiveness, timeliness and frequency of financial publications are reviewed. In the event that an audit was conducted on these publications, the auditor's comments are also reviewed. A high degree of transparency, timely and detailed financial reports and financial reports that are published frequently are positive contributors to the credit profile of a subnational. An audit conducted by an independent firm with no comments will also be beneficial to a subnational's credit rating.

- **Budgeting**

The scope of the budget, the budgeting technique and the budgeting procedure are assessed under this heading. The reliability of the budgeting methods when considering the long-term financial strategies are also taken into consideration. A short-term budget that is based on real instead of estimated needs and that is approved after the start of the fiscal year is detrimental to a subnational's credit rating.

- **Long-term capital and financial planning**

S&P investigates to what degree a realistic and well-documented long-term financial plan exists, as well as whether or not it encourages financial discipline and stability. The actual performance of these capital and financial plans are measured against historical medium-term plans. Practical and well defined financial policies as well as a long-term capital and financial plan, that is based on realistic assumptions that stayed stable over time will aid the subnational government's credit quality.

- **Revenue and expenditure management**

The biggest focus when reviewing revenue management is on main taxes, especially the forecasting, administration and collection thereof. The focus when reviewing expenditures is on capital and operating costs. Operating costs are evaluated by looking at the way costs are controlled and monitored. Capital costs are evaluated by investigating the level of detail of the planning, funding and prioritising of projects, as well as the exposures to setbacks and excess costs that may be incurred due to setbacks. A history of a precise revenue and expenditure forecasts, as well as the effective use of the funds are considered credit positives. Inaccurate forecasting, regular overspending, significant overspending, unmonitored capital spending and constant contractual disputes are viewed as credit negatives.

- **Debt management**

S&P reviews the subnational's debt policies, both short-term and long-term, as well as the subnational's appetite for risk and its understanding of risk. Debt related risks like interest rate and currency movements are analysed too. If the policies in place do not prevent exposure to market shocks, long-term debt is used to fund liquidity needs, debt limits are constantly violated and the subnational heavily relies on short-term debt, S&P will consider the debt management position of the subnational as inappropriate. These will impact the subnational government's credit rating negatively.

- **Reserve and liquidity management**

Reserve and liquidity management entails forecasting cash flows, recognising cash flow shortcomings in advance, managing these shortcomings and having good relationships with banks and investors. Equally important is the investment and liquidity policies in place and a subnational's appetite and understanding of the risks related to these policies. Reserve and liquidity management is considered inadequate when detailed guidelines for desired levels of cash do not exist, if no cash flow planning takes place, if there are substantial delays in payments, if inadequate liquidity reporting takes place, if the subnational government does not have control over cash flows and if it only has limited sources available for funding purposes. These will lead to a deteriorating credit rating.

- **Management of government-related entities**

The purpose of government-related entities, their financial performance and their operational effectiveness are considered. The clarity of the government-related entities' financial reports and medium-term business strategies, as well as their overall financial health are also taken into consideration. Suitable reasons for the existence of government-related entities and government related entities that are able to fund their own costs from the transfers received will benefit a subnational's credit quality.

- **Political and managerial strength**

The subnational government's dedication and capability to implement fiscal discipline is examined since it is needed to maintain and enhance the subnational government's credit stance. Dedication and capability to implement fiscal discipline will be affected by the political stance, as well as the expertise and capability of the subnational's management team. If the subnational's governing party is also the ruling party of the country there will be political consensus within the subnational, this will have an positive impact on the subnational's credit rating. Other positive factors are when the government is able to implement structural reforms, pass budgets, take unpopular decisions and has a strong management team with appropriate expertise and qualifications.

- **External risk management**

The following are considered by S&P as external risks: economic recessions, natural disasters, significant decreases in government grants or changes to the government system. External risk management needs to be reviewed since it provides information as to whether or not a subnational will default in extreme stress scenarios. S&P assesses the subnational government's ability to identify, measure and handle external risks. If a subnational government is unable to perform these functions its external risk management will be considered inadequate and thus its credit rating will be impacted negatively. As will an unwillingness to reduce public services in the event of a external risk as this can have an impact on the subnational's ability to reduce expenditures in an effort to avoid defaults.

Factor 4: Budgetary flexibility

Budget flexibility measures whether or not a subnational is able and willing to adjust revenues and expenditures. Subnationals with budgetary flexibility would be more likely to avoid defaults, especially in times of external shocks. Budgetary flexibility depends on both revenue flexibility and expenditure flexibility, Table A.5 provides details.

- **Revenue flexibility**

Revenue flexibility is determined by a subnational's ability to raise revenue, its political and economical limitations as well as potential revenue from assets sales. The ratio of adjustable revenues as a proportion of operational revenue provides information regarding a subnational's capability to raise revenues. Adjustable revenues are seen as revenues that the government is allowed to raise or reduce. Operational revenues are seen as recurring revenues that the subnational receives, excluding capital revenues. The higher a subnational's percentage of adjustable revenues compared to operating revenues, the better the subnational's credit rating. S&P gauges political and economical limitations by comparing the subnationals tax rates to the tax rates of its neighbouring subnationals and the average tax rate of the country as a whole. If a subnational's tax rate is higher than its neighbouring subnationals' tax rates, it might lead to the migration of citizens and

Capital expenditure as % of total expenditure	Modifiable revenues as % of adjusted operating revenues				
	>70%	>50%	>30%	>10%	<10%
>15%	1	2	3	4	4
<15%	2	3	3	4	5
Qualitative factors positively affecting the score include:			Qualitative factors negatively affecting the score include:		
Demonstrated capability and willingness to cut operating spending --typically by more than 5%--thanks to a flexible cost structure, flexible legislation, and widespread political support.			Highly limited leeway to adjust modifiable revenues --typically less than 2%--either because tax rates are already high, tax collection levels are very low, or tax pressure is above peers', and/or because of a lack of political willingness to increase taxes.		
Ability to increase operating revenues --typically by more than 5%--through the creation of new taxes or influence on shared taxes.			Highly limited ability to cut expenditures , because of significant infrastructure needs or large-scale projects, and/or owing to significant pressure on operating costs or political priorities.		
Demonstrated ability to postpone capital expenditure due to excellent infrastructure, typically by more than 20%.					
Above-average capability to generate revenues from asset sales (outstanding of sellable assets estimates to more than about 25% of the subnational's revenues).					

Table A.5: *The cohesion of the aspects used to assess factor 4, the budgetary flexibility of a subnational (S&P, 2010)*

therefore a loss of income due to a smaller tax base. S&P considers the ability to alter revenue as a credit positive. Asset sales are an additional source of income, but these are generally limited by legal and political impediments. A below-average capability to generate revenues from asset sales is viewed as a credit negative.

- **Expenditure flexibility**

Expenditures are normally divided into operating and capital expenditures. Operating expenditures are defined as costs incurred by funding the subnational's operations, administration and service provisions. Capital expenditure is viewed as costs incurred to develop new infrastructures and to keep existing infrastructures maintained. Subnationals have limited control over operating expenditures. Thus, the ratio of capital expenditure as a percentage of total expenditures forms the basis of assessing expenditure flexibility, but operating and capital expenditure flexibility and expenditure as a potential source of pressure are also taken into account. Operating costs are generally inflexible due to political reasons, but variable flexibility does exist to some degree. The more capable and willing the subnational is to cut operating expenditure, the better the impact on its credit rating. Theoretically capital expenditures are more flexible, except in scenarios when the subnational have a great need for infrastructure development or if a big construction project is already under way. The more capable the subnational is to cut capital expenditure the better the impact on its credit rating. Expenditures may not only be inflexible, they may also pose potential pressure for instance when the subnational needs to increase services or improve infrastructure. Expenditure as potential sources of pressure needs to be taken into account when assessing operating and capital expenditure flexibilities.

Factor 5: Budgetary performance

The assessment of the budgetary performance of a subnational government depends on the accounting system in place. However, the assessment is based on two main ratios operating balance as a percentage of adjusted operating revenues and the balance after capital costs as a percentage of total adjusted revenues, as well as some quantitative aspects (Table A.6).

Operating balance as % of adjusted operating revenues	Balance after capital accounts as % of total adjusted revenues				
	>0	<(5%)	<(10%)	<(15%)	>(15%)
>5%	1	2	3	4	4
<5%	2	3	3	4	5
<0%	N/A	4	4	5	5
Qualitative factors positively affecting the score include:			Qualitative factors negatively affecting the score include:		
Expected structural improvement: If base case forecasts point to a material structural improvement versus period average, likely the score would be adjusted up to the expected performance level.			Expected structural deterioration: If base case forecasts points to a material structural deterioration form the period average, likely the score would be adjusted down to the expected performance level.		
High cash reserves levels: In cases where deficits are temporary and can be totally or partially covered by cash reserves, likely the score would be adjusted for the deficits covered by reserves.			Pronounced volatility in performance: Likely the score would be adjusted downward if a combination of one or more of the following factors are seen: high inflation, very cyclical revenues, dependence on volatile state transfers, and exposure to event risk.		
			Underestimated cash outflows: Likely the score would be adjusted downwards if a combination of one or more of the following factors are seen: significant under spending, large unpaid debt to suppliers, and off-budget financing through public companies.		

Table A.6: *The aspects reviewed by S&P when considers factor 5, the budgetary performance of a subnational government (S&P, 2010)*

- **Operating balance to adjusted operating revenues ratio**

The operating revenue of a subnational is the recurring revenues that the subnational receives. This includes, for example, grants, fines and rents, but exclude capital revenues. When the operating revenue is altered to take into account significant non-cash or pass-through items, it is considered the adjusted operating revenue of the subnational. Operating expenditure, as defined in the previous paragraph, adjusted to take into account significant non-cash or pass-through items, is considered the adjusted operating expenditure of the subnational. The operating balance is defined as the adjusted operating revenues minus the adjusted operating expenditures. The operating balance as a percentage of adjusted operating revenues provides an indication of the subnational's cash flows from its operations. A high ratio indicates that the subnational is in a position to cover its operational costs from its recurring revenues. A higher ratio leads to better credit quality. A low ratio indicates that the subnational is more exposed during recessions or unexpected events because it might not be able to cover its operational costs from its recurring revenues. A lower ratio leads to low credit quality. S&P considers trends in this ratio and they compare the subnational's ratio to its peers' ratios.

- **Balance after capital accounts to total adjusted revenues ratio**

The balance after capital accounts of a subnational government is the operating balance plus capital revenues minus the capital expenditures. The balance after capital accounts as a percentage of total adjusted revenues is an indication of the subnational's overall funding requirements or excess resulting from its operating and capital activities. A low ratio will have a negative impact on a subnational's credit rating, even more so in the case of a negative ratio.

- **Base case projections**

S&P also considers some base case projections that are based on their macroeconomic outlook of the subnational. The expected infrastructure changes, improvements as well as deteriorations, are taken into account. Cash reserve levels are considered in conjunction with shortfalls. High cash reserve levels will have a positive impact on credit ratings in the case of temporary shortfalls or when shortfalls can be covered by cash reserves. On the other hand, under-estimated cash outflows will have a negative impact. As with aspects like high inflation and a seasonal income dependency which may cause volatility in performance.

Factor 6: Liquidity

The aim of the liquidity assessment is to determine the effect that the liquidity sources of a subnational might have on its ability to repay its debts. Liquidity sources can either be internal, cash reserves and cash flow generation, or external, bank lines and market access.

S&P takes seasonality into account when assessing internal liquidity. The assessment is forward-looking and considers the minimum and average cash reserves, as well as the subnational's cash flow generating ability. These are measured against annual debt service and other cash outflows. Internal liquidity sources should not be reserved for loan agreements, it should not be needed for daily operations or planned capital investments and it should be available to use for debt servicing purposes.

When analysing the use of external liquidity sources S&P reviews country-specific and subnational-specific features since the use of external liquidity sources can be enhanced or restricted by the legislative framework in place. Committed bank lines are taken into consideration when reviewing a subnational's liquidity position.

Free cash, liquidity assets and committed bank lines as a percentage of the next twelve months' debt servicing needs forms the basis of the liquidity assessment. A high ratio contributes to credit quality, likewise a low ratio is seen as worsening a subnational's credit quality. Outstanding access to external liquidity sources, good quality committed bank lines and an outstanding internal cash flow generating capability are viewed as credit positives. Restricted access to external liquidity sources, high funding needs and a situation where debt repayment is not seen as a priority is viewed as credit negatives. Other credit negatives are high cash flow volatility, lumpy debt amortisations and large bullet maturities since these cause volatility in the coverage ratio mentioned above. See Table A.7 for more information regarding the interaction of the different aspects used to review a subnational's liquidity position.

	Free cash and liquid assets as a % of next 12 months' debt service	Free cash, liquid assets and committed bank lines as a % of next 12 months' debt service			
	>100%	>120%	80%-120%	80%-40%	<40%
Score:	1 (very positive)	2 (positive)	3 (neutral)	4 (negative)	5 (very negative)
Qualitative factors positively affecting the score include:			Qualitative factors negatively affecting the score include:		
Access to external liquidity is exceptional (upward adjustment by two categories) or strong (upward adjustment by one category).			Access to external liquidity is limited (downward adjustment by one category) or uncertain (downward adjustment by two categories).		
The subnational controls a bank and its debt can be repurchased at the central bank, which gives the subnational indirect access to central bank funding.			Expected funding needs are very large , deriving from working capital and investments, including potential large amounts of unpaid supplier debt at the subnational level or at its satellite companies (typically equating to more than four months of operating spending).		
Internal cash flow generation capability is very robust compared with peers' in this category (translating into an annual operating balance before interest/debt service in the range of greater than or equal to '2'). Cash flows are evenly distributed during the year and very predictable.			Excepted volatility in the 12-month coverage ratio: In case of high cash flow volatility, a lumpy debt amortisation profile, or large bullet maturities beyond 12 months, the assessment would be adjusted to reflect the lowest expected coverage ratio.		
			Debt repayment is not defined by law as a priority expenditure for the subnational.		

Table A.7: *The interaction of the different aspects used to review factor 6, a subnational's liquidity position (S&P, 2010)*

Factor 7: Debt Burden

S&P conducts a futuristic review of a subnational's debt burden and interest burden. This review is not limited to core government debt, but includes the debts of trusts and not self-supported government-related entities. The debt burden assessment is based on the tax-supported debt to operating revenues ratio, the interest to adjusted operating revenues ratio, exposure due to market risks and other long-term liabilities (Table A.8).

- **Tax-supported debt to consolidated operating revenues ratio**

Tax-supported debt includes the direct and indirect debt of the subnational government. Consolidated operating revenues are the operating revenue of the subnational plus the income generated by the government-related entities. Revenues received by government-related entities from the subnational government are not included in the calculation. The ratio of tax-supported debt to consolidated operating revenues provides an indication of the debt that relies on the subnational's total revenue for repayment. A low ratio is contributing to the subnational's credit rating.

Interest as % of adjusted operating revenues	Tax-supported debt as % of consolidated revenues				
	<30%	<60%	<120%	<180%	>180%
<5%	1	2	3	4	N/A
5%-9%	2	3	4	4	5
>9%	N/A	4	5	5	5
Qualitative factors positively affecting the score include:			Qualitative factors negatively affecting the score include:		
Debt burden mitigated by an exceptionally high operating balance: Typically, direct debt represents less than three years of operating margin. Debt burden mitigated by self-supporting on-lent debt.			Potential significant volatility in the debt burden owing to high exposure to market risks: This could stem from exposure to interest rates or currency fluctuations, a very short-term maturity profile (typically less than two years), and aggressive use of derivative instruments, which could lead to an increase of the cost & level of debt to the next category. Large share of unfunded pension liabilities: This would typically occur if unfunded pension liabilities are greater than 50% of operating revenues and the subnational has no clear policy to reduce the deficit over time.		

Table A.8: *Aspects considered by S&P when reviewing factor 7, the debt burden of a subnational government (S&P, 2010)*

- **Interest to adjusted operating revenues ratio**

Interest included in this calculation refers to gross interest on the direct debt of the subnational itself. The ratio thus provides an indication of the portion of revenue available to cover the interest of direct debt. The lower the ratio the better impact it has on the subnational's credit rating.

- **Exposure to market risks**

Market risks like interest rate risk and currency risk can cause instabilities in interest and debt levels, which in turn causes volatility in a subnational's debt burden. When reviewing interest rate and currency risks, S&P only focuses on debts that are sensitive to these risks. They analyse the effect that adverse changes may have on debt, as well as the subnational's monitoring and management of these exposures. Debt maturity profiles are reviewed too since a short amortisation profile causes debt to be sensitive to interest rate changes. Another market risk that has to be taken into account is the use of derivatives instruments. The purpose of these instruments, the extent to which they are used, the subnational's management's risk tolerance, their capability of using these instruments, their understanding of the risks involved in using these instruments and the monitoring thereof are considered. High exposures to market risks are considered as credit negatives since they will cause volatility in the subnational government's debt profile.

- **Other long-term liabilities**

Pension fund liabilities may affect a subnational's debt profile and thus its credit rating. The effect of this depends on the size of the pension fund that the subnational is responsible for. In the case where the subnational is completely responsible for the pension fund, S&P will include it in the debt calculations. A large share of unfunded pension liabilities will affect a subnational's credit rating in a negative manner.

Factor 8: Contingent liabilities

Contingent liabilities is defined by S&P as obligations that may materialise under certain circumstances that could affect the subnational's ability to honour its debt obligations. Contingent liabilities are normally not recorded on the balance sheet itself, it is therefore also referred to as off-balance sheets risks or liabilities. Contingent liabilities arise from companies within which the subnational has some degree of ownership and that the subnational has to provide guarantees for. These guarantees can stem from formal agreements or from a moral obligation like political, economical or social reasons. The types of companies that can be a source of a contingent liability are government-related entities, lower levels of government and public-private partnerships. Government-related entities that are not self-supporting has been dealt with under the previous factor, debt burden, thus government-related entities dealt with under contingent liabilities are only the self-supporting ones. S&P reviews the likelihood of the occurrence of each type of contingent liability as well as the size of the specific debt sources relative to the debt of the subnational. The types of contingent liabilities assessed are those stemming from non-financial companies, financial companies, private-public partnerships and a large number of small companies, as well as securitisations, litigations, unfunded post-employment benefits and other contingent risks. In the event that a subnational has very limited contingent liabilities or when it owns shares in companies that operate in low risk industries and the companies are financial strong, the credit quality of the subnational will improve due to its contingent liabilities. If a subnational owns the majority of shares in a self-supporting company that would require the assistance of the subnational in times of distress, or if the subnationals contingent liabilities are potentially sizable, but the information is scarce the credit rating of the subnational will be influence negatively.

A.2 Regional subnational credit rating methodologies of developed countries**A.2.1 DBRS's methodology to rate Canadian provincial governments**

This section is based on the DBRS document that records the agency's methodology for rating Canadian provincial governments, referred to as DBRS (2011). Canada's subnational level of government comprises three territories and ten provinces. The methodology captured in this document is used by DBRS to establish the credit quality of only the ten Canadian provincial governments.

Although there are several differences between provinces, a number of similarities also exist since they all function within in the same operational environment. The similarities includes broad taxation powers, broad revenue generating powers, responsibilities for providing services, a reasonably stable political and economical environment, as well as significant support from the national government. Although these similarities cause the provinces to have good credit ratings, these will not be used to rate these provinces among each other since these aspects remain stable from one province to another. However, the province's specific differences will be used to rate them. These differences include economic diversification, management styles, fiscal priorities, overall financial strength and economic differences. Due to the fact that these provinces already have good credit ratings because of their political and economical environment, these differences can only improve their credit ratings to a better or lesser extent. DBRS assesses only two different types of factors to determine the credit rating of a Canadian provincial government. These factors are the province-specific operating risk and the province-specific financial risk* (Figure A.5).

*The DBRS document refers to province-specific aspects as issuer-specific factors.



Figure A.5: *DBRS's factors used to credit rate Canadian provincial governments (Adapted from DBRS, 2011)*

Factor 1: Operating risk

DBRS reviews primary and additional province-specific operating risk aspects in order to reach an opinion about the provincial government's operating risk aspects. The province's economic structure, fiscal management, financial management and intergovernmental relations are viewed as primary province-specific operating risk aspects, all other aspects are viewed as additional province-specific operating risk aspects.

- **Economic structure**

The ability of a provincial government to generate the revenue needed to honour its responsibilities is greatly impacted by the province's economy. An investigation of the province's economy provides information regarding the stability and growth potential of the province, including the ability to create jobs and to generate wealth. Above average GDP growth, a diverse economy, access to a broad international export market, a solid population growth and a highly skilled labour force are considered strong credit positives.

- **Fiscal management**

The revenue generating capacity, spending discipline and the allocation of public resources are investigated to review the fiscal management of a province. The quality of the fiscal management framework, the key assumptions of the budget process, the adequacy of the revenue levels, as well as the revenue and expenditure flexibility are scrutinised. DBRS also assesses the fiscal results' volatility, the effectiveness of the budget process and the quality of the fiscal planning framework. Well managed expenditures, a budget based on conservative assumptions, the ability to manage deficits and to raise taxes, as well as transparency and timeliness in reporting contribute considerably to the credit quality of a provincial government's credit quality.

- **Financial management**

An assessment of the financial management strategy in place provides information regarding the volatility of debt requirements. Special attention is paid to the composition of debt, the maturity profiles of debt and the profile's sensitivity to inflation, interest and exchange rate changes. The liquidity position and the sources of internal liquidity are assessed too. The sources are considered by taking into account the fiscal conditions, scheduled debt repayments and the availability of external sources of liquidity. Debt and liquidity practices that are ideal and conservative, a debt structure that is practical, a well-established borrowing environment, a sustainable level of liquidity and an unfunded pension fund liability that is low are viewed as strong credit positives.

- **Intergovernmental relations**

The relationships between the provincial government and the national government* and the lower levels of government are considered. This needs to be reviewed since provincial governments are reliant on the national government for revenue transfers. If the political conditions change, the revenue allocations might also change. Also, conflicting tax and social objectives between the different levels of government can cause challenges in the fiscal management of a provincial government. Low reliance on funding from the national government, accommodating relationships with the national government, limited interference by the national government and lower levels of government with low financial demands contribute significantly to the credit quality of a provincial government.

- **Priorities of government in power**

Large-scale tax reductions or spending increases can influence a province's fiscal position and thus its ability to repay debt. DBRS therefore investigates the tax priorities of the government in power.

- **Tax competitiveness**

DBRS compares the province's tax competitiveness with its regional peers. DBRS also investigates the province's income and tax bases. This has to be reviewed since the structure of the tax base affects the province's ability to entice business opportunities and skilled labour, this might ultimately influence the province's ability to raise income and thus to honour its debt responsibilities.

- **Economic potential**

If a province demonstrated stable historical economic growth it will most probably be able to generate the income needed to take care of its population and to build up fiscal resources. The key measures used to gauge economic potential are GDP per capita, income per capita, real GDP growth, real employment growth and private sector investments. An additional indicator is the availability of electricity at a competitive rate.

- **Demographics and social structure**

The demographic and social structure of a province can influence its fiscal position via political stability, the labour force, income structure and the demand for social services. The key measurements used to gauge the demographic and social structure of a province are: the average age of residents, dependence ratios, migration trends, education achievements, welfare caseloads, income distribution and wealth distribution.

*The source document refers to the national government as the federal government.

- **Political environment**

Although Canada as a whole has a very stable political environment, DBRS still investigates the province under review's political environment. DBRS reviews the province's historical record of political stability, the overall public satisfaction in terms of the ruling party within the province and whether the ruling party of the province is the same as the ruling party of the country. DBRS also investigates whether or not the province is close to an election, in the case of a nearby election the influence and philosophy of the opposition party is also taken into account.

- **Transparency**

The transparency of a province's financial reports and the degree to which they can be relied upon are investigated too. The following are features of transparent financial reports: consolidation of government entities, punctual reporting, adherence to standards, compliance with guidelines, as well as the prompt implementation of new rules and guidelines.

- **Ownership of government-owned enterprises**

DBRS reviews the advantages and disadvantages that government-owned enterprises* might have for a provincial government's fiscal position. If a government-owned enterprises is generating a steady income stream it is viewed as beneficial since the income can be used to honour the province's debt agreements. The opposite is also true.

Factor 2: Financial risk

DBRS examines quantitative and qualitative aspects to measure the financial risk position of a provincial government. The following aspects are reviewed: the fiscal balance, revenues, expenditures as well as balance-sheet and financial flexibility.

- **Fiscal balance**

The fiscal balance of a province provides insights into the quality of the management of the province and the dedication of the management team towards financial soundness. Revenues minus dedicated expenditures are used to assesses the fiscal flexibility of the province. The fiscal balance is used to assesses the fiscal sustainability and the given year's financial needs of the province. Past and future results are examined. Although DBRS reviews the seasonality and sensitivity of a province's budget and financing requirements, the province will only be penalised for budgetary shortfalls if these are the result of organisational imbalances that the government is not trying to remedy. DBRS also uses the fiscal surplus or deficit to GDP ratio, the historical fiscal results and the medium-term outlook of the province to review its fiscal balance. See Table A.9 for the guideline values of the measures used. Some of the measures are adjusted by DBRS in order to make results comparable across provinces. For more information regarding these adjustments refer to source document.

*Crown Corporations, as indicated in the original document, is government-owned enterprises.

APPENDIX A. DETAILS OF SUBNATIONAL CREDIT RATING METHODOLOGIES

Ratio	Effect		
	AAA: Exceptional	AA: Exceptional	A: Superior
DBRS adjusted debt to GDP	Less than 15%	10% to 40%	30% to 70%
DBRS adjusted surplus / deficit to GDP	Recurring surpluses	3% to -3%	Persistent deficits
Real GDP growth rate	At or above national average	At national average	Below national average
National transfers to total revenue	Less than 20%	10% to 30%	20% to 50%
Interest cost to total revenue	Less than 5%	3% to 10%	5% to 20%

Table A.9: *Measures used by DBRS to review Canadian provinces' financial risk (DBRS, 2011)*

• Revenues

The major revenue sources of Canadian provincial governments are: tax, royalties, user fees, transfers from the national government and income from government projects. DBRS investigates the variety and volatility of these sources and the government's ability to increase these revenues. The flexibility of revenue sources, the degree of reliance on national transfers and the competitiveness of the tax system are of particular importance when reviewing the revenue of a province. The ratio of tax revenue to total revenue, national transfers to total revenues ratio, natural resources revenues to total revenues ratio, government-owned corporations' earnings, the stability of these earnings and historical revenue growth are also assessed. See Table A.9 for the effects these measures can have on a provincial government's credit rating.

• Expenditures

DBRS examines the government's role within the economy and its responsibility towards service delivery. The major sources of expenditure, for example capital and debt servicing, are investigated in terms of trends and current and future strains caused by these expenditures. The capital needs of the province are determined by investigating the condition of the province's infrastructure, costs to maintain the current assets and growth related improvement needs. The stability and the trend of interest and debt repayment are reviewed since debt servicing is the most inflexible source of expenditure. The debt structure and the debt management strategy are also taken into account. Health-care contributes the biggest portion of provincial expenditures. Therefore the demographic trends of the province, attempts to restrain salary increases and to improve productivity within these sectors are reviewed since it provides insights to the future spending and the stability of the fiscal strategy of the province. DBRS also uses the ratios of health-care, education, social services and interest expenditures as percentages of total expenditures to review a province's expenditures (Table A.9). Expenditure growth trends are also taken into consideration.

• Balance-sheet and financial flexibility

Current and future levels of indebtedness and all aspects that could affect this are taken into consideration, with the main focus is on tax-supported debt. Tax supported debt is debts that the taxpayers are accountable for. The tax supported debt are compared to the GDP of the province since the GDP indicates the province's capacity to repay debt. Interest charges to revenue provide insights into the affordability of outstanding debt. DBRS also uses the tax-supported debt to GDP, total debt to GDP, floating-rate to tax supported debt and foreign currency-denominated debt to tax supported debt ratios as qualitative measures (Table A.9). The debt maturity profile, capital programme, the expected impact of the capital programme on debt, gross borrowing needs and the borrowing strategy are also used to review the balance-sheet and financial flexibility of a province.

A.2.2 AustraliaRatings' credit rating methodology for Australian states and territories

The document AustraliaRatings (2014) was used as the source document for this section.

Australia's subnational government comprises six states and two territories. Australia's history of political and organisational stability guarantees relatively high credit ratings for all Australia's states and territories.

The principal responsibility of the subnationals is to provide the necessary public services and infrastructure. The funds to fulfil these responsibilities are provided by the national government,* since the taxation powers and expenditure responsibilities reside with the national government.

AustraliaRatings examines the current and future economic and financial situation of a subnational, as well as the strategy of the specific subnational government. The analysis entails quantitative and qualitative measures and is based on four different factors, namely the economy, financial management, accounting and budgeting policies and the debt profile of the government (Figure A.6).

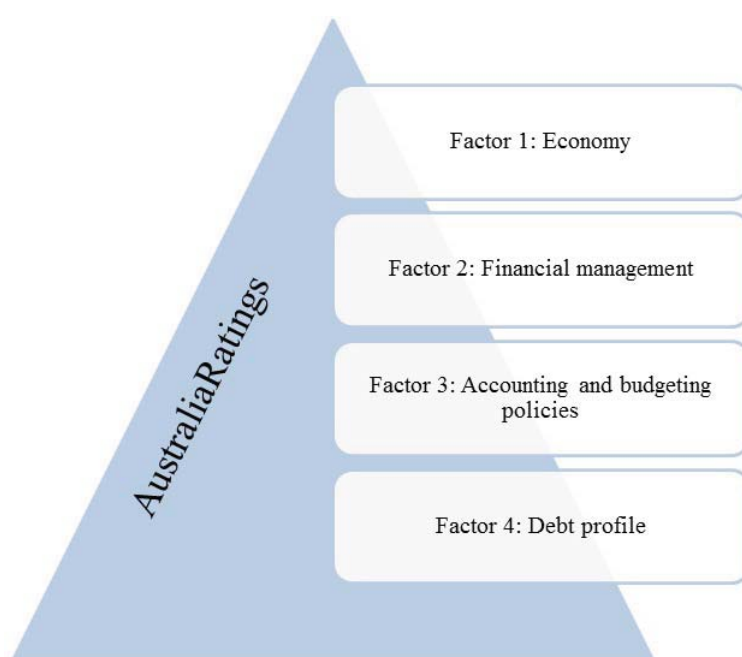


Figure A.6: *The four factors used by AustraliaRatings to determine the creditworthiness of an Australian subnational government (Adapted from AustraliaRatings, 2014)*

*Indicated as the Commonwealth of Australia in original documentation.

Factor 1: Economy

The Australian states' and territories' regional economies reveal some of the same properties, but also some differences. AustraliaRatings investigates future economic growth and the demographic profile of the state or territory under review. Generally an increase in population constitutes to an increase in infrastructure needs, but also an increase in economic activities and tax base. AustraliaRatings reviews the economic composition, the degree of diversification, the existence of concentration risk, as well as the current and future growth in gross state output.

Factor 2: Financial management

The financial management strategy of a subnational plays a major role when determining the credit rating of the subnational government. Characteristics like the quality, clarity and completeness of available financial information, budgeting capability, revenue generation capability, expenditure management, capital planning, financial planning, asset management, debt management, political leadership and the executive managerial strength are reviewed to determine the strength of a government's financial management. Special attention is given to revenue management, especially to taxes and national grants since, these are the primary revenue sources of Australia's states and territories.

- **Taxes**

Taxes raised on transfers of properties, financial transactions, capital transactions and payrolls is one of the main sources of income of Australia's subnationals.

- **Grants from national government**

The national government allocates grants on the principal of fiscal equalisation. This principle aims to aid states with weak tax bases or unfavourable demographic profiles since these states have a lower capacity to raise revenues. National government grants generally add up to more than half of a subnational's revenue. These grants can be either specific-purpose payments or untied grants and may be used to cover state expenditures. Specific-purpose payments could be used to pay recurring or capital expenses, fund local governments and to partially fund health and education expenses. Health and education spending are the biggest spending areas of Australian subnational governments.

Factor 3: Accounting and budgeting policies

The investigation of the accounting and budgeting policies of a subnational government supports the analysis of the financial management of a subnational. The income statement, cash flow statement and balance sheet of a state or territory is reviewed, both current and forecasted numbers. The financial statements are audited annually by the state or territory auditor general.

- **Accounting**

By law all states and territories have to use the full accruals based accounting method, to allow for direct comparisons between states and territories. The financial statements includes an operating statement, a balance sheet, a statement of changes in equity and a cash flow statement. All of these should be comprehensive and transparent. The unconsolidated financial statements are used to conduct a general review of the government.

- **Budgeting and financial flexibility**

AustraliaRatings investigates a subnational's degree of budgetary flexibility to determine the flexibility to increase revenues and to decrease expenditures in order to honour debt responsibilities. The budgetary flexibility is reviewed by assessing the government's ability to raise taxes and state charges, its ability to cut expenditures, revenues that could be earned by selling state assets, as well as the political willingness to increase taxes and decrease expenditures. The budget statement of a subnational government provides insight into the government's future strategy, forecasted revenues and expenditures and policy decisions on funding plans.

- **Budgeting performance**

The budgeting performance of a state or territory is reviewed to provide insight into the efficiency of the financial strategy of the government. The operating balance to operating revenue ratio is used to assess if the government is able to cover its operational costs from recurring revenues. The balance after capital accounts to total revenue ratio, on the other hand, is used to assess the government's shortfall or surplus generated by operational and capital activities.

Factor 4: Debt profile

The current and future debt levels of the subnational are reviewed under the heading debt profile.* The analysis mainly focuses on forecasted debt levels, forecasted interest costs, possible volatility of cost due to capital market volatility, long-term liabilities, debt maturity profile and dependence on short-term funding.

- **Guarantees**

States and territories provide general guarantees for treasury vehicles due to the centralised nature of government borrowing activities.

- **Management of market risk**

AustraliaRatings considers a government's levels of interest rate and currency rate risks, as well as the potential exposure due to these risks. The use of derivative contracts is reviewed since, although the use of these is allowed, speculative use of these is considered as a credit negative.

- **Liquidity**

The cash reserves, cash flow generating ability, access to external bank lines and the financial market are used to gauge a state or territory's liquidity position. The liquidity position of a subnational government provides insight into the government's ability to meet financial obligations on time.

- **Support**

The national government does not explicitly guarantee a subnational's debt obligations, although historically they did provide support to states and territories with financial problems. Thus AustraliaRating assumes that the national government will provide guarantees in case of need. This is taken into consideration when AustraliaRatings determines the creditworthiness of Australian subnationals.

*The source document refers to this factor, debt profile, as debt, contingent liability and liquidity.

A.3 Regional subnational credit rating methodologies of developing countries

A.3.1 Fitch's criteria report for Indian state governments' ratings

India's subnational level of government comprises twenty eight states and seven territories. The source document for this section, Fitch's criteria report for Indian state governments' ratings 2009, documents Fitch's methodology to determine the standalone credit profiles of India's subnational governments. The methodology could be used to determine the credit quality of Indian state or territory governments. This methodology is based on Fitch's credit rating methodology for international local and regional governments as was discussed in Section A.1.1, although the methodology for the Indian subnational credit ratings are based on the 2009 version rather than the 2011 version. The old factors can roughly be regrouped into the newer methodology's factors (Table A.10). Fitch adjusted its international rating methodology to be applicable to India by taking into account India's complex inter-governmental relations, complex administrative, regulatory and financial structures, as well as the difference in availability and presentation styles of data, Fitch employs five factors to determine the standalone creditworthiness of Indian subnational governments (Figure A.7).

Regrouping of the factors of the 2009 and 2011 versions Fitch' international and local governments rating methodologies	
2009 Factors	2011 Factors
Institutional and administrative matters	Institutional framework
Economic and social profile	Economy
Fiscal and budgetary performance	Institutional framework and Finances
Debt, liquidity and indirect risk	Debt and other long-term liabilities
Management	Management and administration

Table A.10: *Regrouping of the factors of the 2009 version of Fitch' international local and regional governments rating methodology into the 2011 version's factors (Author's own compilation)*

Factor 1: Institutional and administrative aspects

Fitch reviewed the Constitution of India since it stipulates the powers assigned, in particular the taxation powers and revenue-generating powers and the expenditure responsibilities assigned to the different levels of government. India also has a Finance Commission and a Planning Commission. The Finance Commission stipulates what share of central taxes will be divided between the different states, it also decides on how these taxes will be divided. The Planning Commission determines the funding granted to states for the implementation of projects. The stipulations of the Finance and Planning Commissions are thus also reviewed. Under the Constitution of India states and territories are allowed to establish their own legislature. However, the legislature of territories has only limited powers. States and territories with their own legislatures have their own budgets. Market borrowing is allowed, but only with the consent of the national government.* India's national government provides financial support to states when needed, but the responsibility to service debt obligations remains that of the state through their own budgets. Therefore the budgets of the states have to be evaluated. Fitch uses different indicators to assess the relationship between India's national and subnational governments. These indicators are the subnational's own revenue in comparison with the national government's revenue, the growth of the own versus national revenue ratio, as well as the specific subnational's own central taxes and grants to its gross state domestic product.

*The national government is referred to as the Government of India or the centre in the original document.

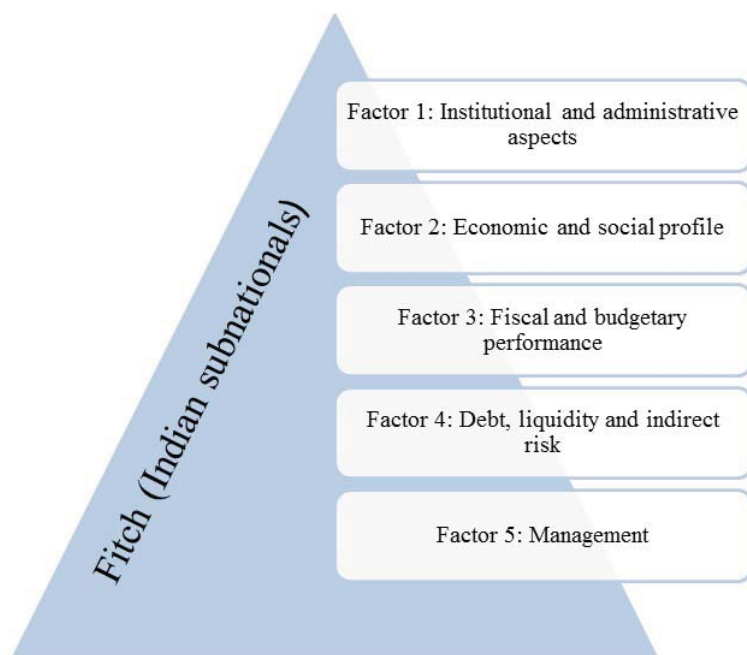


Figure A.7: *The factors used by Fitch to credit rate Indian subnational governments (Adapted from Fitch, 2009)*

Factor 2: Economic and social profile

The size and structure of a subnational government's economy affects its revenue generating capacity and thus its ability to honour its debt obligations. The size and structure of states' economies within India are influenced, for example, by the national economy and tax policies, but states and territories are allowed to set their own industrial policies and some other policies. It is best for subnationals to align these policies with the national policies. Fitch views a diverse economy with a blend of manufacturing, agriculture and services industries as beneficial to an Indian subnational's credit rating. A subnational's economy that is based on its own resources and its own geographic advantages is also considered a credit positive as it would lead to a stronger economy compared to the economy of a state that is dependent on the national government for revenues.

A state's growth is also affected by its demographic profile since it may cause a need for social and infrastructure development. The need for social development may lead to an increase in expenditure on education and public health. Fitch uses the following measures to gauge the economic and social profiles of Indian subnationals: the size of the economy indicated by the gross state domestic product, the structure of the economy, the growth of the economy, the sources of the growth in economy, demographic trends, literacy rate, health indicators, poverty ratio, urbanisation, infrastructure and unemployment. Some of these indicators are only available via periodical surveys and thus may have a significant time lag and may also not be available for some of the smaller states.

Factor 3: Fiscal and budgetary performance

Medium-term trends in fiscal performance and fiscal position is the main focus of fiscal and budgetary performance since it provides insight into the state or territory's future economic growth and fiscal performance. The differences between Indian subnationals' economic and fiscal performances are driven by their individual economic and fiscal policies since the national policies will have the same effect on all Indian subnationals.

Even though India's subnationals will have different economic and fiscal profiles, the three fiscal consolidation programmes in India will affect them all in the same way. The first fiscal consolidation programme, the fiscal reform programme and fiscal reform facility, aims to enhance the states' medium-term revenue accounts. The debt-swap scheme aspires to reduce the burden of high interest payments. The third programme, the debt consolidation and relief facility, was put in place to combine loans from the national government and to exempt debt from the national government. India also has a new pension scheme in place, which will help subnationals to lessen their long-term pension liabilities. For more information regarding the three fiscal consolidation programmes and the new pension scheme, refer to the source document.

Fitch uses a number of measures to gauge the fiscal performance and budgetary performance of subnationals, as well as liquidity-related issues. These measures are focussed on the subnational's income receipts, the subnational's expenditures and the balance of the two. Examples of the measures used are increases in the state's own tax revenue and non-tax revenue, salaries to gross state domestic product, growth in net lending as well as revenue, fiscal and primary balances to gross state domestic product. The full list of measure used by Fitch is documented in the source document.

- **Receipts**

Receipts can be split into revenue receipts and capital receipts. Capital receipts are viewed as the repayment of loans or advances extended by subnational governments. A decrease in capital receipts because of a decrease in loans and advances indicates an improvement in fiscal health. Revenue receipts includes own receipts and receipts received from the national government. States that rely on the national government for the biggest portion of their revenues are exposed to seasonalities of the national economic growth, as well as the fiscal shocks of the national economic and fiscal performance. Industrialised subnationals, on the other hand would have greater revenue flexibility and thus a better credit rating.

- **Expenditures**

Expenditures can be split into revenue expenditure and capital expenditure. Revenue expenditure is used for current expenditure and interest payment. A large portion of current expenditure in India is committed to for example salaries, pensions and interest payment. The committed versus the non-committed relationship is more important than the current expenditure trend, since this relationship provides insights into what may be expected in the future. Fitch also reviews the trends of current expenditure to gross state domestic product, revenue receipts, deficits and other macro-economic indicators. Capital expenditure is used for investment purposes. Due to the large portion of committed expenditure there is little room for capital expenditure in India. It is normally the capital expenditure of a government that gets restricted during times of distress. This may have an impact on infrastructure and social development and thus may ultimately affect economic growth and thus the credit stance of a subnational in a negative way.

- **Balances**

There are three types of balances in the Indian context that are used for analysis. These three balances are: the revenue, fiscal and primary balance. The revenue balance is difference between revenue receipts and revenue expenditure. The sum of the revenue balance and net lending, minus planned capital expenditures forms the fiscal balance. Thus the fiscal balance is the difference between revenue receipts and revenue expenditure, plus net lending minus planned capital expenditure. The primary balance is the difference of the fiscal balance minus interest payments.

A positive revenue balance implies that current revenue exceeds current expenditure. A large deficit of the revenue balance implies that the specific subnational has limited capital expenditure opportunities. In the case where the current expenditure to current revenue ratio is decreasing, the reasons have to be established too. If this is due to a decrease in interest payments, subsidies and salaries, it may be viewed as beneficial to the credit rating of the subnational government under review. Should this decrease be considered to ultimately have a negative effect on growth prospects of a subnational, this will be viewed as detrimental to the credit rating of the subnational. If the decrease in the current expenditure to current revenue ratio is due to a seasonal increase in current revenue the decrease becomes a credit negative as the seasonal increase may reverse at any time. In the case that the decrease in the current expenditure to current revenue ratio is due to simultaneous revenue decrease and expenditure increase, it is also seen as detrimental to the creditworthiness of the subnational.

When a deficit in the fiscal balance is evident the quality of the deficit and the reasons for the deficit have to be assessed. The revenue balance to fiscal balance ratio may provide some insight into the reasons for a fiscal deficit. A large ratio indicates that the deficit is caused by financing current consumption; this will have a negative impact on the subnational's credit rating according to the Fitch standards.

A small ratio indicates that the deficit is caused by financing investments; this will have a positive impact on the subnational's credit rating according to the Fitch standards. The primary balance supplies information regarding the subnational's finances when no debt is present.

- **Liquidity**

The constant use of the facilities provided by the Reserve Bank of India and the national government to fund temporary mismatches between revenue and expenditures implies a liquidity strain and poor cash-flow management. This ultimately indicates that the credit quality of a subnational is poor.

Factor 4: Debt, liquidity and indirect risk

Debt has to be reviewed since even good economic and fiscal foundations can be negatively affected by too high levels of debt. Fitch considers the primary account balance, the rate spread, the usage of debt incurred, the structure of debt and indirect risks. The rate spread is defined as the nominal growth of the economy, minus the average interest rate on debt. A surplus on the primary account that is accompanied by a positive rate spread will lead to better credit quality since it will cause a decrease in the debt to gross state domestic product. When investigating the usage of debt Fitch assesses whether the debt is used for current consumption or for investment purposes. It is common practice for Indian subnational governments to guarantee the debt programmes of their public sector entities. These guarantees are viewed as indirect risks and are also considered by Fitch. Fitch uses four ratios and three other types of measures to do the debt, liquidity and

indirect risk assessment. The four ratios are: the debt to gross state domestic product, debt to revenue receipts, guarantees to gross state domestic product and guarantees to revenue receipts. The other measures are: debt growth, growth in guarantees and the rate spread.

Factor 5: Management

The national government of India determines the economic, fiscal and monetary policies that the subnationals have to abide to. The five year plans of these policies are brought before the National Development Council. Subnationals play a role in future economic growth and fiscal performance via this council. Fitch uses a subnational's historical record of successful implementation of policy interventions and its historical record of the implementation of best practices of fiscal management as qualitative measures to gauge the management quality of a subnational. The quantitative measures are adherence to the Fiscal Reform and Budget Management Act's annual rolling targets, the operating revenue to budgeted operating revenue ratio, the operating expenditure to budgeted operating expenditure ratio and the capital expenditure to budgeted capital expenditure ratio.

A.3.2 CRISIL's rating methodology for Indian state governments

This section is based on CRISIL's document containing their rating criteria for Indian state governments. CRISIL assesses the credit quality of most of India's state governments. The three factors used by CRISIL to evaluate the credit quality of Indian state governments are the economic structure of the state, the state government's finances and the economic management of the state government (Figure A.8). The outcomes of the factors of the subnational government under review are compared with outcomes of the factors of other states when assessing the credit quality of a specific state.

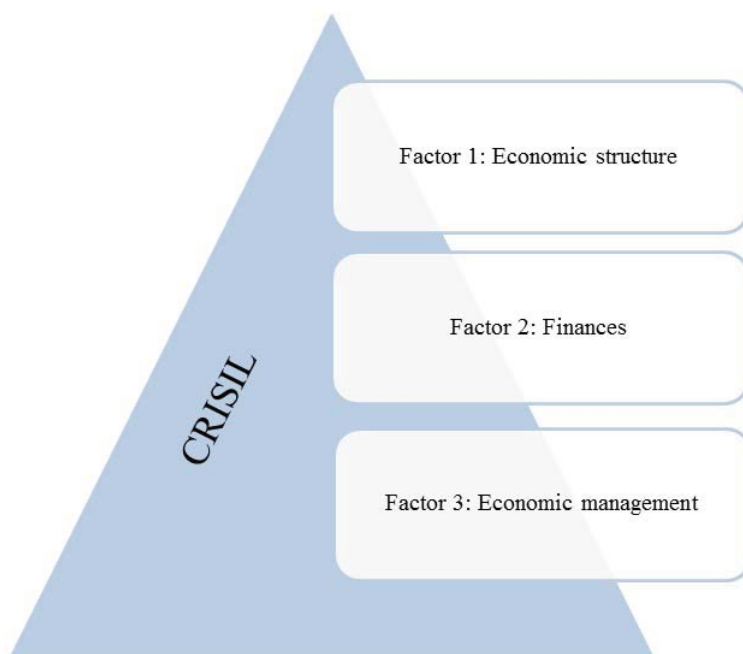


Figure A.8: *CRISIL's methodology to determine the credit quality of Indian subnationals (Adapted from CRISIL, 2011)*

Factor 1: Economic structure

In order for a state to develop economically, a well-developed economic infrastructure and a well-developed social infrastructure and sufficient natural resources are needed. Economic development in a state will lead to the enhancement of the state's finances. The economic development and thus the improvement of a state's finances will be hindered by an under-developed economic and social infrastructure. Investments in social development take longer to bear fruits than investments in economic development. Due to these reasons a state needs to find a balance between investing in economic and social development.

- **Gross state domestic product**

Agriculture, forestry, fishing and mining are viewed by CRISIL as the primary sectors of Indian state economies. Manufacturing, construction, electricity, gas and water supply is viewed as secondary sectors and trade, hotels, financing, insurance and real estate are examples of industries within the tertiary sector. Over-reliance on the primary sector limits a state's tax resources, except when a state has the competitive advantage within the primary sector because of the higher incomes and sales taxes. An economy based on a mixture of primary, secondary and tertiary sector industries are better protected against economical fluctuations and thus more stable according to CRISIL. CRISIL also views over-dependence on just a few industries or agricultural crops as negative when considering the credit strength of an Indian state government.

- **Demographic profile**

A well-educated population only requires limited future social investments. It will also ultimately lead to economic growth because of the highly trained and healthy manpower it brings forth. The capita per income, population below the poverty line, level of urbanisation, employment rate, literacy, birth, death and infant mortality rate are measures used by CRISIL to investigate the demographic profile of a state.

- **Social infrastructure**

The social infrastructure of a state has an effect on its demographic profile and thus on its economic growth, as explained above. CRISIL investigates the availability of educational and health care facilities to determine the social infrastructure within a state. A good social infrastructure will aid the credit rating of an Indian subnational government.

- **Economic infrastructure**

The economic infrastructure of a state provides information regarding the state's capability to increase its economic activities and the investment opportunities that it holds for the private sector. CRISIL pays special attention to the availability of power, the irrigation facilities and the transport infrastructure of an Indian state when they assess the economic infrastructure of the state. The availability of power is assessed by investigating the installed capacity, the power generated and the increase in installed capacity. The availability of power has to be reviewed since it is required for future industrial development. Irrigation capacity is needed in order for a state to increase its agricultural products. CRISIL investigates the availability of roads, railways, ports and airports of Indian states to gauge their transport facilities. These facilities are needed to ensure the proper movement of goods and people. The better the economic infrastructure of a state, the better the credit quality of the state.

- **Industry profile**

A state's economic development is affected by its level of industrial development, the diversification within the economy and the growth prospects, according to CRISIL. Negative trends on these aspects will also affect the credit rating of the state negatively.

- **Investment attractiveness**

A state needs to attract investments in order to stimulate and maintain economical growth and ultimately to honour its financial obligations. CRISIL evaluates this ability via the industrial entrepreneurs' memorandum in relation to the size of the state's economy.

- **Labour market**

CRISIL evaluates the labour market circumstances of Indian states by reviewing the availability of trained manpower, the industrial relations, employment rate and occupational patterns. Proper labour market conditions aid the credit rating of an Indian state.

- **Natural resources**

CRISIL investigates a number of natural resources when reviewing the economic structure of a state. These natural resources includes forest cover, water and irrigation resources, rivers and rainfall, mineral reserves, as well as the accessibility of coastline and port facilities.

- **Agriculture**

CRISIL also reviews the stability and increase in agricultural products as part of their economic structure assessment, since agriculture is the primary occupation in most Indian states. The cropped and irrigated land under a variety of agricultural products, the composition of agricultural produce over time, growth trends in the total and the per hectare agricultural output, as well as the use of modern methods and inputs are used by CRISIL to determine the stability and growth of the agricultural output of an Indian state. Positive growth trends in the total and the per hectare agricultural output, as well as the use of modern methods and inputs are beneficial to the credit stance of the state government under review.

Factor 2: Finances

CRISIL evaluates the finances of a state by reviewing the state's fiscal management, including resource availability, expenditure management and indebtedness level.

- **Revenues**

The four main sources of revenue of Indian state governments are own tax revenues, own non-tax revenues, share in national taxes and grants from the national government.* A state's level of own taxes indicates the state's capability to generate revenues and to maintain expenditures. According to CRISIL, this revenue source depends on tax potential and tax effort, although tax effort is an administrative management indicator rather than a fiscal management indicator. Tax potential is determined by the income level and the composition of the gross state domestic product. The tax effort, on the other hand, depends on the state's accomplishment on collecting taxes. A extraordinary tax effort will result in better tax revenues and a poor tax effort will lead to unused

*The source document refers to the national government as the centre.

revenue resource. A state's share in national taxes is determined via the Finance Commission's recommendations and is calculated on a formula basis. Thus it is considered to be stable and non-discretionary. Over-dependence on the share in national taxes are viewed more favourable than a dependence on grants from the national government, but not as favourable as dependence on own tax and non-tax revenues. Grants from the national government consist of grants from the Planning Commission and the Finance Commission. The grants from the Planning Commission are viewed as more discretionary than grants from the Finance Commission. Due to this discretionary component of grants from the national government, CRISIL considers an over-dependence on this revenue source as a credit negative. An over-dependence is a sign of inadequate own revenue sources.

- **Expenditure**

CRISIL firstly investigates whether a state government's expenditures are in line with its revenues. In order to assess this CRISIL reviews whether or not the government made and implemented any election promises and if the government implemented expenditure control programmes. CRISIL also investigates the composition of expenditures. Governments should have a balance between spending on social and economical development.

- **Deficit management**

The deficit level of a state provides information regarding the quality of the economic management of the state. CRISIL uses the ratios deficit level to revenue receipts, deficit level to revenue expenditure and gross fiscal deficit to gross state domestic product to gauge the deficit management of a state. The composition of the gross fiscal deficit of a state in terms of capital expenditure, net lending and revenue deficit is also reviewed. This indicates the quality of a state's fiscal and economic management. CRISIL believes that a low portion of revenue deficit will ultimately lead to better tax potential, since this will increase capital development and thus economic activities within the state. Thus it will ultimately improve the credit quality of the state.

- **Indebtedness**

The debt-bearing capacity of a state is reviewed by measuring the state's level of indebtedness compared to its revenues and the size of its economy, as well as debt-coverage through revenues. More specifically, CRISIL uses some ratios to gauge a state's level of indebtedness. An example of these ratios is total debt and guarantees to total revenue, refer to the source document for the full list. CRISIL also investigates the composition of debt, the growth rate of debt, and the existing and expected future accessible debt.

Factor 3: Economic management

The economic policies of a state and its possible influences on the state's financial position and economic development are investigated to assess the economic management of a state. The main aspects of economic management are a consistent focus on economic reforms, guarantee and debt management, industry and infrastructure policy, liquidity position, performance of state-owned enterprises, as well as political risk. CRISIL investigates each of these aspects separately.

- **Consistent focus on economic reforms**

Consistent focus on economic reforms is needed to ensure continual economic growth and improvement of fiscal health. Constant adherence to economic reforms shows that a state is capable of implementing reforms in a sustainable manner. A state's credit profile is enhanced by attempts to minimise wasteful expenditure and efforts to increase revenues. A state's credit profile is negatively affected by actions like free electricity to farmers, giving away hand-outs and the waiving off of principals and interest on loans.

- **Guarantee and debt management**

Indian state governments extended guarantees to the borrowing programmes of their government-owned enterprises.* The chances that these guarantees could be called upon had become very high in recent years. This prompted CRISIL to pay special attention to a state's criteria for extending guarantees, how a state monitors existing guarantees and if a state is preserving sensible limits on contingent liabilities. An adequate buffer to fund the redemption of guarantees is viewed as a credit positive.

- **Industry and infrastructure policy**

According to CRISIL the industry and infrastructure policy of a state affects the economic growth of the state. CRISIL therefore seeks to understand a state's policy on the development of, for example, roads, airports, power and water supply. Private sector participation in infrastructure development enables the state to apply their funds towards other development projects. Private sector participation therefore is considered to have a positive effect on a state's credit rating.

- **Liquidity position**

Indian state governments are allowed to borrow money from the Reserve Bank of India to cover their short-term funding gaps. CRISIL considers consistent borrowing of large amounts to indicate to poor liquidity management. This will impact the credit rating of the state in a negative manner.

- **Performance of government-owned enterprises**

The financial performance of a state can be affected by the financial performance of its government-owned enterprises. The recent reforms within the electricity sector in India will most probably have a short-term and medium-term effect on states' financial performances. These effects have to be taken into account when assessing the creditworthiness of Indian state governments.

- **Political risk**

The political situation within a state can influence the state's finances and economic development. For example, frequent changes in the government of a state may disrupt the consistency of the execution of economic policies. When the relationship between the national and a state government is disrupted the discretionary transfers may also be effected. This is another example of the political situation's effect on a state's finances. For these reasons CRISIL reviews the political situation within a state when assessing the credit quality of an Indian state. A stable political environment will improve the credit stance of an Indian state government.

*Government-owned enterprises are referred to as state-owned enterprises in the original documentation.

A.4 Public sector risk management framework of South Africa

The National Treasury developed the PSRMF to aid, among others, provincial governments and departments in their implementation and maintenance of effective, efficient and transparent systems of risk management and control. The PSRMF was developed in response to the Public Finance Management Act (PFMA). This act will be discussed in Chapter 4 along with some other South African regulatory information.

No regional subnational credit rating methodology, like the DBRS methodology for Canadian provinces or the CRISIL methodology for Indian states, currently exists for South Africa's subnationals. In the absence of such a regional subnational credit rating methodology the PSRMF could be reviewed in order to gain background knowledge for the development of a South African subnational credit rating methodology. However, this framework is considered to be vague. Thus for the purpose of this thesis Table A.11 in Appendix A lists some of these vague aspects but no formal review will be conducted. Note that the goal is not to document a complete assessment of the PSRMF, but only to highlight some of the vague aspects.

The booklet on the PSRMF, National Treasury (2010), was used as the source document of this section.

APPENDIX A. DETAILS OF SUBNATIONAL CREDIT RATING METHODOLOGIES

Chapter	Page	Example of statements	Assessment
Chapter 1: Definitions	15	Risk appetite is the amount of residual risk that the Institution is willing to accept.	Definitions are vague. For example, what does accept mean?
Chapter 2: Purpose, applicability and background	19 and 20	The public sector environment is fraught with unique challenges such as inadequate capacity, excessive bureaucracy and silo mentality, limited resources, competing priorities and infrastructure backlogs. The underlying intention is that institutions should through the risk management process achieve, among other things, the following outcomes needed to underpin and enhance performance: (d) reduced waste; (e) prevention of fraud and corruption.	Important that these problems and outcomes are recognised, but there are few to no suggestions as to how to solve these problems and how to achieve the outcomes.
Chapter 3: Creating an enabling environment	22 and 22 23 25	The accounting officer / authority should ensure that institution: (e) has an appropriate organisational structure supported by basic financial and management systems underpinned by risk management and internal controls. The risk management policy should: (e) outline the risk management approach. The chief risk officer and his/her staff should possess the necessary skills, competencies and attitudes to execute functions set out.	This is a good practice, but the question arises as to why only basic financial and management systems? No guidance is provided as to what these internal controls are. It would be best if the risk management policy provides details about the risk management approach, not only an outline. Insufficient details are provided.
Chapter 4: Integration of risk management activities	28	The Institution should: communicate timeously with other organs of state in instances where the identification, evaluation and management of risk to the Institution require the participation of these organs.	Relevant senior officials within these organs are not identified.
Chapter 5: Risk identification	30 31 31	The risk identification process should cover all risks, regardless of whether or not such risks are within the direct control of the Institution. Risk workshops and interviews are useful for identifying, filtering and screening risks, but it is important that these judgement based techniques be supplemented by more robust and sophisticated methods where possible, including quantitative techniques. Risk identification should be strengthened by supplementing management's perceptions of risks, inter alia, with: (d) historic data analyses; (e) actual loss data (f) interrogation of trends in key performance indicators (i) scenario analyses and (j) forecasting and stress testing.	No examples provided. Normally quantitative techniques produce results first. The quantitative results are then used to supplement the qualitative assessments. These should be undertaken first and foremost and not only be used to strengthen management's perceptions of risks.

APPENDIX A. DETAILS OF SUBNATIONAL CREDIT RATING METHODOLOGIES

Chapter	Page	Example of statements	Assessment
Chapter 6: Risk assessment	34	Risks should be assessed on the basis of the likelihood of the risk occurring and the impact of its occurrence on the particular institutional objective(s) it is likely to affect.	Statement is vague. Unexpected events are where the real risk resides, but no attention has been given to unexpected events.
	35	Risk assessment should be strengthened where possible by supplementing management's perceptions.	Statement is vague. This also implies that management perceptions come first in the assessment process, not quantitative analysis.
Chapter 7: Risk response	38	Management should develop the internal control architecture through: (a) preventative controls to prevent errors or irregularities from occurring (b) detective controls to find errors or irregularities after they have occurred (c) corrective controls that operate together with detective controls to correct errors or irregularities.	These measures are the critical drivers of the risk management process. Thus the statement is viewed to provide too little information, some examples are provided in this case.
Chapter 8: Communication and reporting	40	The institution's risk communication and reporting process should support enhanced decision making and accountability through: (a) dissemination of relevant, timely, accurate and complete information.	Statement is unclear. For example, it does not inform regarding the channels to use for the communication. This reporting channels is a crucial aspect of communication and reporting.
Chapter 9: Monitoring	41	Monitoring activities should focus on evaluating whether: (a) allocated responsibilities are being executed effectively (b) response strategies produce desired result of mitigating risks or exploiting opportunities (c) positive correlation exists between improvements in the system of risk management and Institutional performance.	Elusive statement that does not provide information regarding the procedures for risk monitoring, risk monitoring responsibilities and risk monitoring frequency.
Chapter 10: Risk management functions of executive authorities	42	The executive authority should take an interest in risk management to the extent necessary to obtain comfort that properly established and functioning systems of risk management are in place to protect the Institution against significant risks.	No explanation is provided as to what significant risks are. This has to be defined before the executive authority can take any interest in risk.
Chapter 11: Risk management functions of accounting officers / authorities	44 and 45	High level responsibilities of the accounting officer / authority should include: (a) setting an appropriate tone by supporting and being seen to be supporting the institution's aspirations for effective management of risks (i) approving the institution's risk appetite and risk tolerance (j) devoting personal attention to overseeing management of the significant risks.	Insufficient information provided as to what appropriate tone and devoting personal attention mean. Also does not explain how risk tolerances are arrived at or calculated.

APPENDIX A. DETAILS OF SUBNATIONAL CREDIT RATING METHODOLOGIES

Chapter	Page	Example of statements	Assessment
Chapter 13: Functions of risk management committees	50	In discharging its governance responsibilities relating to risk management, the risk committee should: (a) review and recommend for the approval of the accounting officer authority the: (iv) institution's risk appetite, ensuring limits are: - supported by a rigorous analysis and expert judgement (v) institution's risk tolerance, ensuring that limits are supported by a rigorous analysis and expert judgment of: - the institution's ability to withstand significant shocks.	The concepts rigorous analysis and significant shocks are not explained. The confidence level is not quantified. No explanation provided as to how the rigorous analysis and expert judgment is supposed to interact.
Chapter 14: Functions of chief risk officers	54 and 55	The high level responsibilities of the chief risk officer should include: (d) continuously driving risk management to higher levels of maturity.	The statement is very vague and non-committal. Overall, insufficient details are provided regarding the functions of the chief risk officers.
Chapter 15: Risk management functions of management	56 and 57	High level of responsibilities of management should include: (f) providing risk management reports.	No information offered as to how frequent these reports should be provided or to whom. Overall, insufficient details are provided regarding the functions of management.
Chapter 16: Risk management functions of other officials	58	High level of responsibilities of other officials should include: (d) cooperating with other role players in the risk management process and providing information as required.	Insufficient details are provided regarding the functions of other officials.
Chapter 17: Functions of risk champions	59 and 60	The risk champion should also add value to the risk management process by providing guidance and support to manage problematic risks and risks of a transversal nature that require a multiple participant approach.	No explanation provided of what the difference between a risk quantitative analyst and a risk champion is. Overall, insufficient details are provided regarding the functions of risk champions.
Chapter 20: Risk management functions of the national treasury	65 and 66	With respect to capacity building, the National Treasury should assist national departments, national public entities, constitutional institutions, municipalities and municipal entities in building their capacity for, among other things, efficient, effective and transparent risk management.	No guidance provided on how should this be undertaken and implemented.
Chapter 21: Risk management functions of the provincial treasuries	67 and 68	With respect to capacity building, the provincial treasury should assist provincial departments, provincial public entities, municipalities and municipal entities, among other things, in building their capacity for efficient, effective and transparent risk management.	No guidance provided on how should this be undertaken and implemented.

APPENDIX A. DETAILS OF SUBNATIONAL CREDIT RATING METHODOLOGIES

Chapter	Page	Example of statements	Assessment
Chapter 22: Evaluation of risk management effectiveness	69	Institutions should strive to incrementally and sustainably achieve a mature risk management regime in order to realise the outcomes.	Subjective and vague statement.
	73	The accounting officer / authority, in consultation with the risk management committee, should evaluate the performance of the chief risk officer through the following and other relevant indicators: (f) absence of surprises. The accounting officer / authority should evaluate the performance of management through the following and other relevant indicators: (f) absence of surprises.	Statements provide too little information.

Table A.11: *List of some of the vague aspects of the PSRMF (Author's own compilation)*

Appendix B

ADDITIONAL TABLES OF THE INVESTIGATION OF MODEL ADVANCEMENTS

The detailed results of the models resulting from the model advancement investigation conducted in Chapter 7 are documented in this appendix.

B.1 Results of Health with time dataset (HT)

R-Square	0.48
Adjusted R-Square	0.41

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-0.20	0.00	0.84	0.00
Indicator_KZN	-2.64	-0.61	<.0001	1.09
Indicator_Lim	-1.04	-0.24	0.05	1.08
Indicator_Mpu	-1.31	-0.30	0.02	1.09
ln_x28_Zmean	0.31	0.29	0.03	1.14
ln_x58	0.88	0.23	0.05	1.02

Table B.1: *Linear regression model based on the alternative dependent variable of the HT dataset*

APPENDIX B. ADDITIONAL TABLES OF THE INVESTIGATION OF MODEL ADVANCEMENTS

R-Square	0.53
Adjusted R-Square	0.44

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-2.83	0.00	0.22	0.00
Indicator_KZN	-2.51	-0.57	<.0001	1.30
Indicator_Lim	-1.28	-0.29	0.02	1.15
Indicator_Mpu	-1.04	-0.24	0.11	1.60
ln_x28_Zmean	0.29	0.26	0.05	1.31
ln_x58	0.85	0.22	0.06	1.03
ln_x14	0.37	0.09	0.53	1.64
x52	0.18	0.09	0.46	1.15

Table B.2: *Linear regression model including independent variables selection based on subject knowledge of the HT dataset*

R-Square	0.58
Adjusted R-Square	0.53

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-0.60	0.00	0.52	0.00
Indicator_KZN	-2.87	-0.67	<.0001	1.10
Indicator_Lim	-1.24	-0.29	0.01	1.08
Indicator_Mpu	-1.43	-0.33	<0.01	1.09
ln_x28_Zmean	0.37	0.35	<0.01	1.15
ln_x58	0.76	0.20	0.06	1.02

Table B.3: *Stepwise linear regression model without outliers in the dependent variable of the HT dataset*

R-Square	0.65
Adjusted R-Square	0.60

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	0.05	0.00	0.95	0.00
Indicator_KZN	-2.85	-0.75	<.0001	1.09
Indicator_Lim	-0.14	-0.03	0.77	1.06
Indicator_Mpu	-1.80	-0.43	<0.01	1.07
ln_x28_Zmean	0.32	0.32	<0.01	1.09
ln_x58	0.45	0.13	0.21	1.04

Table B.4: *Stepwise linear regression model without outliers in the independent variables of the HT dataset*

APPENDIX B. ADDITIONAL TABLES OF THE INVESTIGATION OF MODEL
ADVANCEMENTS

R-Square	0.80
Adjusted R-Square	0.76

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	1.04	0.00	<.0001	0.00
Indicator_WC_ln_x49	-19.71	-0.32	<0.01	1.11
x27_grouped_Indicator_x36_Z	-0.66	-0.35	<0.01	1.26
Indicator_Lim_ln_x36_Zmean	0.59	0.37	<.0001	1.18
Indicator_KZN_ln_x48	-31.99	-0.60	<.0001	1.12
Indicator_Mpu_ln_x57	-0.20	-0.44	<.0001	1.13
Indicator_Lim_ln_x50	-66.26	-0.37	<.0001	1.13
Indicator_FS_ln_x33	-22.00	-0.17	0.03	1.06
x27_grouped_ln_x34	-15.10	-0.31	<0.01	1.22

Table B.5: *Linear regression model including interaction effects without outliers in the dependent variable of the HT dataset*

R-Square	0.90
Adjusted R-Square	0.88

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	0.93	0.00	<.0001	0.00
Indicator_WC_ln_x49	-18.54	-0.31	<.0001	1.12
x27_grouped_Indicator_x36_Z	-0.58	-0.32	<.0001	1.42
Indicator_Lim_ln_x36_Zmean	0.93	0.58	<.0001	2.10
Indicator_KZN_ln_x48	-30.85	-0.60	<.0001	1.11
Indicator_Mpu_ln_x57	-0.15	-0.31	<.0001	1.15
Indicator_Lim_ln_x50	-128.57	-0.54	<.0001	1.78
Indicator_FS_ln_x33	-34.79	-0.22	<0.01	1.12
x27_grouped_ln_x34	-13.69	-0.29	<.0001	1.34

Table B.6: *Linear regression model including interaction effects without outliers in the independent variables of the HT dataset*

B.2 Results of Health without time dataset (H)

R-Square	0.46
Adjusted R-Square	0.41

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-1.35	0.00	0.42	0.00
Indicator_KZN	-2.51	-0.58	<.0001	1.13
Indicator_Lim	-1.18	-0.27	0.03	1.08
ln_x14	0.83	0.21	0.10	1.12
x27_grouped	-0.54	-0.32	0.01	1.11

Table B.7: Linear regression model based on the alternative dependent variable of the H dataset

R-Square	0.53
Adjusted R-Square	0.46

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-4.19	0.00	0.04	0.00
Indicator_KZN	-2.38	-0.54	<.0001	1.19
Indicator_Lim	-1.40	-0.32	0.01	1.09
ln_x14	0.79	0.20	0.11	1.15
x27_grouped	-0.50	-0.29	0.02	1.15
ln_x58	0.57	0.15	0.20	1.06
x52	0.27	0.14	0.25	1.09

Table B.8: Linear regression model including independent variables selection based on subject knowledge of the H dataset

R-Square	0.68
Adjusted R-Square	0.65

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-2.40	0.00	0.07	0.00
Indicator_KZN	-2.64	-0.62	<.0001	1.13
Indicator_Lim	-2.68	-0.50	<.0001	1.06
ln_x14	0.92	0.24	0.02	1.09
x27_grouped	-0.53	-0.31	<0.01	1.12

Table B.9: Stepwise linear regression model without outliers in the dependent variable of the H dataset

APPENDIX B. ADDITIONAL TABLES OF THE INVESTIGATION OF MODEL ADVANCEMENTS

R-Square	0.72
Adjusted R-Square	0.69

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-1.92	0.00	0.11	0.00
Indicator_KZN	-2.68	-0.66	<.0001	1.13
Indicator_Lim	-2.73	-0.53	<.0001	1.06
ln_x14	0.79	0.21	0.03	1.09
x27_grouped	-0.46	-0.28	0.01	1.11

Table B.10: *Stepwise linear regression model without outliers in the independent variables of the H dataset*

R-Square	0.85
Adjusted R-Square	0.82

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	1.12	0.00	<.0001	0.00
x27_grouped_ln_x57	-0.05	-0.34	<.0001	1.07
Indicator_KZN_ln_x49	-31.05	-0.69	<.0001	1.04
Indicator_Lim_ln_x36_Zmean	0.59	0.45	<.0001	1.13
Indicator_Mpu_ln_x58	-0.63	-0.34	<.0001	1.05
Indicator_WC_ln_x13	-0.35	-0.45	<.0001	1.06
Indicator_Lim_ln_x50	-44.66	-0.31	<0.01	1.11

Table B.11: *Linear regression model including interaction effects without outliers in the dependent variable of the H dataset*

R-Square	0.82
Adjusted R-Square	0.78

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	1.01	0.00	<.0001	0.00
x27_grouped_ln_x57	-0.04	-0.24	<0.01	1.12
Indicator_KZN_ln_x49	-32.06	-0.63	<.0001	1.05
Indicator_Lim_ln_x36_Zmean	1.08	0.69	<.0001	1.96
Indicator_Mpu_ln_x58	-0.76	-0.40	<.0001	1.06
Indicator_WC_ln_x13	-0.33	-0.37	<.0001	1.06
Indicator_Lim_ln_x50	-121.13	-0.53	<.0001	1.82

Table B.12: *Linear regression model including interaction effects without outliers in the independent variables of the H dataset*

B.3 Results of Education with time dataset (ET)

R-Square	0.49
Adjusted R-Square	0.43

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	15.99	0.00	0.01	0.00
time	-0.20	-0.23	0.09	1.31
Indicator_Gau	1.75	0.45	<0.01	1.46
ln_x36_Zmean	-0.72	-0.41	<0.01	1.11
ln_x57	-1.50	-0.42	0.01	1.82

Table B.13: *Linear regression model based on the alternative dependent variable of the ET dataset*

R-Square	0.49
Adjusted R-Square	0.41

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	10.34	0.00	0.34	0.00
time	-0.22	-0.25	0.10	1.69
Ind_Gau	1.77	0.46	0.02	2.72
ln_x36_Zmean	-0.71	-0.41	<0.01	1.14
ln_x57	-1.15	-0.33	0.21	4.76
ln_x14	-0.03	-0.01	0.95	2.44
x52	0.18	0.11	0.49	1.78

Table B.14: *Linear regression model including independent variables selection based on subject knowledge of the ET dataset*

R-Square	0.74
Adjusted R-Square	0.68

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	95.37	0.00	<.0001	0.00
ln_x57_ln_x60	-1.39	-0.71	<.0001	1.43
time_Indicator_NC	0.03	0.02	0.85	1.08
ln_x29_ln_x29	-2.12	-0.45	<.0001	1.19
Indicator_Mpu_ln_x50	-75.45	-0.31	<0.01	1.10
Indicator_EC_Indicator_x36_Z	-1.10	-0.23	0.05	1.64
Indicator_Lim_ln_x50	-42.55	-0.27	<0.01	1.01
x27_grouped_ln_x50	-18.30	-0.37	<0.01	1.32
time_Indicator_Gau	0.39	0.34	<0.01	1.09

Table B.15: *Linear regression model including interaction effects without outliers in the independent variables of the ET dataset*

B.4 Results of Education without time dataset (E)

R-Square	0.45
Adjusted R-Square	0.39

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-2.51	0.00	0.03	0.00
ln_x14	0.68	0.27	0.03	1.08
ln_x36_Zmean	-0.87	-0.50	<0.01	1.27
x52	0.54	0.32	0.01	1.08
ln_x65	-2.08	-0.45	<0.01	1.26

Table B.16: *Linear regression model based on the alternative dependent variable of the E dataset*

R-Square	0.86
Adjusted R-Square	0.83

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	35.65	0.00	<0.01	0.00
ln_x8_ln_x8	3.15	0.59	<.0001	2.16
ln_x29_ln_x29	-2.96	-0.68	<.0001	1.30
ln_x57_ln_x60	-1.14	-0.61	<.0001	1.11
Indicator_x28_Z_ln_x33	35.63	0.78	<.0001	2.21
Indicator_NC_ln_x14	0.13	0.07	0.35	1.13
Indicator_Mpu_ln_x50	-49.69	-0.22	<0.01	1.05
Indicator_Lim_ln_x50	-35.74	-0.25	<0.01	1.03

Table B.17: *Linear regression model including interaction effects without outliers in the dependent variable of the E dataset*

R-Square	0.75
Adjusted R-Square	0.71

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	46.28	0.00	<0.01	0.00
ln_x8_ln_x8	2.69	0.47	<0.01	2.13
ln_x29_ln_x29	-2.88	-0.61	<.0001	1.29
ln_x57_ln_x60	-1.20	-0.62	<.0001	1.11
Indicator_x28_Z_ln_x33	31.72	0.64	<.0001	2.15
Indicator_NC_ln_x14	0.14	0.07	0.45	1.12
Indicator_Mpu_ln_x50	-52.15	-0.21	0.02	1.04
Indicator_Lim_ln_x50	-36.34	-0.23	0.01	1.02

Table B.18: *Linear regression model including interaction effects without outliers in the independent variables of the E dataset*

B.5 Results of Combined with time dataset (CT)

R-Square	0.39
Adjusted R-Square	0.35

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-3.01	0.00	<0.01	0.00
Indicator_KZN	-1.53	-0.37	<0.01	1.18
Indicator_Lim	-1.17	-0.28	<0.01	1.13
ln_x14	0.91	0.33	<0.01	1.12
x27_grouped	-0.59	-0.37	<0.01	1.14
x52	0.47	0.27	<0.01	1.05

Table B.19: *Linear regression model based on the alternative dependent variable of the CT dataset*

R-Square	0.49
Adjusted R-Square	0.45

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-5.81	0.00	0.00	0.00
time	-0.11	-0.11	0.26	1.63
Ind_KZN	-1.51	-0.35	<0.01	1.21
Ind_Lim	-1.52	-0.35	<.0001	1.14
ln_x14	1.31	0.45	<.0001	1.13
x27_grouped	-0.48	-0.29	<0.01	1.36
x52	0.46	0.25	<0.01	1.06
ln_x58	0.32	0.09	0.38	1.53

Table B.20: *Linear regression model including independent variables selection based on subject knowledge of the CT dataset*

R-Square	0.50
Adjusted R-Square	0.46

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-5.00	0.00	<.0001	0.00
time	-0.14	-0.14	0.10	1.17
Indicator_KZN	-1.51	-0.35	<.0001	1.20
Indicator_Lim	-1.68	-0.38	<.0001	1.12
ln_x14	1.29	0.45	<.0001	1.12
x27_grouped	-0.47	-0.28	<0.01	1.34
x52	0.48	0.26	<0.01	1.06

Table B.21: *Stepwise linear regression model without outliers in the independent variables of the CT dataset*

B.6 Results of Combined without time dataset (C)

R-Square	0.39
Adjusted R-Square	0.35

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-3.01	0.00	<0.01	0.00
Indicator_KZN	-1.53	-0.37	<0.01	1.18
Indicator_Lim	-1.17	-0.28	<0.01	1.13
ln_x14	0.91	0.33	<0.01	1.12
x27_grouped	-0.59	-0.37	<0.01	1.14
x52	0.47	0.27	<0.01	1.05

Table B.22: *Linear regression model based on the alternative dependent variable of the C dataset*

R-Square	0.49
Adjusted R-Square	0.45

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-4.83	0.00	<.0001	0.00
Indicator_KZN	-1.52	-0.36	<.0001	1.20
Indicator_Lim	-1.59	-0.35	<.0001	1.16
ln_x14	1.18	0.41	<.0001	1.15
x27_grouped	-0.51	-0.31	<0.01	1.23
x52	0.52	0.28	<0.01	1.06
ln_x65	-0.52	-0.12	0.16	1.15

Table B.23: *Stepwise linear regression model without outliers in the independent variables of the C dataset*

APPENDIX B. ADDITIONAL TABLES OF THE INVESTIGATION OF MODEL ADVANCEMENTS

R-Square	0.57
Adjusted R-Square	0.52

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-1.69	0.00	0.01	0.00
Indicator_KZN_ln_x64	0.82	0.40	<.0001	1.22
Indicator_Department_ln_x49	-6.65	-0.20	0.02	1.17
Indicator_Lim_ln_x59	-0.41	-0.24	0.01	1.24
Indicator_EC_ln_x63	1.45	0.27	<0.01	1.19
Indicator_Gau_ln_x65	1.32	0.14	0.07	1.11
x27_grouped_ln_x65	-0.87	-0.36	<0.01	1.46
Indicator_Lim_ln_x50	-44.73	-0.25	<0.01	1.07
ln_x14_ln_x58	0.26	0.29	<0.01	1.39
Indicator_NC_ln_x34	13.71	0.14	0.06	1.02

Table B.24: *Linear regression model including interaction effects without outliers in the dependent variable of the C dataset*

R-Square	0.59
Adjusted R-Square	0.54

Parameter Estimates				
Variable	Parameter Estimate	Standardised Estimate	p-value	Variance Inflation
Intercept	-1.76	0.00	<0.01	0.00
Indicator_KZN_ln_x64	0.81	0.40	<.0001	1.22
Indicator_Department_ln_x49	-7.14	-0.21	0.01	1.17
Indicator_Lim_ln_x59	-0.31	-0.17	0.04	1.20
Indicator_EC_ln_x63	1.44	0.27	<0.01	1.19
Indicator_Gau_ln_x65	1.32	0.14	0.06	1.11
x27_grouped_ln_x65	-0.83	-0.35	<0.01	1.46
Indicator_Lim_ln_x50	-45.22	-0.26	<0.01	1.06
ln_x14_ln_x58	0.27	0.30	<0.01	1.36
Indicator_NC_ln_x34	13.58	0.14	0.06	1.02

Table B.25: *Linear regression model including interaction effects without outliers in the independent variables of the C dataset*

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Explanation of data CD

The data CD included contains two Microsoft Excel files namely DevelopmentData.xlsx and ValidationData.xlsx.

1) DevelopmentData.xlsx

The DevelopmentData.xlsx file includes the data used for the development of the linear regression models, documented in Chapters 6 and 7. The six datasets (HT, H, ET, E, CT and C) used are made available on six different sheets. The file includes 45 data points for the HT, H, ET and E datasets and 90 data points for the CT and C datasets. An additional sheet containing the data sources, variable names, descriptions and broad factors of the variables has also been added.

2) ValidationData.xlsx

The ValidationData.xlsx file contains only the data used for the validation of the developed models as documented in Chapter 8. Again, the six different datasets used (HT, H, ET, E, CT and C) are made available on individual sheets and an additional sheet containing the data sources, variable names, descriptions and broad factors of the variables was added to the file. This file contains only nine data points for the HT, H, ET and E datasets and 18 for the CT and C datasets.

Refer to Chapter 5 for the detail of the compilation of the datasets.