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HIGH-DENSITY AFFORDABLE HOUSING IMPACT INVESTING: A BEST-IN-CLASS PROJECT SCREENING CREDIT RISK MANAGEMENT MODEL

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PLAGIARISM DECLARATION

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Silimela Lallie

ACKNOWLEDGEMENTS

I would like to dedicate this thesis to the memory of my grandparents Mr. J.M and Mrs. M.N Lallie- their incredible work ethic and commitment to making a difference in the lives of others has set our family on a trajectory of excellence.

I would like to thank my family, the Lallie Family, for the motivation and patience they have given me throughout this period of immense growth, *uyabulela uMaduna omncinci kuni nonke Magubevu*. I'd also like to make a special mention of my mother H.E. Amb. N.M Lallie, for giving me the world and whose belief in me has propelled me to heights greater than I would have ever imagined- you are the wind beneath my wings mom.

ABSTRACT

Constrained housing supply coupled with rapid urbanisation and a volatile domestic credit market have put affordable rental housing development under the spotlight. Addressing this demands appropriate and deliberate capital provisions to induce the property development market to deliver the scale needed to tackle the supply-side of the problem. Inducements are needed for residential property developers to choose to develop high-density affordable rental housing on land that presents great accessibility to economically vibrant nodes, where land is priced at a premium. The greenfield residential property development space is in need of sophisticated and specific funding interventions to evolve it beyond the sporadic developments we observe located on the urban periphery on cheap land. The benefits of sophisticated funding models in commercial property have seen the widespread proliferation of building and investment activity. Rental housing, however, lags behind owing to an immature market, shallow investment analysis and rudimentary risk-weighted debt-funding solutions. These funding instruments impede developers building affordable housing schemes on well-located parcels of land near existing amenities and profoundly incorporate *green* technology into buildings. This research presents a proof of concept for a sophisticated model for high-density housing. A largely 'spatial economic' model for risk analysis, it is developed to attain a so-called Probability of Default Ratio ("PDR") by coalescing two formulae regarded as international best-practice: The risk types incorporated into the model are (1) borrower-level credit risk, (2) property/development-level risk, and (3) cash-flow risk factors.

The research is proof of concept of a credit risk management tool for impact investment funding model using these formulae and Geographic Information Systems ("GIS"). It calculates the extent of credit risk for income-producing real estate fundamentals and uses endogenous factors- risk factors and drivers associated with the housing scheme to be build and the surrounding area it is to be built in. The study area covers the 336 contiguous municipal wards that make up the Johannesburg, Tshwane and Ekurhuleni metropolitan municipalities.

GLOSSARY OF TERMS

Agglomeration	The act of assembling a mass of a particular thing/facet - in the case of this research, the assembly of businesses and people in a particular locale.
Agglomeration Economies	An economic theory that proposes benefits to be derived from businesses of people assembling near each other.
Basel IRB approach	A measure that allows banks to use their own estimated risk parameters for the calculating regulatory capital for credit risk and exposures. It allows only certain banks, those with approval from their Central Banks for meeting certain minimum conditions, disclosure requirements to use it.
Bulk services	Physical civilian infrastructure provided by a local authority such as roads, refuse removal, sewerage, storm-water, electrical and water reticulation
GIS	Geographic Information System: a cadastral completed using computer software
Greenfield	The construction or erection of a new structure on a site which was previously vacant
Impact Investing	Investments intended to create a positive impact beyond financial return. Many transactions take the form of private equity, debt investments, guarantees or collateral undertakings.
NHBRC	National Home Builder's Registration Council- a statutory agency of the National Department of Human Settlements that sets norms and standards for construction of residential property and enforce the SANS 10400 building codes and regulations to govern standard of constructing new homes.
Obligor	The party ultimately responsible for the debt incurred- this may be the group holding company, "key-man", or transaction underwriter
Origination Fee	A fee a bank may levy to a debtor upon the commencement of a new loan
PDR	"Probability of Default Ratio" is the percentage probability of a borrower entity to produce a default event as perceived by the lender over a specified period of time, typically one year. The PD is most often stated for a future period beginning immediately, but can also be expressed as a forward default probability beginning in one year for one year

Polycentric	An area or region with many central nodes of high economic activity
SRI	Socially Responsible Investing: A subset of *impact investing* where investors seek transactions that minimize negative societal impact (of already precarious industries/practices) rather than proactively create positive impact.
Urban Edge	The semi-fixed municipal boundary established to allow no further municipal services to be built/supplied, except for services to agricultural land and therefore also the spatial limit whereby no new erven or townships will be proclaimed.
UrbanSim	A sophisticated spatial econometric model for simulating potential outcomes for key decisions and policy choices for households and businesses, and development choices of property developers
Zoning	The real rights, vis-à-vis permissible land use, that a parcel of urban land has been granted by the relevant local authority

ABBREVIATIONS

CBD	Central Business District
ESG	Environmental, Governance & Social
GCR	Gauteng City Region
GPF	Gauteng Partnership Fund
HDP	Historically Disadvantaged Person (as defined by National Dept. of Labour)
HIFSA	Housing Impact Fund South Africa
IFC	International Finance Corporation- subsidiary of the World Bank®
IRB	Internal Rating's Based
JSE	JSE Limited (previously the JSE Securities Exchange and the Johannesburg Stock Exchange)
NHFC	National Housing Finance Corporation
NPO	Not-for-profit Organisation
NURCHA	National Urban Reconstruction & Housing Agency
SARB	The South African Reserve Bank
TUHF	Trust for Urban Housing Finance
UN	The United Nations
UNEP	United Nations Environmental Programme
VaR	Value at Risk

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CHAPTER 1: INTRODUCTION

1.1 Background

> *"On 27 June 1975 one single whale saved by Greenpeace was, factually, one single whale, but the action was about whales and, by extension, whale catching as such. Even more, it was about our relationship with animals and the planet as a whole". Like Greenpeace in its best days Social Banks*[1] *are competing for symbolic worldview supremacy in their field. These banks are able to deploy capital to endeavours that strengthen their beliefs and ideologies*" (Benedikter 2011, p.3)

Financial institutions in South Africa, those with commercial and developmental aspirations, provide the impetus that promotes or hinders the reengineering of the spatial distribution. It is exactly *how and where* they deploy their capital that reinforces or changes the status quo and, by extension, the potential to defeat the scourge of racial and class segregation. They can create urban plural metropolises that are not only diverse in their housing mix, but that seek to find efficiency in current and future spatial planning and resource allocation. The working class must have a wider array of housing options located in and near the economic cores of a city or region and economic incentives that make affordable housing feasible in the short and medium term must emerge. Failure to radically address the lack of inclusive and diverse neighbourhoods in and near the urban cores will mean that defeating apartheid spatial planning will remain an unaccomplished goal.

Professor David Harvey, the renowned economic author and scholar, in a July 2015 public lecture in London titled "Slums and Skyscrapers" said that in this neoliberal world, where urbanisation occurs at an unprecedented rate, we develop cities for people to invest in, and not for people to live in. He further stated that there exists a crisis of affordable housing at the very same time upper-end apartments were built and lay largely vacant because wealthy people such upper-end apartments as speculate investments and nothing more. Furthermore, he suggests that the best way to launder money from one part of the world to

[1] Also called development banks in the Southern Africa context.

another is to “invest” in property market. This unabated promotion of the speculative property market has come at a direct cost to the working class, creating a serious scarcity in their end of the housing market. This is urbanisation of a subversive sort and not broad-based development and growth as it comes part-and-parcel with displacement of people and entrenches the relegation of the working class and the proletariat to the urban edge.

Urban land economics asserts that lower rents for those living further away from the CBD are directly offset by the time and costs associated with lengthier commuting (Duranton & Puga 2004). In case of most major cities or regions around the world, there is a perennial premium attached to centrally located land and it has become a globally accepted practice in residential property markets that land that exhibits this price premium (higher land rent), should be on-sold or developed for the benefit of affluent users with a higher indifference curve and therefore higher budget constraint. This is the backbone of entrenched inequality.

Over the last two decades, South Africa’s three biggest metropoles have seen vacant land command prices largely only afforded by the affluent. This is most notable in the northern suburbs of Johannesburg and Durban, the suburbs of Pretoria East and indeed all of the surrounding neighbourhoods of the Cape Town CBD. The middle to ‘lower-middle’ income groups have been largely relegated to finding new housing stock close to the urban edges or in excessively congested neighbourhoods that, although not far in terms of physical distance from the economic centers, are by virtue of the over-reliance on private transport and an under-capacitated road network in reality hours away from work.

With the level of speculative investment activity nowhere near any other major global city, we still face, albeit on a smaller scale, the scourge identified by Professor Harvey(2015), namely that the upper-end of the housing market serves as a vessel to house and grow private wealth and possibly launder money. This exclusionary and divisive growth in the

housing market spells trouble for a country in transition such as ours; especially given the waning status of the *rainbow nation*[2] we professed to be creating only two decades ago.

1.2 Research Area

In 2014, the acceptable definition of a low-income worker or household was one where the nominal household income was between R3,500 and R15,000 per month. The national Department of Human Settlements' defines of affordable housing as a single dwelling unit (freehold or sectional title) with a selling price of between R350,000 and R500,000 and the intended target markets are households with a gross income ranging from R9,000 to R15,000 per month. In the previous year, the proportion of houses registered in the national Deeds Registry with a selling price of below R500,000 was 58%. With respect to rental housing the broad definition in the national Human Settlements department in 2015 was a residential unit with a nominal gross rental of no more that R6,500 per month.

How and where people live in relation to their jobs, place of study/instruction and amenities their households need is at the core of creating and maintaining wellbeing in communities, particularly in the racially fragmented and unequal urbanised communities of South Africa. At what cost are we ignoring not only the crippling inequality, but the ills directly attributable to urban migration, urban decay and urbanisation? How can we continue to live with the unacceptable levels of economic mobility of historically disadvantaged persons? Bearing in mind South Africa's shambolic public transport system, can we afford to continue to relegate the working class to the urban periphery where the social costs of creating adequately resourced communities is possibly greater than a solution that integrates them closer to the core?

When Old Mutual Ltd. launched its R7.2 billion Housing Impact Fund ("HIFSA") in 2011, through its alternative investments division, the estimated national shortfall in the affordable/gap market was estimated at 650,000 housing units; with over 50% of that

[2] A term coined by Archbishop Emeritus Desmond Tutu in the mid-90s to describe the multiracial and united post-apartheid South Africa.

demand coming from Gauteng. In 2014, it was estimated that this growing demand had edged to 1 million housing units but that only an estimated 20,000 units were being built per year- with 75% or more of that new supply being built in Gauteng (Gauteng Department of Human Settlements, 2013). To rethink and subsequently re-engineer the spatial distribution in South Africa in such a way that it no longer favours racial and income segregation and isolation is paramount if we wish to become a harmonious and equitable society. We may be free from the ravages of legislative inequality, which were the hallmark of our society under apartheid, but the Spatial Mismatch Hypothesis[3], first published in 1968, and concretized in South Africa by discriminatory apartheid laws is a barrier to economic growth that continues to haunt our democratic dispensation. This is as true now for most Historically Disadvantaged Persons ("HDPs") as it was almost 50 years ago for USA's urban black population. If we are able to accomplish sweeping positive changes in *where* and *how* the working class live, we can begin to see inclusive economic growth as an attainable goal. The research aims to address the existing gap in these very issues. It does by developing a model that would allow funding of affordable housing in well-located sites, thus enabling the marginalised working class to succeed in finding better places to live.

The Gauteng Department of Human Settlements' 2015 Strategic Directive lists eight strategic goals for itself, the first and arguably most paramount being to "build inclusive human settlements consistent with integrated, efficient and equitable spatial patterns". The department cites land acquisition as being the biggest hurdle, greater cooperation is needed between provincial and municipal authorities overcome this hurdle.

The successful implementation of private sector financing interventions, which are profitable for residential property developers and financiers, lies at the core in aiding the achievement of far-reaching public benefits. It also makes the work of provincial and local

[3] Serious limitations on black residential choice, combined with the steady dispersal of jobs from central cities to suburbs, are responsible for the low rates of employment and low earnings of Afro-American workers (Kain, J.F, 1968. "Housing Segregation, Negro Employment, and Metropolitan Decentralization."

government easier as private developers become trailblazers in leading the charge for financially feasible inclusive housing (Gauteng Dept. of Human Settlements, 2013 & 2015).

Major strides have been made by local commercial banks and, of late, private equity investment firms in funding the development of affordable high-density housing schemes. This has seen a strong rise in supply, albeit from a very low base. The new affordable housing stock is, however, overwhelmingly located in the periphery of the city, where the level of existing infrastructure and community services is underdeveloped.

The major drawback to erecting well-located housing schemes is the effect that higher land prices in desirable nodes have on the feasibility of affordable housing over conventional housing schemes aimed at the upper-middle income group. This 'problem' could, however, be overcome by lowering barriers attributed to the long-term finance of such schemes.

The residential property development market believes that greater returns lie in developing more upmarket housing, this for a narrow affluent market, rather than for a buoyant working-class market; a driving factor is the underdeveloped credit market for financing affordable housing. Opting for the conventional residential market means utilising more capital to build homes of a higher specification and incredibly costly finishes and materials for affluent residential owners who appear, to a large extent, to use these properties for investment purposes, rather than to live in them. Catering to the affordable housing market demands lower building specifications and finishes, and therefore less capital outlay to complete a project, therefore a lower debt commitment- all in servicing a wider and more buoyant market. Quality[4], as the building regulations and standards, must be maintained but the market is one where nominal incomes are largely limited to R20,000 per month per dual-income household. This low-to-middle income market constitutes the vast majority of the commuting public in any given Metro and the peak hour commute strains the road network, not only for them but for other road users as well.

[4] Quality- suitability for intended use.

The current trend towards the development of high-density affordable housing largely supports the foundations of apartheid spatial planning (discussed in the literature review) as housing schemes are built along the same sparsely accessible road networks in the peripheral neighbourhoods. This has continued almost entirely unabated in South Africa and for "good" economic considerations - the continuing development of a city is driven by a two-factor mechanism, namely a coherent city/municipal spatial planning policy and competitive profit-maximising. Property developers are currently *not* incentivised to explore affordable housing developments in centrally located parcels of appropriately zoned land and therefore very few such affordable housing schemes exist. A fundamentally neoliberal approach is required to change the outcomes of our current spatial patterns, insofar as they pertain to income/wealth and racial segregation. Impact investments will play a key role in deliberately augmenting the spatial distribution in major cities in South Africa. We have seen the mobilization of billions of Rands by the private sector and the crowding in of public funds too to invest high-density property developments in the rapidly urbanizing Gauteng and Western Cape Provinces. The funds, however, could be deployed in arguably smarter ways to ensure they create maximum social and environmental impact.

Financial incentives by way of concessionary development funding afforded to property developers who wish to erect an affordable housing scheme will directly impact on the nature of developments (and target markets) for land that municipalities have granted high-density residential rights. This concessionary finance is available from funders who pursue triple bottom line profits[5].

1.3 Problem statement

Competing affordable housing developers have insufficient institutional funding support, and more specifically access to concessionary finance from so-called *triple bottom line*

[5] The triple bottom line is best described by Benedikter (2011) as "a valid measurement" for fulfilling the core business mandate of pursuing or advancing:

- Profit-economic rationality. Instances of losses or loss-leading transactions that threaten the development or sustainability of financier have to be avoided.
- Environment-Natural habitat protection and sustainable handling of resources
- People - the primacy of the community and the balanced advancement of society as a whole.

financiers to feasibly develop high-density affordable rental schemes in well-located and available land parcels in the Gauteng City-Region[6] ("GCR"). This lack of support partially emanates from insufficient investment screening tools and subsequent reporting for the funding of these developments; this leaves developers little choice outside of foregoing the land purchase, or, purchasing the land and developing a more upmarket residential scheme.

The greater level of social impact is seemingly either unrelated or poorly correlated to the location of proposed rental housing schemes. The correlation seems evident – even though it may be anecdotal – that the better placed the housing scheme the higher the level of occupancy will be. It is also evident that there are enhanced levels of benefits to be derived by prospective tenants as centrally located rental housing schemes are closer to social amenities. Occupants enjoy a better level of physical infrastructure and ameliorate the time and cost of commuting.

There is adequate liquidity in affordable housing development finance in Gauteng and there is a solid supply of suitable land to build such housing schemes, but in the absence of concessionary funding developers won't or can't build new affordable housing. Rather, developers build for a more affluent target market in order to make or meet their hurdle rates of return. It may be that insufficient tools exist to screen and analyze social impact and credit risk associated with funding such developments or that the relationship between greater social benefit and lesser finance costs has not been adequately examined.

As interest in socially responsible investment grows, so does the potential liquidity. Better metrics should emerge for measuring, at the very least, primary or even predetermined social impact to credibly justify progressively concessionary funding as social benefits have

[6] The GCR includes a cluster of cities, towns and urban nodes. It incorporates Gauteng province in its entirety, with its three large metropolitan municipalities (metros) and a range of smaller urban centers that spread out across and beyond the provincial boundary of Gauteng to neighbouring regions characterized by several urban and industrial centers: Rustenburg in the north-west, Sasolburg to the south, to the south-west a handful of gold-mining towns (such as Potchefstroom and Klerksdorp) and to the east medium-sized towns, Middleburg and Secunda, "to create an almost continuous urban agglomeration." (Wray, 2010, p.39). While it has no official border nor legislative or dedicated administrative political agency, it represents a coherent economic and geographic space (Wray 2010) within which regional competitiveness may be harnessed (OECD, 2011)

been difficult to value, measure and compare in the past. In addition, the process of tracking and measuring these social returns has been costly in terms of time and other resources (Wilson et al. 2015, citing OECD, p. 116).

1.4 Purpose and significance of the Research

The existing measures and projects from Government to address housing market mismatches and apartheid spatial planning could be described as "ineffective" at best; they do little to attract the interest of private residential property developers and as such leave Gauteng, which has a recently estimated population of 13.2 million people. Gauteng faces the perilous situation of being confined to the prevailing spatial and income distribution, while it *grows at such a rate that the population is expected to double by 2055.* (Mubiwa & Annegarn 2013). With new low-cost and affordable housing being delivered at a yearly average that exceeds 50,000 units per annum in Johannesburg alone, the local government's lower-level estimate of new households needing houses is estimated to reach 400,000 by 2030, while the upper-band estimation is one million. According to various observers the 2011 Census data indicates that this is a potentially significant under-estimation indicating just how far demand could outstrip supply (Wray et al. 2013).

Property developers constantly change the physical landscape and as such are instrumental in how spatial distribution evolves. The level of financial incentive for mass housing developers should change if we wish to see a spatial centralizing of working class housing. Very few inroads will be made in creating inclusive and diverse neighbourhoods if optimally-located residential land cannot, in any reasonable way, be converted to affordable housing. Such a situation will result in the concretizing of the existing critical mass of working class that work in Gauteng's metropolises living on the periphery — with many in decaying neighbourhoods and areas of concentrated poverty.

In adopting a neoliberal outlook, we would expect to see the greatest level of housing development activity in profit-maximising nodes amid being guided by the concentric zone model [Burgess Model 1925]. Urban land-use theories suggest that more centrally — and

therefore *optimally* — located land would command the higher economic rent. The research contends that in a post-apartheid South African city, affordable housing is able to be profitably built on such optimally located land parcels provided the land's economic rent would be offset by the extent of concessionary funding granted to finance such affordable housing. The basis for offering such concessionary funding would be based on the social impact of a proposed development, chiefly that of building new working-class housing inward of the commuter zone. In the case of urban spatial structure, we have observed good private sector uptake in urban regeneration projects and industrial development zones, both largely due to indirect interventions such as tax relief for investors. By changing the incentives and allowing market players to change their actions and practices to take advantage of the incentives a city or region can induce the particular outcome which leads to the intervention.

This research develops a tool to further close this 'measurement gap', this by identifying and classifying the credit risk inherent in advancing loans to affordable rental housing, arguably the biggest sector globally to attract impact investment capital. The formula derived by the research, is intended for use by non-bank senior secured debt financiers- such as private equity funds, development finance institutions and specialised lenders. It is anticipated to be the foundation of an optimal funding rate [interest and upfront financing fees] model for lenders whose respective investment mandates allow direct investment in affordable housing rental stock in pursuit of seek *triple bottom line* gains. Cumulative causation, insofar as it could pertain to catalysing inclusive housing, is anticipated to drive the further benefits of not only inclusive working-class housing, but also the impact of this particular framework (derived through this research) (Duranton & Puga 2004, p. 2077).

If we begin building a model for high-density affordable housing by postulating an aggregate triple-bottom line function with increasing marginal social returns for more favourable land, we limit the outcome of the research. If instead we derive this aggregate triple-bottom line function from first principles, we may likely observe that its efficiency can be improved upon by back-testing curated data and incorporating more sophisticated quantitative techniques

to measuring not only the total counterparty risk we endeavour to manage, but also the forecasted triple bottom line profits.

The basis of this study, then, is to create credit risk assessment tool for a *best-in-class* selection basis to assess the microeconomic risks in undertaking to fund a high-density rental housing scheme. This is the model developed by the research. The credit risk assessment tool is aimed at lowering the average funding rate for proposed high-density housing schemes by incorporating a property developer's experience and financial standings with the area-specific risks of the proposed location. By locating their developments in close proximity to economic centers or employment nodes, the developers could achieve a funding (interest) rate low enough to absorb the premium paid for the well-located parcel of land (based on bid-rent theory). This premium in land price would have otherwise been passed on to the end user by means of higher rental, possibly making it unaffordable. The research endeavours to create a quantifiably sound model for use in a polycentric city-region ultimately providing a guide-price for debt funding on new developments undertaken in the study area.

1.5 Research Questions

Is the location of a new high-density affordable housing development – and the characteristics of its neighbourhood – able to be the significant factors for best-in-class screening in impact investment?

1. Can the principles of the Basel II Capital Accord[7]'s Foundation IRB Approach be used as the basis for creating a non-bank credit assessment model of impact investors?
2. Can the probability of possible default on a secured senior debt loan be reduced based on (a) the quality and desirability of the specific location that the development will be built on, (b) the financial standing of the developer and (c) the developer's capability?
3. Can a spatially aware *best-in-class* impact investment credit risk assessment model be developed for high-density affordable housing in the Metropolitan areas of Gauteng?

[7] Basel Committee on Banking Supervision (2004): International Convergence of Capital Measurement and Capital Standards - A Revised Framework.

1.6 Objectives of the Research

To establish proof of concept for a reduced form credit analysis model. The model employed a *best-in-class* impact investment screening methodology for affordable housing financiers (non-bank) by means of:

1. Forming a multilayered cadastral tool for determining endogenous property-related risk for affordable housing impact finance/investment.
2. Establishing a multifactor credit risk-forecasting model for future use by impact investors in affordable housing. Model validated using Spearman's rank order correlation of $\rho \geq 0.5$ in relation to aggregated credit expert panel ranking opinions. Ranking done on the basis of trade-offs between industry-wide expert-level credit analysis and the social impact of proposed affordable housing rental apartment block (simulated sample data).
3. To advance the economic rationale, both at micro and macro/meso-level of inclusive affordable high-density housing.

1.7 Research Hypothesis

If the correlation is equal or below 0.5, then there is limited or no consensus between the experts and the data would not be sufficiently valid (data validity) to infer consensus. Alternatively, if the correlation is more than 0.5, then there is consensus between the experts and the data would be sufficiently valid to infer consensus.

1.8 Structure of the Research

The study will critically review literature on the economics of housing delivery, land use and urbanisation to lay a theoretical basis for developing the credit risk assessment tool.

The research methodology will stablish the ideological framework of the experimental research to be undertaken and expand upon the analytical techniques and tools used to develop the credit risk model's specifications.

The data analysis will methodically set out to attain proof of concept for the tool deduced by the research and evaluate the outcomes of the pilot study conducted. The conclusion will summarize the research findings and articulate areas of further study.

CHAPTER 2: REVIEW OF LITERATURE

2.1 Introduction

This chapter reviews literature in four broad areas that are useful for this study. Firstly, it reviews the benefits attainable by society when inclusive housing policies and patterns. It shows how impact investing could, as a developing nation, be used to engineer that ideal societal outcome. It then provides the theoretical underpinnings of inclusive population distribution. Secondly, it examines the empirical literature on the subject of impact investment in developing and developed nations with particular emphasis on peoples regarded as the base of the pyramid in society, that is, those most marginalised and vulnerable to economic shocks. Thirdly, it then delves into working class agglomeration and the spatial distribution of the Gauteng province. Lastly, it reviews modeling architecture available for affordable housing financing and risk management.

2.2 Societal Benefits for Advancement of Inclusive Affordable Housing

Throughout the last half a decade housing policy in OECD countries, with a particular emphasis on the USA, has been subjected to and guided by a plethora of research linking projects designated for low income earners with social ills relating to concentrated poverty, racial segregation and hindrances to economic opportunity and mobility. Many countries, where this research had been conducted, have experienced a far less precarious history of race relations than South Africa, yet the problems of concentrated poverty, racial segregation and hindrances to economic opportunity and mobility still existed and persisted; these are discussed in sections 2.2.1 and 2.2.2.

2.2.1 Inclusive Housing and urban agglomeration

A local researcher Jacobus (2015) suggests that inclusionary housing offers one of the only effective strategies for overcoming economic segregation and building sustainable and diverse communities. Furthermore, the evidence he observed suggests that economic integration is an important way to combat the negative effects of generational poverty. According to him, this economic integration would be achieved through a more even and representative distribution of employment and entrepreneurial opportunities. Lastly, he

asserts that integration across neighbourhoods and regions would create benefits for residents across all income levels. These would include: reducing sprawl (and the associated costs for taxpayers), living in more sustainable cities; and experiencing cultural, racial, and economic diversity. Beyond Jacobus's observations such measures would, in the short-to-medium term, give rise to greater optimization of existing public infrastructure and lead to coherent planning and the optimized and unbiased allocation of public funds and resources.

It is understood that land, which enjoys closer proximity and accessibility to economic activity and amenities, enjoys higher land rent and therefore higher potential selling prices. However, the preceding statement holds insofar as the land does not have materially adverse characteristics such as poor ground/soil conditions, being excessively undulating or being close to noxious/hazardous industries or sources of noise pollution (Alonso 1964; Fujita et al. 1999). The above forms the bedrock of William Alonso's seminal work that was based on a monocentric city with one CBD. These foundations have endured in spite of the evolution of a contemporary "city" as we know it today, with its various CBDs that typically have their own specialization or characteristics. The core of Alonso's theory has therefore become outmoded by a more dynamic and multi-node city structure which has come to be known as the polycentric city and its foremost proponent is arguably Masahisa Fujita whose work enjoyed many iterations and modifications.

Duranton and Puga (2004) posit that land near an economic hub is not only more expensive, but also smaller and typically more land-intensive (higher average density). There is voluminous literature analysing the sorting of housing across neighbourhoods which considers how income affects the appraisal of (a) land, (b) leisure foregone in commuting and (c) access to amenities, all of which contribute to determining residential location (p. 2072). The remaining challenge in South Africa is; how do we bring in the marginalised to take part in the mainstream economy? How do we afford their children and future generations the benefits of urban life and modern social and educational infrastructure so that they can one day become competent global citizens who work in and own competitive business that contribute to the nation?

With reference to areas where speculative investment capital is awash, such as the Menlyn and the Sandton-to-Rosebank business nodes (two urban regions that have become favourably consolidated into high-end service and retail nodes) the jobs offered in such nodes are likened to what Harvey (1989) describes as service jobs. The bulk of these jobs are low-paying administrative and service jobs, with a few highly paying managerial spectrum. The latter are exponentially fewer and particularly in South Africa a genuine middle class in these metropoles is so small; it has almost come to be a "missing middle" as their lifestyles are largely fueled by credit.

If living in the core of the city is the preserve of only in the investor class (of which there are very few) and the majority of workers in an urban business node are classified as the working class (e.g., clerical, cleaning and security) and middle-income earners (skilled and/or professional), then they become further victimized by the success of the wealthy and the growth of their local economy. This is due to a multitude of reasons: they earn enough to keep up with inflation, thus failing to save; they own assets that are difficult to leverage for investment purposes; their earnings are eroded by their high indebtedness in increasingly volatile credit markets; and they bear the brunt of irrational and volatile commuting costs. All the while property priced in better located areas are rising faster than their incomes, thus widening the gap between where they *are* and where they *wish to be*.

Meeting the steep demand for housing by providing a wider variety of housing options for the urban working class tantamount to an enrichment of spatial alternatives — this enrichment is enjoyed by a whole community or city. Better housing options would serve to improve the well-being of "home-seeking" families in the short-term and drastically improve the prospects for economic self-sufficiency and mobility in the long-term by enhancing their access to employment information networks. Better housing options also provide access to better education and training by virtue of greater proximity and near-perennial exposure to, and reinforcement of, social norms that encourage and reward education and employment. (Polikoff 1994; Cisneros 1995 & Rosenbaum 1995)

There are benefits to be derived in inclusive community building from a *learning and knowledge* perspective; in a broad sense (encompassing schooling, training, and research). This is not only a very important activity both in terms of the resources devoted to it, but also in terms of its direct and indirect contribution to societal and economic development. When coupled with success in well integrated urban regions, inclusive housing can unlock a wider spectrum from which innovation can flourish. Numerous authors, including Duranton and Puga (2004), have stressed how the environment offered by cities improves the prospects for generating new ideas.

A fundamental characteristic of learning is that it seldom takes place in isolation and grows in reach because of social interaction among peers. This could be as complex as the transfer of breakthroughs or advanced technologies and ideas or as simple as the gradual accumulation and diffusion of everyday skills, (knowing *how* and knowing *why*, etc. (Lucas 1988). It is because of these characteristics that the knowledge mechanisms and outcomes are difficult to confine or are non-excludable. By bringing together a large number of cities, learning opportunities can be offered and provided which create a strong enough justification for their own existence. They classified learning mechanisms into those dealing with knowledge generation [8], knowledge diffusion [9] and knowledge accumulation [10] (Duranton & Puga 2004, p. 2098).

When it comes to primary school children, recent studies (conducted in low-income communities in the USA) found that children who were subjected to moving houses/homes frequently (to different communities or regions) scored lower in mathematics and reading, especially in the foundation phase. This was due to a variety of factors; with a large contributing factor identified as adjusting to a new domestic and schooling environment and

[8] A key issue regarding the generation of knowledge in cities is the role that diversified urban environments plays in facilitating search and experimentation in innovation.
[9] The notion that proximity to individuals with greater skills or knowledge facilitates the enhanced acquisition of skills and the exchange and diffusion of knowledge because geography is pivotal to these individuals who choose to, or by circumstance are forced, to live in the hinterland are subject to less potential interaction with teachers or instructors.
[10]The learning and training facilities (basic and higher education, vocational and technical training as well as the embodied knowledge learnt by individuals that they are able to use in their current or future occupations.

coping with anxiety, while continuing to keep up with an existing curriculum at the new school (Brisson & Duerr 2014)

When affordable housing construction cannot be contained to well-located urban sites the new occupants of the new schemes become vulnerable to many economic upheavals that may lead them to move to cheaper locations that offer a less desirable quality of life. When the cost of commuting progressively spikes because of higher public transport, fuel or vehicle repayments or because of interest rate instability, it becomes increasingly difficult to balance a family's budget as disposable income erodes sharply and the possibility of frequently moving house/home becomes a reality. Containing the negative impacts of spikes in the cost of living can be achieved through strategic and well-located affordable housing as rental escalations are annual and escalation rates are overwhelmingly market-related at Consumer Price Index ("CPI") + 4% — this gives families the scope to plan and budget long in advance. And since commuting costs are reasonable (owing to short distances travelled) budget shocks can be better absorbed, even without upward income adjustment.

The "spatial distribution" of amenities and activities of *employers* and *employees* (hereafter described as "agents") in a city is the principal component of a varying number of negative externalities such as urban decay, the extent of service delivery, socio-economic segregation, traffic congestion and poor road infrastructure and networks. Regarding positive externalities, these include factors/attributes that most affect the value of land and real estate (Hurtubia & Bierlaire 2014).

2.2.2 Economic Mobility and the concentration of poverty

Society and the interaction among economic agents are both harmonized when the working class are progressively or even gradually afforded a greater chance of accessing modern social amenities and given a fair chance to have balanced, safe and harmonious domestic environments (Rosenblatt et al. 2012).

A recent and substantial body of quantitative research emerged in the USA which used "multivariate statistical techniques to establish the degree to which neighborhood

environments affect the social and economic outcomes of low-income… families and their children" (Galster 2007, p. 3)[11]. This research largely indicated that a narrower band of employment opportunities and an increased propensity to engage in unlawful activities was highly probable for those who grew up in areas of concentrated poverty. The research found that the type of neighborhood one grew up in appeared to be a key determinant of one's "opportunity structure". This type of research has, however, been marred by controversy, especially as it relates to biased methodologies and can therefore regarded as anecdotal best (Galster 2007).

Sharkey (2009) documented a similar study conducted in Pennsylvania and Washington DC on the subject of economic mobility; in this study, 5,000 families were surveyed over a decade. The study found that the severity or rate of poverty in a neighbourhood where children grew up had a strong correlation with their ultimate mobility along the income ladder as adults. The neighbourhood dynamics were a stronger determinant of economic mobility than their respective home environment which indicated that they were more susceptible to the influence of their community than their parents were a generation before. Comparatively, this correlation was far stronger than even the difference in their parents' level of education to theirs. In South Africa, the evidence for this claim was observed in a 2011 social study conducted by the Gordon Institute of Business Science (University of Pretoria) that found that the largest determinant of the potential extent of economic mobility for people under the age of 35 in the GCR was how much each subject's father earned.

In moderate contrast, Jacobus (2015) suggests that integration and social mixing itself, among income and class groups, cannot be relied on as the cornerstone to achieving diversity in economic mobility. His assertion is that it is the reluctance or refusal [attitude]to integrate within society which should be eliminated to ensure diversified mobility. Furthermore, endeavours that seek to integrate across communities along dividing lines must be encouraged for the sake of creating sustainable regions and economies. Doing this would

[11]See reviews by Haveman and Wolfe 1995; Ellen and Turner 1997, 2003; Leventhal and Brookes-Gunn 2000; Sampson et al. 2002; Lupton 2003 for further explanations.

create adequately resourced communities who can broadly benefit from living in higher-opportunity locations. He concludes that striving for the latter is sufficient to justify the promulgation of government policies and societal intervention that promote integration and diversity. Land in established and well-serviced neighbourhoods of the city presents an optimum opportunity as places where inclusive housing can occur (Overman, Punga & Turner 2003).

2.2.3 Affordable Housing in Gauteng Province

Since the democratic dispensation in 1994, Government's housing policies have dominated the economic and social discourse. The focus has been narrowly confined to fully-subsidised low-cost housing, or RDP/BNG housing as it has come to be known.[12] Although many discussions in public fora have centered around the pace and quality of subsidised housing projects there has been a concerted mind-shift over the last five years to reformulate better policy to deliver housing on a larger scale, across multiple levels of affordability and a more intense use of land parcels (densification)(Melzer 2015; Tissington 2011). In 2006, the affordable housing market began to expand, with efforts by the government to lend into the market and to encourage commercial banks to follow suit. However, adverse credit conditions and the introduction of the National Credit Act in the latter half of 2007, coupled with the Global Financial Crisis of 2008, slowed home loan activity; resulting in rental housing gradually becoming an appealing option to households.

In 2011 a State of Cities Report[13] (South African Cities Network, 2011) highlighted the slow and unsatisfactory progress in delivering housing to the affordable housing market segment. Despite government's earlier attempts to entice home mortgage lenders by subsidizing the purchase price paid by new buyers from households earning between R3,500 and R15,000[14] , very few households were able to access private home mortgage funding in the gap housing market even after the introduction of these subsidies in 2008. Issues identified were, *inter*

[12] See, White Paper on Housing 1994; The Housing Act 107 of 1997 (amended by Acts 28 of 1999, 60 of 1999, 4 of 2001, 43 of 2007); Breaking New Ground 2004; and the Framework for Inclusionary Housing Policy in South Africa 2007.
[13] published by the Centre for Affordable Housing Finance ("CAHF") and South African Cities Network
[14] through the Finance Linked Individual Subsidy Program (FLISP)

alia, the insufficient supply of suitable and well-located land, delays and costs in providing bulk civil infrastructure and services and a mismatch between available stock and end-user appetite. The latter explained by consumers showing limited interest in buying homes on the outskirts of their respective cities.

More has been done to encourage rental as an attractive form of tenure as property developers found more suitable development land that would enhance their investment/property portfolios. Simply put, the better the site the more valuable the income-generating property that is built and operated on that site. These maneuverings have boded well for the affordable (or gap) housing sector as private equity funds have become big investors and funders in the market, with banks increasingly becoming amenable to fund developers with proven track-records. Policy interventions are taking place in both national and various provincial housing departments to make available finance for the development of high density schemes for rental. Gauteng has the largest number of institutional and state-sponsored funders for affordable housing. These include: TUHF, NURCHA, GPF, NHFC), HIFSA, Chartwell Housing Finance and the commercial banks with their specialised lending divisions.

2.3 The Evolution of Impact Investing

Social Impact Investing often used interchangeably with the term *responsible investing* can be pursued in a wide range of sectors for enhancing people's welfare, catering for basic needs and increasing amenities in a community or region. This is typically achieved through physical and economic infrastructure investment, human capacity building and training and the creation and targeting of employment opportunities for marginalised workers, whether directly (i.e., as employees) or indirectly (i.e., through procurement). These investors seek market-based solutions to the world's most pressing challenges, including sustainable agriculture, affordable housing, affordable and accessible healthcare, clean technology and telecommunications, and inclusive financial services sectors. The aforementioned are identified as among those with the greatest potential for social impact. Enterprises

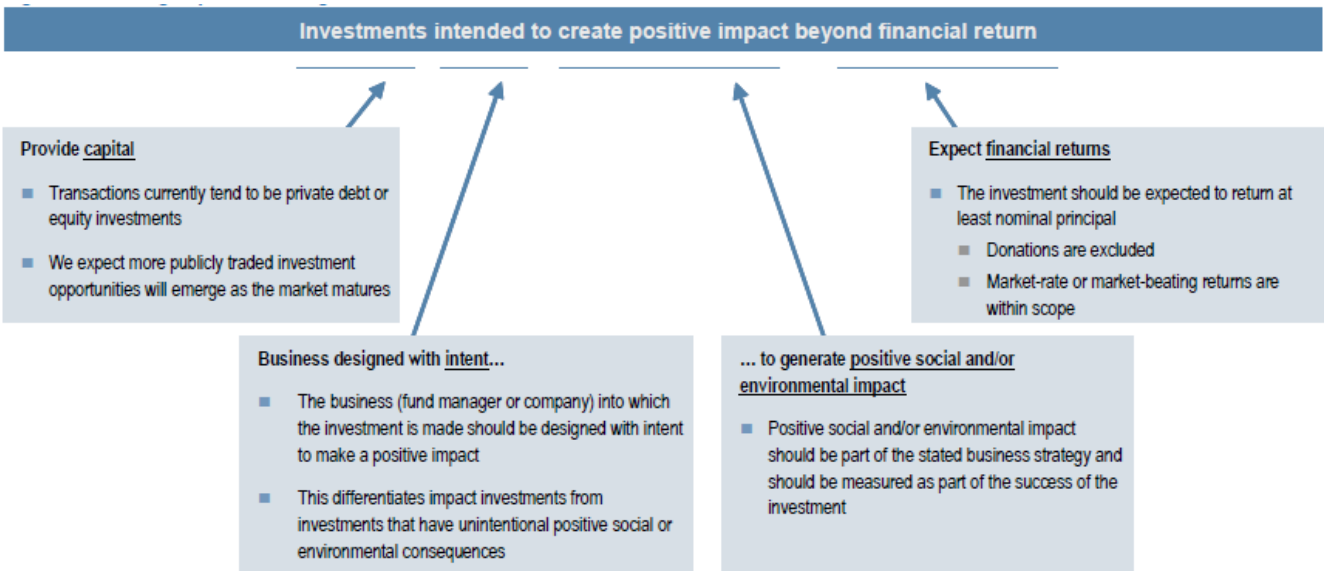
intimately involved in these fields form part of the optimal investment pool that *impact investors* target (GIIN, 2014)[15]

Historically, the majority of impact investing occurs in private markets, typically through private equity investment and financing using instruments such as debt, equity and guarantees. The intention has always been to generate financial return, while being a force for social and environmental upliftment, this being the *triple bottom line* (Matthews et al. 2015). Triple bottom line gains are the outcome of a free-market philosophy namely impact investing. Globally, the market is buoyant, with major proponents being high net-worth individuals going *beyond* philanthropy, and investment funds; whether they be sovereign wealth, pension, exchange traded, collective investment schemes whose investment mandate(s) resonate with the UN's PRI[16], or whether or not they are signatories of the PRI. The sustainability and success of impact investments rests on the assurance that they are largely undertaken to generate a financial return. The pairing of these two motivations — profit-making and being a force for good — by financiers aims to encourage investee enterprises to develop in financially sustainable ways.

JPMorgan-Chase Bank provided a conservative estimate of the potential profit opportunity arising from the provision of affordable urban housing in emerging markets to be about US$177billion (O'Donohue & Bugg-Levine 2010). Other sectors, including the venerable *Microfinance* sector, are all exponentially smaller in estimated potential combined investment and potential profits. The social and/or environmental impact is likely to be delivered through the business operations and processes employed, the products or services produced and/or the target population served (Arosio 2011). Clearly, the risk of an impact investment will be particular to the investment, including its stage, sector and geography.

[16] Principles for Responsible Investments— An investment accord of the United Nations Environmental Programme- Financial Initiatives ("UNEP-FI"), whereby signatories publicly pledge their commitment to, and undertake to abide by, the six(6) voluntary and aspirational principles of ESG promoting investment behaviours/actions as identified by the UNEP-FI.

Figure 1: Motivations of Impact Investors



Source: O'Donohue & Bugg-Levine 2010

Over the past decade, social stock exchanges have been created in both OECD and non-OECD countries[17]. These exchanges target smaller high-growth enterprises in sectors such as health, sanitation, education, environmental protection, housing for the poor and working class, sustainable forestry and organic agriculture and other "base of the pyramid"[18] interventions. Social stock exchanges seek to build a platform for social businesses to attract capital, and these markets provide liquidity and facilitate transactions for companies that generate both economic and social returns (Wilson et al. 2015, p. 30).

Advances have been made in the development of frameworks for the measurement of investment impact. The Impact Reporting and Investment Standards ("IRIS") framework provides a taxonomy to standardize social impact reporting and facilitate the creation of

[17] None such "non-OECD" country was located on the African continent

[18] "The phrase "Base of the Pyramid" is used for two interrelated concepts:
1) A socio-economic designation for the 4-5 billion individuals that live primarily in developing countries and whose annual per capita incomes fall below $1,500 (in PPP terms); and
2) an emerging field of business strategy that focuses on products, services, and enterprises to serve people throughout the base of the world's income pyramid." http://www.bring.com/resources/bop

industry benchmarks. These new benchmarks have consideraby reduced due dilligence costs because they are standardized and parsimonious, making it easy to collate and compare/ventures options . As their use spreads they should become a generally acceptable acid-test for the nature investments made and the level of ESG related impact they have created. This has been a crucial step in ensuring the sector continues to distinguish itself from regular venture capital and private equity investments. A particularly notable feat is the development of a set of reporting standards called the Impact Reporting & Investment Standards ("IRIS") by GIIN. Without further development of standards and benchmarks for ESG performance, investors will:

a) Revert to relying on their own judgment and proprietary systems to rate the risk or return hurdles; and
b) Be limited in their ability to understand how the social performance of their investments compares to those made by other investors (peers).

2.3.1 Fiduciary Responsibility and Impact Investing

Less than a decade ago, socially responsible investment ("SRI") was at loggerheads with the *fiduciary duty of trustees*, of which all recognised private equity firms, investment and fund managers are bound by (because they are mandatories investing on others' behalf). A comprehensive report published by the UNEP's Finance Initiative in October 2005 and commonly known as the Freshfields Report (UNEP Finance Initiative 2005) highlighted the disparity that existed in what it identified as *value-driven* and the distinctly different *values-driven* investment philosophies; with both centered around the decision-making process of fiduciaries. The report suggests that the former is about following the correct process (the fiduciary duty of "prudential management"), while the latter is more about pursuing a proper objective (the fiduciary duty of acting only in the interest of their beneficiaries).

The bone of contention around SRI and the fiduciary duty centered around the duty to *act in the interest of the beneficiaries,* where many contended that pursuing SRI went against the profit maximization objectives of investors who were seemingly being made vulnerable to an untested asset class, which could dilute their investment returns The report largely concludes that SRI could be pursued in investment decision-making where express or tacit

consent was given by the beneficiaries. Furthermore, it suggests that ESG considerations can validly be included in investment and disinvestment decisions so as to more precisely analyze the future financial performance of the subject asset (Richardson, 2011). Formal, written and deliberate disclosure by fiduciaries to beneficiaries — about ESG considerations used for investment decision-making — is not mandatory in South Africa, it is however fervently encouraged so as to bolster the often nebulous issue of *tacit consent*.

2.3.2 Impact finance and investing: Screening investments and return expectations

O'Donohue and Bugg-Levine (2010) contend that insofar as investor expectations go in the world of impact investing there seems to be a *mixed bag* of investor expectations. On the face of it, there are many who legitimately expect their impact investments to outperform traditional assets/positions in the same sector/category, while other investors are content with trading-off enhanced financial return for achieving greater societal impact from their funds. A trend is emerging among newer entrants into the SRI segment who focus their funding activities on endeavours that are aimed at society's most vulnerable people; these being minimum-wage earners and the indigent, typically referred to as the "base of the pyramid". The credit risk associated with funding opportunities that cater for this designation is so volatile that it typically prices most deals out of the market. As a result, investors that are active in transactions for *base of the pyramid* candidates are amenable to trading-off appropriate returns in order to make a powerful and enduring social impact and to enable the sustainability pf the endeavour/product. This trade-off has generally been deemed as concessionary funding[19]. The extent to which this trade-off can be negotiated would ordinarily be determined at a point lying between the maximum anticipated impact and the best rate of return that would be expected in the market for a similar transaction.

Return expectations and whether or not impact investments should surpass traditional investments is reliant on investor perception, the type of investment instrument, the investment term, and the "appropriateness" of the benchmark used. The determinants of whether investors' return could surpass or equal other market investments could lie in

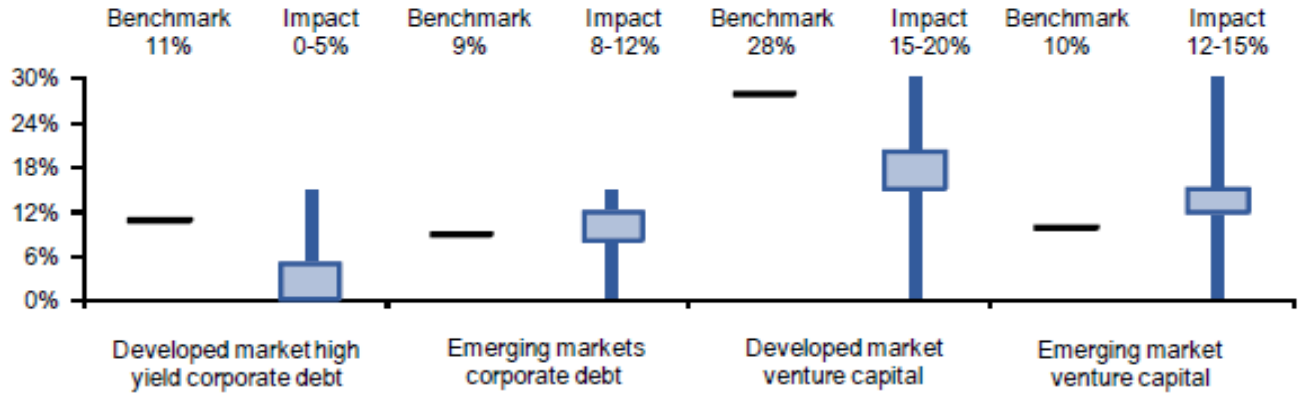
[19]Concessionary loans or finance are advances of debt capital bearing a rate of interest that is below the average cost.

whether investments are in developed or emerging markets. Donohue and Bugg-Levine (2010) confirm the existence of evidence which suggests impact investments in advanced economies tend to attract investors that sacrifice financial return as a trade-off for societal impact. In contrast, those in developing nations are more than likely to expect competitive risk-weighted returns. They further contend that this may be due to the *regulatory enticements* that exist in developed economies to encourage investments in lower-yielding social endeavours. These enticements would, *inter alia*, take the form of tax reliefs and incentives which often don't exist in developing nations for a myriad of reasons. This observation about SRI return expectations also applies to most funding instruments from equity to secured debt. The subjects of their research (interview respondents) did, however, indicate a possible concessionary stance could be granted for developing nations' debt where the cost of debt in the investee country is higher than the reasonable anticipated impact investment return.

The data provided below, supporting these return expectations, are depicted in the figure below. The data for South African impact investors, or investors domiciled and investing in emerging markets was not found. The expectation of return from the point of view of emerging market investors is therefore inconclusive (O'Donohue & Bugg-Levine 2010).

Figure 2: Average return Expectations by Instrument and Region

Horizontal bars: Average realized returns for benchmark and average expected returns for impact investments, gross annual IRR or yield, in USD. Vertical lines: Range of expected returns reported, gross annual IRR or yield, in USD.



Source: GIIN, J.P. Morgan. Survey participants were given a predetermined choice set of return ranges (0–4.9%; 5–7.9%; 8–11.9%; 12–14.9%; 15–19.9%; 20–24.9%; 25%+) which is why the averages are presented in the form of ranges rather than single data points. Benchmark returns are average annual returns for: J.P. Morgan's Developed Markets High Yield index and Corporate Emerging Market Bond ("CEMBI") Index, over the period 2002 – 2010 (our full data history); and Cambridge Associates US Venture Capital Index and Emerging Markets Venture Capital and Private Equity Index, for vintage years over the period 1989 – 2006. Impact investment return expectations are calculated by taking an average of survey responses (each of which represents a range of expected returns for a given investment instrument in a specified region) across the population of reported investments. The number of investors who responded for each instrument, and the number of investments in the sample (respectively) are: Dev mkt HY debt = 9, 219; EM HY debt = 10, 411; Dev mkt venture capital = 6, 91; EM venture capital = 15, 119. Readers should note the low number of Dev mkt venture capital investors represented. Note that the range of expected returns for developed market debt excludes a single investment reported by one respondent with an expected range of returns of 20-24.9%; all other data points fall within the range shown. Both the developed market and emerging market venture capital ranges include investments with expectations of 25%+ return (the range was not specified above that level).

Source: O'Donohue & Bugg-Levine (2010)

2.3.3 Investment Management and Disbursement of Impact Investment Capital

The potential for impact investments to attract a larger portion of mainstream private capital and anticipate that more investors will seek to generate positive social and/or environmental impact when making investment decisions has been recognized. Affordable housing has been long recognised among other sectors as where the greatest potential for social impact exists. As such, enterprises in that field form part of the optimal investment pool for *impact investors* to target. As with investing in most asset classes, manager selection is a primary determinant of investment success. In turn, selection by investment managers is informed by how well the manager is with the asset class and key market indicators and tendencies. This has, in many emerging markets, created challenges as managers cite a lack of performance data and overall industry track record to support their attempts to build capital raising strategies (Arosio 2011).

In global capital markets, funds are allocated and reallocated in order to optimize their risk-weighted returns. This optimization strategy is nebulous when dealing with impact investment as social and envirnmnetal returns are incorporated into the total financial return that the investor makes. For this reason, the impact investmnet asset class has historically been the preserve of quasi-philanthropic high net-worth individuals and organisations with expanded or highly developed corporate social responsibility programmes where financial refurns were an ancillary objective of capital deployment.

2.4 The Urban Agglomeration and Historic Labour Dynamics in the GCR

Engineering a livable environment – and by this it is meant livable by a diverse cross-section of GCR inhabitants and not just development for a narrow ensemble of speculative investors and the bourgeoisie– has not been possible in South African as a result of our very recent discriminatory past. The *Johannesburg urban agglomeration,* which includes some part of the already defined GCR (namely Ekurhuleni Evaton, Tshwane, Soshanguve, Vereeneging and the West Rand), is the 36th largest urban agglomeration in the world with 13.2 million inhabitants, according to a July 2015 Danish publication, "City Population". Compared with its national counterparts, it seems to be on its own league. For instance, Cape Town's urban agglomeration is ranked 108th with a mere population of 4.2 million people (Brinkhoff, 2015). Achieving city-wide growth of inclusive and well located mass housing can rapidly change the city-region to one which makes "the kinds of physical and social infrastructure that strengthen the economic base of the metropolitan region as an exporter of goods and services" (Harvey 1989, p. 8).

2.4.1 Historic Spatial Formation of Gauteng and its Metros.

The current spatial distribution is rooted in the deliberate actions of the 1940's Nationalist Party's Public Works machinery, which Mubiwa & Annegarn (2013) describe as follows:

> Between 1948 to the late 1950s the growth in industrialisation and urbanisation brought about the regional consolidation that led to the establishment of such industrial towns as Kempton Park and Alberton; this

> came long after the established Johannesburg urban settlements for the mining belt on the Witwatersrand reef. The development of new steel and petrochemical industries, Iscor and Sasol, respectively, which were initiated as State interventions to industrialise South Africa, led to the creation of industry in the newly formed Vanderbijlpark, Sasolburg and Vereeniging. It was, however, discriminatory apartheid legislation (e.g., the Bantu Urban Areas Consolidation Act 25 of 1945 and the Group Areas Act 41 of 1950) that extensively transformed the land-use structure into the apartheid city. Citizens were grouped into racially demarcated precincts, separated by buffer strips of at least 100 m wide, or by distinct industrial or environmental buffer zones (citing Frescura, 1983; 1992; 2000; and 2001).

The development of new high-density townships for designated "Black dwellers" was prominent; these settlements were established on urban peripheries to relocate non-whites who had been forcibly moved from inner city suburbs to the utmost reaches of the cities of Gauteng (formerly Transvaal). Ultimately, the spatial configuration of the region widened and travel distances increased. To ensure that the relocated populations could still serve whites and provide their menial labour, the State constructed railway lines to the townships and heavily subsidised a commuter bus-service linking outlying townships to main urban centers. To ensure that populations could be contained, road networks in these townships were designed to contained the flow of people via a handful of entry and exit roads. The lack of security of tenure for properties "resulted in an almost total absence of normal home improvement and citizen-driven urban infrastructure improvement as the houses were State-owned and rented"(Mubiwa & Annegarn 2013, p.11).

The predominantly east-west transport routes, largely railway, were established to serve all the mines of the then *Witwatersrand Gold Mining Corridor*[20]. What emerged was a linear spatial formation with development and settlement activity radiating out from that line/axis

[20] The mining belt of Gauteng, stretching from Carletonville to Randfontein in the south-west to Nigel in the east.

of the Witwatersrand Reef (Fair et al., 1956 cited by (Mubiwa & Annegarn 2013)). Through the 1900's, the North of Johannesburg CBD became increasingly affluent. The airport, with its extensive cargo infrastructure, created the primary and ancillary industrial nodes of the east of the Witwatersrand.

The Black, Indian and Coloured workers of the now Gauteng Province were confined to townships located 25km or more from their nearest urban employment centers, the only exceptions being Riverlea and Westbury (formerly called Western Native Township). Johannesburg, Tshwane and Ekurhuleni metros continued to grow explicitly along these racial lines until the mid-90s. Much of what we see today in terms of racial and class spatial distributions are due to economic opportunity redistribution of the recent past and the present-day. Exponentially superior upward-mobility enjoyed by the Black, Coloured and Indian population – all this over only the last two decades. The scale of progress in this regard, however, has been far from adequate.

2.4.2 Government's Response to the Current Spatial Distribution

Throughout Gauteng, and arguably the rest of the country, we have often seen that government's response to the housing shortfall is the politically charged and divisive "catalytic mega-project"; where local and provincial governments inject capital to further reinforce the inefficiency of existing social infrastructure. The construction of such places is ordinarily touted as the best means of procuring benefits for historically disadvantaged people within a particular jurisdiction. Benefits, such as job creation and the upliftment of local economies through involvement in the supply chain, are proclaimed. For the most part, the benefits of these mega projects are typically indirect and materialise on a far smaller magnitude and scope than the jurisdiction within which they lie. The finished product is also largely regarded as tawdry by its beneficiaries. Harvey (1989) argues that these mega greenfield or urban regeneration projects "also have the habit of becoming such a focus of public and political attention that they divert concern and even resources from the broader problems that may beset the region or territory as a whole" (p.8).

The less evident long-term effect of these mega-projects is that because they (a) cater to slightly *lower-than-middle* income families and (b) are built in the hinterland near established and largely underdeveloped townships, they can easily become places of concentrated poverty within one generation. This also carries through to the plethora of housing schemes already built in areas just outside the city, where existing economic and social infrastructure is sorely underdeveloped.

Le Roux (2012), in her research, investigated the consequences of the Johannesburg municipality's proposed land use policies. She compared the spatial impact of two different simulations (scenarios) to determine whether spatial equality will be restored to the city by the year 2030. The study considered two options, namely a SLEUTH[21] and Dyna-CLUE[22] model, both of which are advanced computer-aided spatial models (i.e., cellular automata models), which are widely used to model urban growth. The conditions simulated by the most suitable model (the Dyna-Clue model) were found to be:

a. The first scenario, referred to as the '*as-is*' scenario, assumes continued growth from the past decade. The sprawled city with its inherently inefficient social infrastructure is clearly evident in the AS-IS scenario with a large amount of informal settlements in the south and north-east of the city.
b. The policy-led scenario focuses on the immediate and strict implementation of land use policies and strategies designed to limit growth, densify transport corridors and encourage investment in low cost housing in accessible locations. This scenario depicted a far more compact city with a concentration of high-rise business and residential accommodation for a wide variety of income/wealth groups and government housing in the central areas and along transport corridors (Wray et al. 2013, p. 44).

[21] "SLEUTH"- Slope, Land cover, Exclusion, Urbanisation, Transportation and Hillshade- a largely convexly curved multilayered model that does not, however, have dynamic temporal factors.

[22]"Dyna-CLUE"- Dynamic Conversion Land Use & its Effectiveness- a computer program with spatial factors such as- "land use maps, locational driving factors and spatial policies and restrictions. The non-spatial data inputs are as follows: policy scenarios, regional driving factors and expert knowledge"

Le Roux (2012) established that by implementing Johannesburg's proposed land use policies (the policy-led scenario) of implementing densification corridors and restricting development outside the urban development boundary, more economic opportunities would be provided to the poorer households in the southern parts of the city (Le Roux 2012, p. 5). However, even with far-reaching policy intervention, segregation within both the northern and southern regions of Johannesburg will remain.

A key finding was that in the '*as-is'* scenario of growth – along the same lines as has been the case over the past 15 years – would result in increased informality of human settlements, low densities and a large sprawled landscape by 2030. The '*as-is*' scenario also skews economic opportunities and the benefits of growth in favour of the wealthy northern suburbs of Johannesburg whilst restricting the majority of low-income households to the southern parts of the city. The converse is applicable to the *policy-led* outcome where the benefit of increased economic activity as being enjoyed by a broad area spanning Johannesburg where low and middle income earners become spread throughout the city and are not just concentrated in the south of Johannesburg; running from Booysens through to Soweto (Le Roux 2012).

As the GCR grows, urbanises and further spatially integrates, it will need definitive and unflinching spatial guidelines and restrictions informed by a medium to long-term spatial and socio-economic strategy. This will bring the development of the region/city in line with Le Roux's "policy-led" 2030 modeled outcome for the city. Success is possible (a) if the government remains steadfast in implementing the spatial strategy and (b) if the province grows faster than it currently is because that is when resource allocation and capital deployment will be under exceptional scrutiny.

2.4.3 Labour Market Behaviour to Urbanisation

Duranton & Puga (2004) suggest that far-reaching strides can be made in high-density locales to improve the functioning of labour markets insofar as how well the *matching function* operates. An increase in the number of agents (whether job seekers or employers)

in a city "reduces search frictions and results in smaller proportions of unemployed workers and unfilled vacancies" (p. 2093).

The ownership of large number of businesses in certain sectors may allow such owners monopsony power leverage. The wielding of such monopsony power in that sector gives employers the ability to operate in a strategically underhanded manner rather than being conventionally competitive. This could complicate and slightly weaken the tendency of firms to agglomerate either into existing high-value economic nodes or for the purpose of creating new high-activity nodes. Coppola and Nuzzolo (2011) contend that increasing industry agglomeration diminishes monopsony power as it brings about an increase in competition for labour and also increases strategic interactions within the local labour markets, bringing about and reinforcing employee benefits and power as workers can move across and between sectors provided they can deal with the costs involved.

South Africa's chronic unemployment rate makes difficult to have a well-functioning and competitive labour market, especially in the labour pool at the bottom half of the income/organizational pyramid; from the base (clerical/operational) to the middle (junior management). The monopsony power wielded by, for example, blue chip corporates is such that competition in this labour pool is disproportionately fierce, this owing to the number of job seekers in these brackets. The nature of this competition somewhat distorts the labour market by ostensibly exhibiting how expendable theses workers are, even though median wages in this bracket are very low. (p. 2085-6). Those able to find decent jobs at the level below and including junior management eke out a living and finance their lifestyles with credit. This makes them vulnerable to economic setbacks such as the erosion of their disposable income because of commuting and volatile credit costs. These are issues that warrant the need for solutions and measures of redress – redress in the form of interventions to ameliorate commuting/transportation or, better yet and more impactful housing.

Existing theoretical literature on economic growth suggest that *it* is a symptom of growth in the number of employers or employment opportunities. At the meso level, this growth of employers or employment activities has classically been attributed to an interplay between

(a) a city/region's ability to produce an assortment of goods and services and (b) the accumulation of factors of production as key contributors(Coppola & Nuzzolo 2011).

Urban sprawl, according to Harvey (1989), does not allow the optimization of consumer's buying power. Instead it stifles the achievement of economies of scale and prevents a diversification of product/service offerings and hampers the growth of labour markets. It is not just bad for producers and merchants, but is also bad for those particularly remote communities because they become even more vulnerable to income-eroding factors. Under such conditions, economic growth endures prolonged weakness as demand and supply do not adequately interact to create industries, economic and employment opportunities.

In densified urban formations such as cities or regions, entrepreneurs and established businesses are able to harness consumer buying power because it finds the most value in densely populated areas, even in prolonged economic slumps. Downturns, which typically create conditions such as chronically high unemployment rates and a high cost of credit that erodes consumer's buying power, are navigable for businesses in areas where there is a plethora of amenities and a sheer amount of demand, which creates economies of scale. The presence of sophisticated public services and infrastructure in densely populated areas with sufficient scale of demand makes goods and services easy to supply, warehouse, distribute, insure against risk and, ultimately sell (Harvey, 1978).

One such instance that serves to reinforce the relationship between densifying and optimizing labour markets is Helsley and Strange's (2002) "matching" argument between entrepreneurs and specialised inputs available in a city to justify why cities and the benefits derived from living in them favour innovation. A limitation around the perennial nature of innovation-lead growth means that new innovations must remain at almost proportional to the quantity of past innovations in a particular city in order for that growth to remain sustainable. A good case-in-point is Silicon Valley and Hollywood, both in California, USA. This ensures that competition among innovators and entrepreneurs in other locales doesn't diminish the city's prospects of retaining and attracting new markets and capital.

Venables (2002) argues that cities improve the quality of matches and drastically improve productivity as a result of the higher quality matching. He suggests that a random worker (whose skills can be high or low) when matched with a highly skilled local partner to produce/conduct a good/service will certainly be more productive as a result of that match. However, the productive gains from having a high-skilled partner are greater for high-skilled workers. The enhanced matching function that is derived from operating in a city is a further reason to justify the premium paid for business premises; coupled with the relative ease of poaching employees. It is the reason many businesses are happy to pay the premium. It does not, however, bode well for urban land suitable for residential development as it drives up prices. The price in many instances may make developing affordable housing incredibly difficult without concessions that rescue the cost to build, operate and maintain, such as affordable housing schemes. This cost becomes relatively less the higher the density of the scheme because of the economies of scale available to property developers.

2.5 Urban Land Economics and the Scope for Modeling

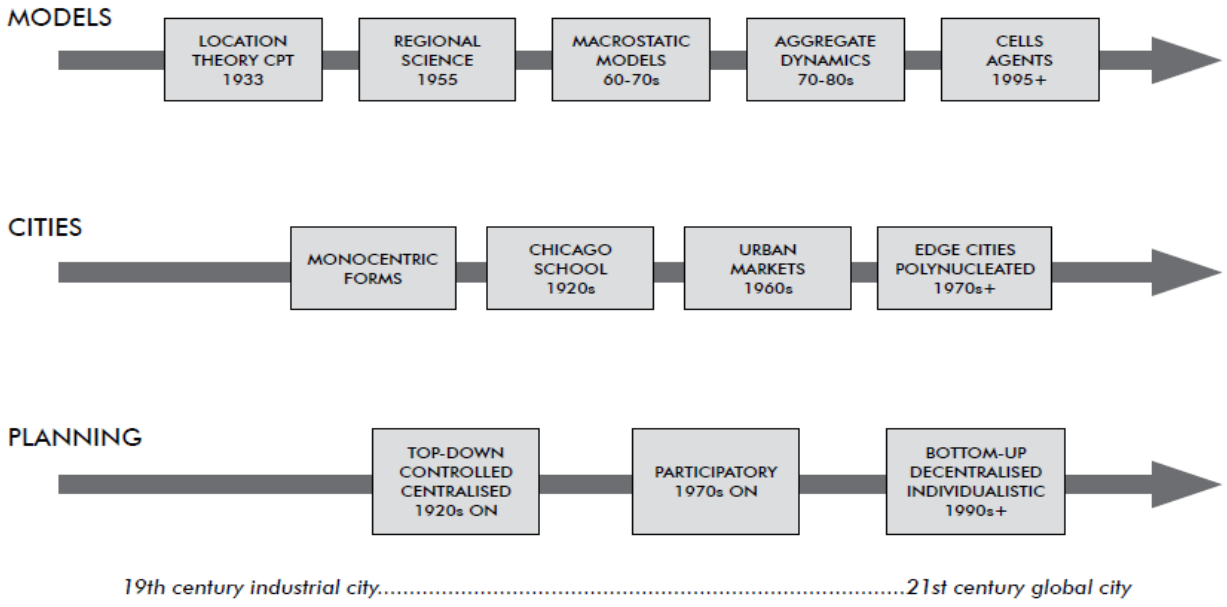
A number of recent events have led to the reinforcement of Alonso's bid-rent theory and particularly the attaching of a price premium for businesses to operate in the local business district. These include (a) drive to pursue innovation-led growth (described in previous sub-chapter), (b) the ease with which employee poaching can be conducted, (c) the presence of adequate physical and technological infrastructure, (d) the assembly of a wide variety of amenities and support services, and (e) the proximity to expert consulting services over the last century. It is the extent to which advantage is taken of personnel poaching and enjoying the benefits of population density in the business district that etches up the premium to be paid for operating there. This premium does not, however, capture all, or even most, of the gains to be made in the area. Firms constantly face a trade-off between

a. central locations (these increase operating costs), which allows them to capture a larger share of the market (enabling them to generate additional revenue), and
b. locations in the hinterland (these reduce operating costs), this enables them to better compete with the intensity of competition (allowing them to more keenly price their final goods and services) (Lauridsen 2012).

Lauridsen (2012) further asserts that spatial economic modeling resembles typical time-series modeling and forecasting in that it incorporates "the explanatory variables of the neighboring spatial units (as well as their error term) into account." He does, however, suggest that the similarities end there as "spatial dependence" for discrete space is able to go forward and backward – whereas time dependence is only able to go forward. The remedy suggested is opting to deem space as continuous rather than discrete. This would further align it to time series as it would remove the possibility of going backward.

The glaring drawback, however, is that it then defines space/land as a near-infinite resource and that no competition exists for alternate uses or that once space (land) is used/developed that unique unit/tract of land does not diminish the available stock, whereas in reality it does. The history of spatial economic modeling is summarised below:

Figure 3: Temporal Flow-diagram of Spatial Economic Modeling



Source: Batty (2009)

The bulk of existing modeling initiatives are primarily GIS based and/or linked to spread sheets containing demographic or housing projections. As such, the South African urban modeling typologies are categorised differently from international typologies and include a broader range of urban modeling techniques. Land use modeling in South Africa has the

potential to be the foremost tool in forecasting the evolution of our cities, from both a productivity and resource allocation perspective. It proves highly effective in also predicting the outcomes of specific interventions such as integrated public transport systems and property development.

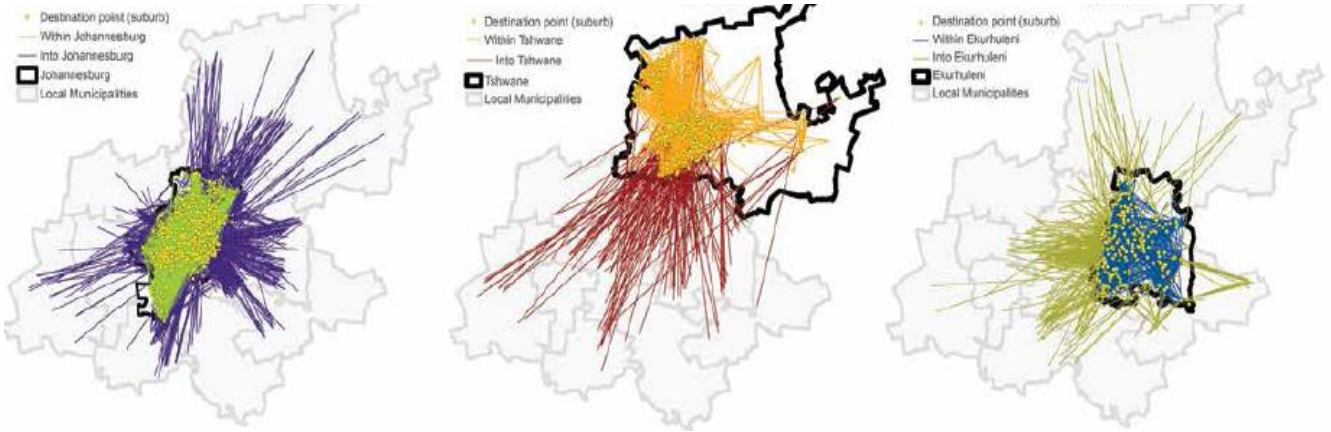
General equilibrium models of spatial economics entail making detailed assumptions about the spatial structure, the production structure, and the mobility of people, goods and ideas - all this under increasing returns. These details are not able to be credibly be fused together without analytical solutions. Such solutions can emanate from uncomplicated but tractable models of cities and regions. Firstly, what is important in such models is that they must incorporate all the relevant costs associated with trade and productivity within the city or region. This plays a fundamental role in any modern models, but their microeconomic foundations have received insufficient attention in the past - it would likely involve looking beyond merely transport costs and "open the black box of the multiplicity of transactions costs associated with trade between different parties" (p. 9). Secondly, the researcher or provider of the analytical solution must develop or adapt a reasonable *theory of proximity* (for lack of a better name). Such a theory would provide some detail or answers, based on solid micro foundations, as to why direct interactions between economic agents matter and to what extent- it would be expected that non-market interactions such as knowledge spill-overs and localised specialization would be considered in the developing of the theory of proximity (Lauridsen, 2012).

There are, however, opponents of the "spill-over" argument, but the rationale reinforcing their positions is archaic; in terms of the modern age of information technology. Many who establish arguments, which depart from Krugman's position on spillovers "leave no paper trail by which they may be measured and tracked" (Krugman 1991, p. 53). They fail to take into consideration the extent to which formal and informal dissemination of information and practices can happen either via the internet using computers and smartphones – evidence of related cases would largely be anecdotal. More contemporary empirical research has been able to establish base evidence that spill-overs leave some paper trails, many of which are

closely associated to patent-related activity – the evidence suggests that patent citations and creation decrease in relation to proximity to a city (Combes & Duranton 2006, p. 2)

2.5.1 Commuting Dynamics in the Subject Locations

Figure 4: Daily commuting to the three Gauteng Metros



Source- GCRO (2011)

Above is a graphic depicting daily travel into and within the three metro municipalities of Gauteng. From left to right the first map depicts commuting in Johannesburg, the second is Tshwane and the last is Ekurhuleni. The graphics above represent the state of affairs before the national highway e-Tolling, Tshwane Metro's Areyeng Bus Rapid Transit system and the full roll-out of the Gautrain and City of Johannesburg's Reya Vaya Phase 1 BRT networks. Subsequent research for mapping the travel patterns of commuters is expected to forthcoming 2015 Quality of Life survey which will be published by March 2016 (after the research is submitted). It is expected that some changes would have occurred on the basis that commuting costs had drastically decreased for millions of workers who use the Rea Vaya and have materially changed, over the medium to long term.

Workers have been able to move towards areas that minimize their commuting costs, especially with the roll-out of Gautrain's complementary bus service, which makes commuting effortless for those within walking distance of these busses. Much of what we observe with commuters coming from outside their respective metros is as a result of lifestyle choices/constraints or affordability constraints of their current accommodation.

An account of how people commute in Gauteng is provided below. Below is a pie chart of travel purposes. It delves into work and job-search related travel and how better location of

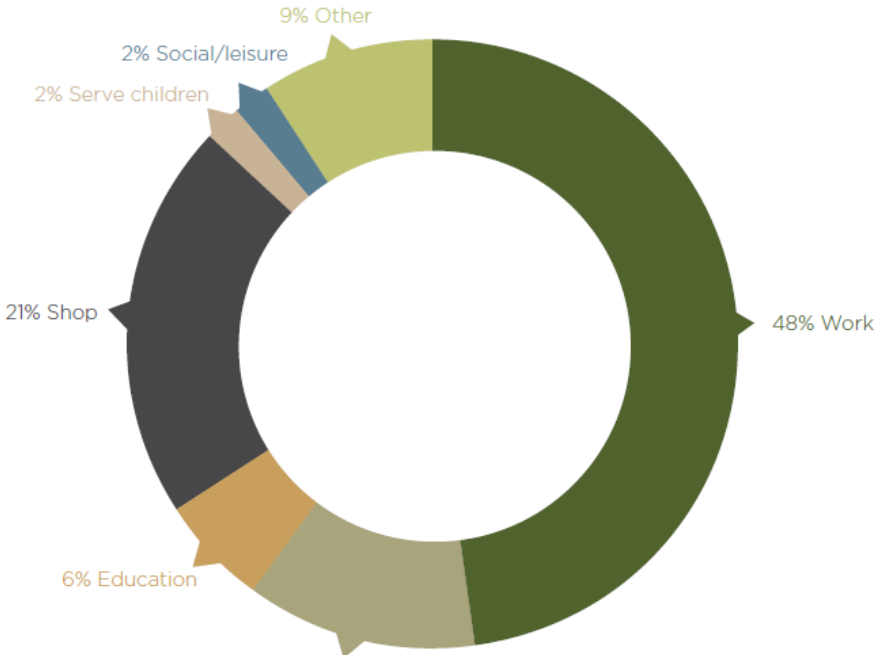
Table 1: Commuter's Mode of Transport

Mode of Transportation	% of respondents
Car and Public transport	3,40%
walk only	10,20%
Private car/motorcycle (driver of passenger)	29,70%
Public Transport only	56,70%
Taxi only	42,0%
Bus only	1,9%
Train only	2,5%
Taxi and bus	0,6%
Taxi and train	10,6%
Bus and train	0,1%

Source- 2011 QoL Survey

dense rental housing within better proximity to employment nodes could drastically reduce travel cost and therefore be an aid to preserve savings. Taxis are a main feature with an estimated 75% of job seekers using them as their main mode travel and their fares are abhorrently volatile.

Figure 5: Proportion of Travel Purposes



Source- 2011 QoL Survey by GCRO

2.5.2 Land Use: Modeling and Spatial Econometrics

In developed countries and many cosmopolitan cities in developing counties, working-class or so-called blue-collar neighbourhoods or boroughs are socially fragmented from middle or upper-middle income areas. This fragmentation typically occurs along ethnic or racial lines. Ducruet & Beauguitte (2013) suggest that we attempt to arrive at a more impartial viewpoint, their contention being that a more analytically fruitful lens through which to observe fragmentation would be in terms of people's relations with the state and different forms of capital. This is a fitting and poignant point-of-departure for a study conducted in South Africa. By doing this we can view housing in South Africa "as a key resource that connects state policies both with the forms of reproduction and (dis)organization of the disadvantaged".

As government policies and technology further develop and become more sophisticated, so we begin to see the development and sophistication of the real estate market and financial capital markets. This sophistication should, in theory, directly and indirectly lead to greater access to housing (across all market segments – from low-cost subsidised government housing to opulent private houses and apartments). This occurs through the opening up of formal credit markets [and more specifically home loans] and this, in turn, contributes directly to the undoing of the historical culture of disposition and insecurity of tenure for people's dwellings and the promotion of home ownership and residential construction. This, indeed, has happened throughout urban settings in South Africa and was most pronounced during the housing boom of 1999 to 2008 where the market's buoyancy changed the neighbourhood demographics of almost all middle and upper-middle income boroughs.

Surveying the demographic profiles of a typical peripheral neighborhood 20 years ago and the same neighbourhood today, it is evident that the changes have been minimal. This is a further reinforcement of the generational constraints that exist in economic mobility. Further interrogation of private-sector-led community development in the peripheral neighbourhoods of Johannesburg, Tshwane and Ekurhuleni reveals that opportunism has been embedded through the financialization of the livelihood strategies of poor households. We see established grocery chains that serve the low-to-middle income market following the

small cabal of property developers into Black and Coloured townships to establish operations along with the entry-level banking segment as well as base-of-the-pyramid orientated clothing chain stores. While we generally regard these as well-meaning endeavours that cater to underserved and under-resourced communities, they are also definitely positioned to capture any surpluses these communities may accumulate over the years of earning meager incomes, their pervasive presence serves as a perpetual enticement to spend rather than save. They also indirectly promote urban decay by capturing the market that has come to be the mainstay of shopping malls and stores, this capture leads to a diminishing level of economic activity in the already somewhat declining CBDs.

Finally, because this hinterland community development process has led to a commodification of those who live on the periphery- a factor on which it highly depended upon, it has somewhat exposed the real and looming problems for class reproduction and deeper fracture lines among the urban poor.

2.5.3 Modeling Architecture Available to the Urban Researcher

Following Fujita and Ogawa (1982) and Imai (1982), whose literature typically assumes that productivity (or output) is assumed to be the product of a standard production function multiplied by an externality term equal to the sum of output in other locations weighted by a decay function. The function itself is beyond the scope of the research but it asserts increasing returns to scale the denser the population around CBD(s) and the denser the concentration of employers and entrepreneurs. Such modeling relies on a so-called *spatial decay function* and the extent to which it can be related to proximity to an economic hub or to commuting costs to either encourage densification or encourage people, most notably the working class, to continue to live in the urban periphery. If the level of spatial decay, as well as the level of commuting costs, are high in the urban periphery, then the rationale for staying in such an area is reduced and a household is encouraged to move closer to the city, thereby marginally aiding its densification. The prevalence of this function in each city becomes the lynchpin for whether there can be a monocentric, polycentric or completely dispersed city. This is because the dependent variable within the spatial decay function amplifies in extent, the further the distance from the CBD. The decay function is low when

we observe decentralized and specialised business nodes that offer good access and economically viable business premises in terms of rentals and ownership. If there is no, or a negligible, decay function in a city then it becomes completely disbursed with no defined cores or business nodes and all areas are free to pursue and entice businesses to operate there, infrastructure and zoning permitting (Duranton & Puga 2004)

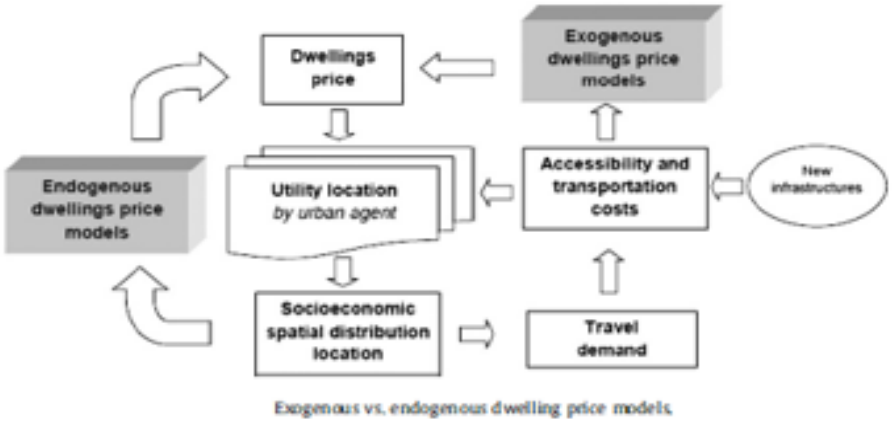
Cities experience a transition from a monocentric to a polycentric structure and then to complete dispersion as the spatial decay function weakens because the decay function weighs down the ultimate production function. So why allow or reinforce the decay function in the peripheries of cities such as Johannesburg, Tshwane and Ekurhuleni? To encourage low to middle income earners in the periphery to seek work and earn incomes that allow them to reside within a reasonable distance from the city or their respective place of employment because, over time, the existing and highly inefficient infrastructure, coupled with a lack of strategic municipal and provincial government interventions will progressively amplify that decay function?

Coppola and Nuzzolo (2011) posit that there are two classes of modeling frameworks for residential property, their use is determined according to the way in which the interactions between accessibility/travel costs and dwellings price are simulated (see Figure 7 below):

a) Endogenous models, favouring the spatial decay function. The endogenous dwelling price models estimates the dwelling price jointly with the location of the socio-economic activities; or alternatively
b) Exogenous models dwellings price where models are based on a linear multivariate regression. Here the demand for dwellings and subsequent selling price depends on the location utility of the particular given zone, the accessibility to services, the presence of green spaces, the state of transport infrastructure and commuting costs, which include both the direct monetary travel cost and the opportunity cost of the time lost to take the daily return trip. These are combined into the aforementioned linear regression to show all zonal and idiosyncratic attributes of the property (the “hedonic price” approach).

The figure below depicts the process of each class of model:

Figure 6: Classes of Dwelling Price Models



Source- Coppola & Nuzzolo (2011)

Zhou and Kockelman (2008) examine microscopic equilibrium of the single-family residential land development based on Alonso's bid-rent theory. They suggest that a model's variables be associated with price competition. There is seemingly no support for class f model along the lines of exogenous and endogenous models, they suggest that equilibrium in incorporates exogenous factors would be based on a logistic ("logit") regression model [not a hedonic regression]. These variables would be used to simulate household location choices in different scenarios, with low, medium and high value-of-travel-time assumptions coupled with a variable to denote urbanism[23], that is how their model is designed. they support the use or a hedonic model but only in cases where there is sufficient data to incorporate idiosyncratic factors about each dwelling- their position I that the hedonic model be bolted on to their existing exogenous factor-based model and not that it be allowed to be a class of model all by itself [as suggested by Duranton and Puga (2004)]

The 'dwelling price' under these modeled circumstances indicates a *willingness to pay* by a buyer, had the transaction been for rental purposes it could still be regarded that the price would be the rental price and not the selling price. When competition in the rental market for a standalone dwelling unit or a one unit in a townhouse complex or apartment block is

[23] Urbanism- The material aspects and characteristics urban living and the cultural aspects of city life for city dwellers.

high enough it plays itself out with potential tenants either increasing the price they are willing to pay for the accommodation or committing to rent it out for longer, thus giving the landlord security of income for a longer period, therefore reducing the potential for vacancy in the rental market, much as it would decrease in the time taken to sell a property in the sales market.

Notwithstanding the solitary UrbanSim project, it has argued that advanced modeling of urban spatial change within South Africa at an institutional level has not reached a high level of sophistication because it is limited to sporadic academic urban simulation research. However, Batty (2009) notes a broadening of model styles, types and computer methods on the fringe of the "urban modeling domain, for example GIS, that in some circumstances may be considered as models when compared to the key urban model types reviewed in the previous paragraphs" (p. 23). Domestically, modeling projects are mainly GIS-based, tracking observed trends rather than simulating future scenarios, with future modeling based on population projections. There is a risk, however, that outdated data, different population projections, duplicated tools and a lack of resources could compromise urban spatial change modeling efforts within government (Batty 2009, p. 49).

2.6 Conclusion

1. The impact Investment landscape has evolved to a sophisticated global market, awash with capital for developing country projects. The perception around returns suggests that investors wish to command higher rates of return for Emerging Market projects or funds because of the perceived risk. This risk is a combination of political, currency and idiosyncratic counterparty risk. These views are driven largely by the negative perception associated with Developed Markets.
2. The spatial distribution in the Gauteng Province was formed by the advent of industrial-scale mining in the late 1800s and was concretized by apartheid-era laws that saw the formation of functional cities and industrial nodes surrounded by white-only suburbs with good levels of physical, civil and social infrastructure and remotely located residential areas for HDPs'. South Africa's urban centers are in dire need of spatial re-

engineering, the emerging middle class and working class alike must be afforded a reasonable chance to access modern amenities and social infrastructure for their personal development and for the development of their dependents. Over the last 25 years, the demographic profile of most middle to upper income suburbs has materially changed, with a greater level of diversity owing to the fall of apartheid in the early 1990's and the residential property boom that was charged by economic growth and massive retail credit expansion which lasted nearly a decade and was extinguished by the Global Financial Crisis of 2008.

3. The affordable or gap housing market, having been largely ignored in the first decade of post-apartheid South Africa, has become a salient factor in the growth and mobility of the middle class due to a combination of rapid urbanisation in Gauteng and the emergence of a swell of households whose incomes rose sharply, beyond the scope of government's low-cost housing programmes. The emergence of specialised lenders and an increased level of appetite by property investors and developers to build affordable housing has been a welcome development within the residential property market since 2005. Rental housing schemes have become increasingly appealing to individual investors/developers and private equity investors as demand has been strong since the introduction of the National Credit Act and the subsequent Global Financial Crisis.
4. Greater social impact is achievable for affordable housing impact investors who fund developments in areas of greater affluence than areas where the quality of life is better. The reporting infrastructure that will allow for benefits to be measured in relation it the funds deployed and transaction costs is becoming sophisticated. Investors who are amenable to diluting their investment returns for enhanced and accurately measured social impact will be a key to unlocking inclusive affordable housing. Developing on land that is centrally located, in suburbs that enjoy good access to nodes of employment density will create more diverse communities. The deployment of concessionary funding to build affordable housing, will be able to keep the rental price stable and affordable in the rental market. the current constraint is that building affordable housing schemes in such areas that are already adequately resourced vis-à-vis physical infrastructure, community resources and amenities is difficult because of the high cost of land- property

developers cost usually passed on to end users by means of higher, but feasible, rentals charged which make them unaffordable to the gap housing market.

5. Productivity gains can be achieved through better social, race and class integration, the spill-over hypothesis, whose evidence is still largely anecdotal, is a practical and observed reality in modern society. Embodied knowledge, which is able to be diffused through peer interaction and training can increase firm-level productivity when workers infuse their new jobs with the acquired skills and insights gained from past experience and collegial interactions. The matching function of economic agents is enhanced when proximity between employers and job seekers is decreased.
6. Centrally located mass housing aids in stemming the growth of peripheral residential nodes, it therefore contributing to enhanced efficiency of social and physical infrastructure. The failure to bring the growing working class into the city means that social services, amenities and infrastructure must be upgraded or developed in the urban periphery where population scale and density make such infrastructure upgrades and new development inefficient. Furthermore, the ills associated with concentrated poverty are worst felt in the peri-urban and rural areas of South Africa, and these more concentrated levels of poverty hinder the upliftment of those residents, especially the youth- whose chances of economic mobility are harshly diminished.

CHAPTER 3: RESEARCH METHODOLOGY & TECHNIQUES

3.1 Introduction

This first part of the chapter sets out the study area and details the sources and types of data employed for the inductive formulation of the sought credit risk model. This review is important as it establishes the basis for undertaking an assessment of data valididty. It then outlines the analystical technique for both the design of the experimental data analysis and the proof of concept. The second part of the chapter outlines how the model was built to achieve proof of concept. This section describes how model components' specification as well as the importance and how weighting of model variables was achieved. It concludes with data and model validation before outlining the key assumptions and limitations faced in formulating the model.

3.2 Proposed Methodology

Batty (2009), a prolific urban spatial modeler, asserts that *system dynamics* offers a way to model the complex relationships and interactions that exist is urban systems or the urban dwellers' way of life, such as transport networks, water and energy supply networks, housing infrastructure, social amenities and networks. He further asserts that the cornerstone of a well-engineered system dynamics models is its ability to aptly represent the results of temporal or *moment-in-time* processes. For the purpose of this research, utilising *system dynamics*[24] models[25] would allow the enquiring party to include temporal and other idiosyncratic factors to estimate the credit risk of undertaking a loan transaction.

Having reviewed the available existing literature, with particular emphasis on the observation that there is a lack of robust literature for credit risk management and modeling

[24] A computer-aided approach to understanding and solving dynamic problems that arise in complex (often non-linear) systems and phenomena

[25] A *model*, in the academic arena, is generally considered as a "theoretical abstraction that represents systems in such a way that essential features crucial to the theory and its application are identified and highlighted" (Batty, 2009, p. 52).

in either wholesale banking disbursements or private equity in affordable housing, the research is unable to posit a generic or prototype (linear or logit) regression for modeling the credit risk associated with financing the housing developments. What the literature was able to uncover is that through Basel's international best-practice framework, much discretion is afforded to a competent authority or committee, within a bank or financial institution, to create their own probability of default model, provided that the data used to refine and calibrate such a model is properly curated and the time period is deemed sufficient as to be *through-the-cycle* and therefore indicative of bull and bear loan performance and trends (see Appendix A). The literature has guided the research towards the practical reality that modeling credit risk, for high density housing finance, even from an impact investor viewpoint would not be able to be undertaken convincingly without loan performance data that is both substantial, in variety, and *through-the-cycle*[26] for assessing expected default frequency.

The most suitable methodology, given the above description and the lack of extant tools, would be to conduct a proof of concept for a modeling framework that could be used to assess and manage credit risk using point-in-time[27] analysis. A formula would be proposed and then be calibrated. The data for such a ranking exercise will be collected through a *ranking survey*. The research will conclude by offering a calibrated formula that has the highest level of correlation to the ranking survey to provide to that select group of credit risk experts operating in Gauteng. The research would therefore be a quasi-experimental study.

The SERVE Centre® describes a quasi-experimental study as follows:

> "A comparison of a group that receives a particular intervention with another group with similar characteristics that does not receive the intervention. where no random assignment is used" (p. 1).

[26] Through-the-cycle(TCC) credit data is data which is collected over a number of years-typically greater than 7 years, which depicts the performance or status of a subject or variable from bullish to bear economic conditions and vice-versa.
[27] Point-in-time (PiT) analysis is a method of producing results that are relevant for a particular point in time-i.e. a price deemed to be accurate as at today, an example of this are spot rates or prices for commodities.

This differs from a purely experimental study only insofar as the removal of random assignment. Where it mirrors an experimental design is in its purpose; which is to analyze and conclude on whether the proposed intervention caused significant differences to the outcomes of the group that received it versus those that did not (SERVE Center at the University of North Carolina at Greensboro, 2008).

The parsimonious and impartial scrutiny of the risks associated with location and the prospective counterparty [as the main drivers for assessing such credit risk] could be incorporated for assessing risk of funding high density housing schemes. From Batty's (2009) viewpoint, the significance of these factors can be used for obtaining nominal property values using *preferences* of a typical potential buyer. These preferences can be modeled in such a way that they make a buyer ask themselves; what am I willing to pay for a house with these exact features/characteristics? The cluster of features for this purpose represent a *willingness to pay*- much like a hedonic regression.

3.3 The Study Area

The unit of analysis for this study is the municipal ward. The study uses data from 336 wards composed of Johannesburg's 130 wards, Tshwane's 105 wards and Ekurhuleni's 101 wards. Below is map of the study area.

Figure 7: The study area in relation to other Gauteng municipalities

3.4 Data

3.4.1 Sources of data

Primary data was sourced from a select panel of credit risk experts. The format of this expert primary data will be a rank-order survey of 10 simulated sample transactions (see Annexure H). The subjectivity of the ranking is mitigated by specifying the same type of residential scheme in different locations (that have different suburban dynamics) and by specifying developers of different experience level and financial standings so that those 3 factors become the subject of differentiation (in line with the research design outlined in 3.5.1 below). As this is a quasi-experimental study, a small number of credit experts were solicited to become a panel of expert respondents.

Secondary data was sourced from the GIS metadata of the:

- GCRO's 2013 QoL survey data; the Infrastructure Index will be used to draw data for assessing property risk (see Annexure E for 2013 QoL Summary documents).
- Bid-rent model; the original model, which mapped all of Gauteng, will be modified to only show the research area bounded by the outer edges of Ekurhuleni, Johannesburg and Tshwane (see Annexure D).

The bid-rent model was published in a Government policy document. Although its contents are not publicly available, obtaining the metadata was not arduous; it comprised telephoning the contractor who undertook the works and it was released. Both secondary data sources are not proprietary as they were all commissioned by the Gauteng Provincial government.

3.4.2 Data Collection and Analysis

For *primary data*, a scoring template was developed to be used in conjunction with the calibrated Probability of Default Ratio ("PDR") equation below.

$$PDR = \frac{1}{1 + e^{(a+b*score)}}$$

Since the "*a"* and "*b*" parameters have been established[28], the only remaining unknown to be solved is the "score", this will be obtained by ticking the conditionally formatted cells in Microsoft Excel® (see Appendix D). The higher the PDR, the higher the associated risk of that particular factor.

For *secondary data*, municipal ward-level GIS metadata (from the municipal wards of the study) area are mapped — using quintile intervals — to provide spatial description of the respective endogenous property-risks used in modeling." [see Annexures B and C]. A property in a specific ward would score between 1 and 5 on each layer of the GIS, with the layers compiled from survey data released by the Gauteng Provincial Government in 2011 Gauteng Spatial Development Framework and the data released by the GCRO in their 2013 QoL survey.

[28] a= 6.0252 and b= 0.16207 (See Annexure I for the detailed calibration calculation).

3.5 Choice of Analytical Technique

Using the scoring template developed in the research, PDR can be established for each proposed residential property development; this is provided that all of the relevant information is collected prior to undertaking the exercise.

The correlation between the aggregated expert ranking and the rankings emanating from the simulated sample transactions PDR formula/model must be a minimum of 0.5 in order to reject the null hypothesis. The respective PDRs of all the simulated sample transactions were ranked using Microsoft Excel's® in ascending order.

3.5.1 Experimental research design

A fractional factorial design was undertaken; non-equivalent groups design is undertaken on the primary data collection. Since a panel of credit experts is sought only a small subset of the already niche community of trained financial risk management professionals are eligible as credit risk experts in this research.

- The credit risk expert's opinions were 'aggregated' by way of a consensus ranking exercise performed over the outcomes of their individual and confidential rankings (see Annexure A).
- The formula for calculating the PDR will be composed of quantitative and qualitative factors, therefore a mixed methodology will be used.

The said panel of credit experts is given identical simulated specimen transactions. From the simulated transactions, experts were to rank transaction from most to least suitable vis-à-vis the inherent credit risk and their potential for positive social impact. The same specimen transactions are then run through the proposed formula. Correlation, of minimum of 0.5, between the proposed formula and the aggregated opinions of a panel of credit risk experts will be deemed as proof that the concept is functional.

This was done as a *Resolution IV*[29], fractional factorial design. These sample transactions depict:

- Gearing ratios (loan-to-value ratio and loan-to-cost ratio);
- Neighbourhood and locality attributes of where the subject property is;
- Financial standings of the proposed borrower;
- Property development experience of the developer; and
- Predicted cash flow and investment yield of the proposed development.

Each sample transaction is (i) in a different location (within the study area), (ii) "proposed" by a different developer with different levels of experience and financial standings, and (iii) has a marginally different cost structure and yields different investment returns. The type of property development, however, is the same for all the different locations, a 150-unit triple-storey apartment complex (see Annexure F). This was done so as to not be an influencing factor in the research.

The fractional data to create or drive a robust model of this type would primarily be *loan-specific* and *counterparty* data collected by banks and non-bank financiers[30] that advance loan funding for affordable housing or middle-of-the-marker residential property. This data would be proprietary and highly confidential, thus not obtainable to be used in research as this one. Would it ever happen that such data could be released to any party outside of the respective organization, it would need to be extensively processed to remove personal particulars of counterparties or any other identifying characteristics.

3.5.2 Proof of Concept

A proof of concept for an *impact investment based* credit-scoring model was undertaken. The ultimate aim was to create an equation to perform credit-risk assessment. This assessment formula is expected to provide an overall score for the quality of counterparty credit risk.

[29] A design of experiment (DOE) resolution that allows the main effects to be confounded with 3-way interactions- being cash flow risk, property risk and borrower risk. http://support.minitab.com/en-us/minitab/17/topic-library/modeling-statistics/doe/factorial-designs/what-is-a-design-resolution/

[30] All licensed by the Financial Services Board of South Africa.

The overall score is then calculated using the expert-based multi-factor formula approach and is expected to be presented in the form of a PDR.

As a *proof of concept* was being undertaken, the proposed credit risk assessment model is intended for use by non-bank financiers of affordable housing schemes in the sample area, that is, the three metropolitan municipalities of Gauteng Province. The USA's National Archives describes a proof of concept as follows:

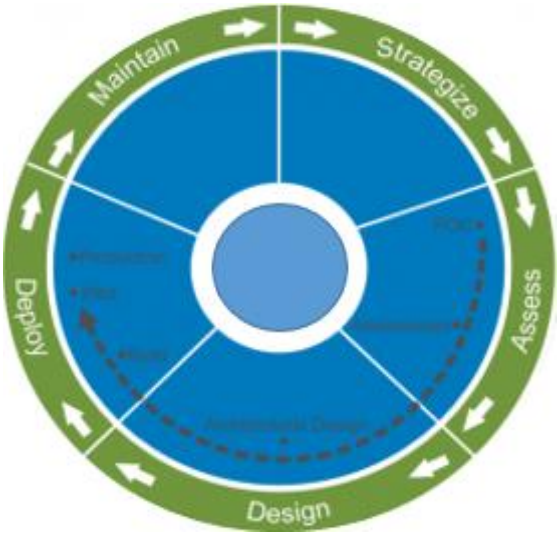
> A project or undertaking demonstrates proof of concept ("PoC") when it shows that its theory can survive application in reality or to prove the feasibility of either a solution, or a critical aspect of a solution. In terms of a product or goods, a proof of concept is often a functional prototype.

A PoC is undertaken to demonstrate functionality rather than to reveal performance. It is successful when it can give the following clarity on the proposed technology/methodology:

a) Will it meet the user's needs?
b) Can it perform as publicized?
c) Can the prospective end user(s) enjoy enhanced productivity having utilised it?
d) Will the ultimate solution be feasible? (United States Government, 2006).

The graphic below depicts a whole project lifecycle and that PoC is at the very beginning.

Figure 8: Proof of Concept Development flow-chart



FACET	POC	PILOT	PRODUCTION
Environment capacity	Minimal users (<10)	Smaller of 100 users or 10%	All users
Alternative method to perform job function	Yes	Yes	No (or yes, but only for limited time)
User sensitivity to issues	Low	Medium	High
Support Mechanism	Informal- solutions team	Formal- solutions team/ help desk	Formal- help desk
High availability	None	Limited or full	Full
User interaction expected	Testing and frequent feedback	Perform job function and high level feedback	Fully perform job function
Change control requirements	None or limited	Organizational standards	Organisational standards
Time to Value	Short	Medium-long	Long
Production Readiness	Low	High	Very high

Source- https://www.citrix.com/blogs/2013/01/25/poc-vs-pilot-vs-production/

The salient constituents for conducting a PoC are:

a) Defining the criteria for success— this definition should be derived from the possible end users and decision-makers and these criteria should be explicit;
b) What follows next to determine the success or failure of the PoC is the evaluation of the solution that has been engineered against the defined success criteria;
c) The decision to proceed beyond the PoC stage to a full undertaking to engage in the project or to not proceed as "proof" was not achieved, the results may be unanimously for or against the defined criteria or partially in favour of it. The decision to not proceed is also a binding measure of the success of a PoC and proves that the undertaking is not feasible. An unsuccessful PoC is one where the success criteria were inappropriate or the test cases were lacking in detail and therefore gave inconclusive outcomes in relation to the defined success criteria. During the course of creating the proposed solution in a PoC the focus is on quick results, tinkering, and calibration rather than thoughtful and methodological configurations; for this reason, changes and iterations are not tracked, but, rather, only the net or final result is necessary to publicize.

What follows are the steps involved in proofing concept in this research:

1. Introduction of the proposed undertaking

   The purpose of this research is to derive a credit risk analysis formula and prove its practicability. It is meant for the non-bank funding of high-density affordable rental housing developments (long-term mortgage secured lending). The area under study is the metropolitan cities of Johannesburg, Ekurhuleni and Tshwane in Gauteng province. These metropolitan cities are contiguous. The formula is intended for use by financiers who subscribe to an impact investment philosophy with the aim to generate triple-bottom line returns for the investments they undertake.

   This formula forms only the foundation of credit risk analysis for this particular type of secured lending. The property risk related components of the formula are designed to be used in conjunction with a four-layer GIS. Although slightly dated (the available Bid-rent

Model data was released in 2011), survey data is used to create new area quality indices to rank endogenous property-related risks. The respective municipal wards, where each simulated sample transaction, falls within becomes the unit of measure.

The formula is to be driven by the:

a) strength and reliability of cash flow from tenants/occupants of the completed affordable housing renal scheme,
b) financial standing of actual approved loan obligors; and
c) salient transaction details such as appraised property value, capitalization rates applied to value, equity provided by loan obligor, nature and value collateral, or loan. It will also be portfolio invariant[31].

The PoC undertaken utilised simulated data for sample loan transactions that was first adjudicated and ranked by credit experts in the Gauteng residential development financing sector. The baseline formula's explanatory variables will be calibrated.

Expert ranking is a credible measure of credit risk assessment when data are either not available or poorly constructed and/or curated. They are favoured because they are fundamentally premised on trade-offs between both signaling (signals) and noise (error term). Subject-matter experts in a field are deemed to be the least influenced by noise and therefore best able to adjudge the trade-off based on signals. These signals become indicators that take primacy in how experts assign risk and therefore rank multiple proposed transactions.

This proposed method makes several assumptions regarding the level of proficiency and knowledge concerning affordable housing development finance and credit risk analysis. A financing agency may possess adequate systems for deal making, loan implementation and loan/client maintenance. Assumptions, *inter-alia*, are that the financiers have:

[31] the risk level for any given loan is to depend only on the risk of that loan and not also on the portfolio to which that loan is added. This is how Basel !! recommends that counterparty risk be measured and such method is referred to as ratings-based risk analysis.

a) created awareness among operational staff as to the importance of records management and curating;
b) encouraged consistent record keeping behaviour among staff and procured Enterprise Resource Management systems with requisite flexibility for effective record keeping; and
c) an understanding of affordable housing development finance (purpose, components, and functionality).

2. Planning the Successful Proof of Concept Study

A study was conducted to affirm that an equation is able to be developed to simulate expert-level decision making around credit risk assessment for decision making for funding high density affordable housing projects.

a) The purpose

The prototype credit risk assessment is an expert-driven model for calculating the likelihood of counterparty default for a single secured senior debt loan used to finance a new high-density affordable housing rental apartment scheme. The goal is to develop a multi-factor equation with a high correlation to a ranking question analysis completed by expert credit risk professionals in the field of residential property development finance.

The objectives of the proof of concept were:

(i) To adapt excerpts of the non-proprietary 2013 Quality of Life Survey (conducted by the GCRO) and use them as the risk drivers in an impact investment risk assessment tool for affordable housing development finance.
(ii) To calculate and assign a percentage of loan default probability on each sample transaction using a probability of default interpolation formula from Basel II's Internal Ratings Based System (see Appendix A for Basel II IBR summary).

(iii) To correspondingly rank a batch of 10 simulated building loan transactions of the property type- namely a 150-unit apartment block for the rental market, the block is assumed to be built in a single phase.

(iv) The ranking will be done using the loan default probability as the unit of analysis.

b) Establishing Success Criteria

The Bank for International Settlements asserts that correlation of 0.5 or more indicates that a model performs without discriminative power and therefore has an appropriate level of explanatory ability. A correlation of 1 indicates the model performs perfectly. Correlation is sufficient in a model when lies "between 0.5 and 1.0 for any reasonable rating model in practice"(Basel Committee on Banking Supervision 2005, p38)

c) Outlining the Benefits of the Prototype

The formula's ability to align to the expert ranking will outline its ability to accurately ascribe the extent of credit risk inherent in financing an affordable housing scheme.

The use of GIS and current data collected to indicate the quality of life in the contiguous study area means the variables driving the quality of the environment a new housing scheme is located in will become tractable and evidence-based. The GIS metadata is obtained from the GCRO's 2013 Quality of Life survey and the Gauteng Provincial Department of Economic Development's Gauteng Spatial Development Framework policy document. The GIS is a critical part of measuring the property-related risk of a proposed loan transaction.

The goal of the research is that the formula leads to a more precise understanding of counterparty credit risk which, in turn, will lead to a higher number of high quality deals being approved for funding in an unbiased manner. The formula is also expected to convey a more transparent manner in which concessionary loans are granted and how financing costs can be reduced to make high quality deals. The quality of a deal, as is the norm, is adjudicated by (i) the financial standing and experience of the counterparty [the borrower], (ii) the expected quality and specification of the

completed housing project; and (iii) the location of the proposed project vis-à-vis the appeal it will garner from the rental market. This appeal is expected not only to keep vacancy (loss of potential cash flow for servicing loan) down, but be an indicator of the social and environmental benefit of the project and how it is captured by its target market.

Moody's Investor Services, whose definitions will be used as the benchmark for assigning counterparty risk, offers the following broad definitions for the rank of credit risk bands which may be assign to a particular transaction or counterparty.

d) Defining the Scope

The scope of the research is to ascribe a specific level of credit risk to a proposal to undertake loan funding for an affordable housing rental project. Through inductive reasoning a formula for loan default probability estimating will be created and calibrated for accuracy using results from an expert ranking survey.

The following aspects of the study will be conducted and explained in sections 4.2 and 4.3 of chapter 4, respectively. Aspects:

e) Conducting the Pilot; and
f) Evaluating the Pilot.

Concluding with aspects which will be conducted and explained in chapter 5, namely:

g) Key Outcomes;
h) Lessons learned; and
i) Summary.

3.6 Model Specification

The research will begin by proposing a scoring model The model is to be stochastic in nature with the following definition being provided on the broader field that stochastic model exist in: "A statistical model is a probability distribution constructed to enable inferences to be drawn or decisions made from data. This idea is the basis of most tools in the statistical workshop" (Dwivedi et al. 2010).

The scoring model created using Microsoft Excel® for the three credit risk fundamentals of any investment property transaction; these credit risks are quantitative and qualitative and are regarded as best practice by risk managers in South African property financiers— the so-called *big 5* commercial banks. [32] These are:

a) Property risk (specification of the proposed property development).
b) Cash flow (the reliability & of projected cash flow that will service the loan).
c) Borrower/Obligor risk (the specific counterparty risk)

A formula of the credit scoring equation is provided in generic form:

$$PDR = f_i(\beta_A X_{A_i} + \beta_{\boldsymbol{B}} X_{B_i} + \beta_C X_{C_i})$$

Where: X_A represents Property risk (calibrated PD calculation score from Basel II)
X_B represents Cash flow risk (calibrated PD calculation score from Basel II)
X_C represents Borrower default probability risk (Altman's Z"-Score©)

These three risks will be individually analyzed and weighted to give a final score for the one-year holistic credit risk rating of the entire proposed affordable housing project.

The PDR is a *point-in-time* transaction risk measure (measuring the stand-alone risk of the probability of counterparty default) for a proposed loan and becomes a random variable (or stochastic variable) on the day of capital disbursement. This is because it is a variable whose value is subject to variations that are due to chance and therefore does not have a single, fixed value (even if unknown). It can take on a set of possible different values, each with an associated probability. This PDR variable is therefore a continuous random variable as it may assume any numerical value in an interval of 0, 01 to 100% projected default probability.

[32] Big 5 Banks- The Standard Bank of South Africa, ABSA Bank (aka Barclays Africa), First National Bank, Nedbank and Investec Bank.

i. *Property risk* ratio- Cross-referencing the GIS data, where risk drivers are determined by the GCRO's and Gauteng Provincial Government's Indexed maps, for the particular location of the proposed development site;
ii. *cash flow* risk ratio- the ICR and developer experience of each simulate sample transaction; and
iii. *borrower-level risk*- adjudged from summary of financial standings of each proposed developer (Group/Firm-level financials) which have been processed to determine their respective Altman's Z''-score.

The Impact Investment principles and gains expanded upon in the literature review (Chapter 2) will be incorporated into the "property risk" section. This section has a large weight in the total score for transaction to be financed. A summary of Moody's ratings categories is provided as Annexure G with the salient information provided below.

Moody's ratings translated to probability of default ratings:

Table 2- Moody's credit rating notches(summarized)

Investment grade		High Yield- speculative grade			Highly speculative			Substantial Risk		
Rating	**Baa3**	**Ba1**	**Ba2**	**Ba3**	**B1**	**B2**	**B3**	**Caa**	**Ca**	**C**
PD	0.42%	0.71%	1.21%	2.12%	3.76%	6.82%	12.61%	12.62% to 23.8%		

Source- Moody's Investor Services (2001)

The probability of default (PD) percentages from the above table will be adopted as the upper and lower bund estimates for the calibration in this research. The calibration itself (see Annexure I) is done with a lower-bound limit of one notch above the PD commensurate with the sovereign rating of South Africa, this being Baa3 and therefore 0.042% PD. The upper-bound limit is the PD commensurate with the last and therefore worst possible Moody's rating band; being a C rating and therefore a PD of 23.8% which is asymptotically zero.

The calibration equation used in the property and the cash flow risks are explained below in *i* and ii, while the Altman's Z"-Score will not be calibrated— it's taken *as-is* and explained in point iii.

i. The score for the property risk will be attained my means of a multivariate weighted average formula; each variable is either a quantitative or qualitative endogenous factor that adds or removes property-related risk. Each variable will be grouped into quintiles and receive a score assigned from a scoring rubric. The maximum value for the score shall be +10 and the minimum value shall be -10 with a rating scale of *Superior* through to *Poor* and a weighting attached to each factor.

Table 3- Rating Scale and scoring values offered by the research

Band	Superior	Good	Average	Below Average	Poor
Score	5	4	3	2	1
Value (translation of score into formula)	10	5	0	-5	-10

The variables that drive the property risk factor are driven by data obtained from publicly-owned GIS metadata.

$$Property\ risk_i = f(\beta_1 X_{1_i} + \beta_2 X_{2_i} + \beta_3 X_{3_i} + \beta_4 X_{4_i} + \beta_5 X_{5_i})$$

Where:

X_{1i} is Loan-to-value (LTV) representing the gearing ratio;

X_{2i} is Bid-rent Index (demarcated by municipal ward);

X_{3i} is Suburb Quality (demarcated by municipal ward);

X_{4i} is Quality of Service Delivery (demarcated by municipal ward); and

X_{5i} is Condition of improvements to the land.

The scores of the independent endogenous factors, except X_1 as (LTV), will be obtained from ward-level sample data collected in any of the three aforementioned GIS database (i.e., the Bid-rent Model and the 2013 QoL Survey).

ii. The score for cash flow risk will be measured with respect to the *interest cover ratio* ("ICR") and development management experience (measured in years) for the sustainability of the cash flows.

The ICR takes into account the ratio of normalised annual net cash flow (obtained from the valuation report) and cumulative annual interest at a benchmark interest rate of 50 basis points above the prime-lending rate (obtained from an amortization schedule).

Table 4- ICR rating scale and intervals

Rating	Superior	Good	Average	Below Average	Poor
Band	1.95 <x	1.8 <x≤ 1.95	1.65 <x≤ 1.8	1.5 <x≤ 1.65	1<x≤1.5
Score	5	4	3	2	1
Value of Score	10	5	0	-5	-10

The developer's experience will be scored as follows:

Table 5- Developer's experience rating scale and intervals

Rating	Superior	Good	Acceptable	Unproven	Poor
Band (years)	10 ≤ x	6 < x ≤ 9	4 < x ≤ 6	2< x ≤ 4	2 ≤ x
Score	5	4	3	2	1
Value of Score	10	5	0	-5	-10

Note: The total score achieved for cash flow risk will be the arithmetic mean of the two scores which will fall into a range of between -10 (minimum) and +10(maximum).

iii. Analysis of Borrower risk being analyzed using Altman's 2002 revised Z"-Score model for non-manufacturing and emerging market companies [33] . The formula uses multivariate discriminant analysis with through-the-cycle data collected over many decades. This is a renowned and globally utilised formula for predicting the probability

[33] Altman's original Z-Score formula was for publically listed manufacturing companies in 1968 in the USA

of business default/ bankruptcy. This research will not use discriminate analysis as is the normal outcome of running the model, where classifications are: "high probability of default" is indicated by a Z"-score below 1.1; a "low probability of default" is indicated by a score above 2.6; and the "gray area" is where the score lies between the aforementioned categories. Instead the score in this research will be standardised to a probability to PDR = (1 – p-value).

The Z"-Score formula, to be used for borrower risk assessment, is expressed as follows:

$$Z = 6.56\left(\frac{working\ capital}{total\ assets}\right) + 3.26\left(\frac{retained\ earnings}{total\ assets}\right) + 6.72\left(\frac{EBIT}{Total\ Assets}\right) + 1.05\left(\frac{Equity\ (book\ value)}{total\ libilities}\right)$$

Source: InvestingAnwers.com (n.d.)

The utilization of this formula gives a rational number- the Z"-score. We substitute a corresponding probability from the Cumulative Normal Distribution Table- because this is a one-tail z-test to the right, the standardized Z"-Score denotes is the likelihood of NOT being bankrupt. The default probability, is therefore 1-*probability value*.

Table 6- Altman's Z"-score and intervals

Rating	Safe	On alert	Moderate risk	High risk
Z"-score	3≤ x	2.7 < x ≤ 2.99	2.7≤ x <1.8	x ≤ 1.8

3.7 Measurement variables

3.7.1 The loan-to-value variable measuring the facet of gearing and solvency

The extent to which a lender can possibly recover at-risk funds when a built property or upcoming development begins to deteriorate is largely driven by the price with which a new would-be buyer (who would be buying the distressed property) would pay for that property. The higher the initial gearing— the market value over the loan amount— the higher the likelihood that a financier would be unable to recover their full outstanding amount as a distressed property is often bought at a discount.

Table 7- LTV scoring and intervals

Rating	Superior	Good	Average	Below average	Poor

LTV ratio	0.5≤ x	0.5 < x ≤ 0.65	0.65 < x ≤0.7	0.7 x ≤ 0.75	0.75< x
Score	5	4	3	2	1
Value of Score	10	5	0	-5	-10

3.7.2 Bid-rent Index variable measuring the *suburb quality* facet

As part of the 2011 Gauteng Spatial Development Framework, a study was conducted for the Gauteng Provincial Economic Development department to ascribe value to land — whether vacant or built on — was done to assess the suitability of land for various public and private sector interventions. This study was undertaken largely to establish areas of high-value, high-growth potential and to indicate areas where development — for residential, social or commercial purposes — would be unsuitable. Is uses a vast array of factors from physical geography to proximity to social and lifestyle amenities to map desirability and "developability" of a piece of land (See Annexure D). This location aspect, in property financing, is a critical component of the proposed investment as it rewards [and penalizes] a developer based on how well the location of their development will be as well as provide immediate and future developmental benefits tenants will enjoy as a result of staying there.

A proposed property development will be placed on a bid-rent curve whose gradient is unique to the particular area or district where the proposed property development is located. The bid-rent curve effectively represents the urban potential of any given point relative to its position within the current and future urban structure; it is based on urban fundamentals such as accessibility, the level of current infrastructure development, and the nature of any proposed infrastructural investments in that area or district.

Table 8- Bid-rent model scoring and intervals

Rating	Superior	Good	Average	Below average	Poor
Bid-rent index	0.5≤ x	0.45≤ x < 0.5	0.35≤ x <0.45	0.25≤ x < 0.35	x < 0.25
Score	5	4	3	2	1
Value of Score	10	5	0	-5	-10

3.7.3 The "Quality of roads Index" variable measuring the facet of accessibility

The accessibility has been expressed either as the potential of a given zone to be reached by other agents (passive accessibility) or as the potential to reach the other agents (active accessibility) from a given zone. Most cities in developing countries lack well-planned transit access for low-income communities. Affordable housing located near public mass transit can help low-income residents save money, access better jobs, schools and health facilities and reach critical community services (Brisson & Duerr 2014).

Formulated from the GCRO's 2013 QoL survey, accessibility index was particularly useful for the assessment of the physical state of the existing roads and storm-water systems and the extent to which residents were satisfied with the capacity of the road network in their respective neighbourhoods.

Table 9- Quality of Roads index scoring and intervals

Rating	Superior	Good	Average	Below average	Poor
Qual. of roads	0.6 ≤ x	0.5≤ x < 0.6	0.4 ≤ x <0.5	0.3 ≤ x < 0.4	x < 0.3
Score	5	4	3	2	1
Value of Score	10	5	0	-5	-10

3.7.4 The "Quality of Service Delivery" variable measuring the facet of neighbourhood satisfaction

Being cognisant of the nature of civil disobedience by communities and the discord in local councils that often fuels such disobedience, it is incumbent, from a risk management view, to incorporate such (dis)satisfaction as it may have material effect on tenant demand and even property value. Areas prone to such civil disobedience are characterized by general

underdevelopment or urban decay of social and physical infrastructure; this acts as a deterrent to potential tenants when considering leasing a dwelling in one such neighbourhood over another that may be more placid.

This variable was formulated by the researched from survey results focusing on service delivery (roads, sanitation, environmental management and electricity). All the individual scores were averaged to obtain a quality of service delivery final score.

Table 10- Quality of Service Delivery scoring and intervals

Rating	Superior	Good	Average	Below average	Poor
Qual. of service delivery	0.9≤ x	0.75≤ x < 0.9	0.6≤ x <0.75	0.45≤ x < 0.6	x < 0.45
Score	5	4	3	2	1
Value of Score	10	5	0	-5	-10

3.7.5 The "Condition/ Specification of Improvements" variable measured by the NHBRC and EDGE® Standards and Codes

The building condition of the proposed scheme will be assessed by making a relevant quintile in the rubric. A score of "Good" denotes a brand-new development to be build according to building guidelines as proposed by the NHBRC.

A score of "Superior" shall be applicable to a building that satisfies the NHBRC's guidelines and further demonstrates certification to the GBCSA[34]'s EDGE®[35] Multi-Unit Residential V1[36] Framework.

[34] Green Building Council of South Africa (GBCSA)— a voluntary body advancing resource efficiency in construction and engineering

[35] Excellence in Design for Greater Efficiencies (EDGE) is a GBCSA certification programme, launched in 2015 to empower the residential property market to design and build resource-efficient buildings.

[36] The EDGE certification tool to assesses the environmental attributes of new multi-unit residential developments.

Table 11- Condition of improvements scoring and intervals

Rating	Superior	Good	Average	Below average	Poor
Condition of Improvements	Edge® certified	Newly built to NHBRC specification	Existing property renovated to NHBRC specification	N/A	N/A
Score	5	4	3	2	1
Value of Score	10	5	0	-5	-10

3.8 Model Validation

Correlation between the rankings provided by the panel of credit experts is sought to establish that the formula will be useful in indicating expert-level decision making. If there is no or very weak correlation between the experts, then there is no way to attempt to replicate or approximate that expert thinking because it would mean that all or most of the experts are assessing and prioritizing different risk factors when making decisions on approving or rejecting loan applications.

The "consensus ordinal ranking system" used assumes *m* rankings of *n* objects, the *m* rankings are aggregated and represent what's considered the consensus opinion? The method is used because most general forms of aggregating rankings produce inferior results as they aren't effective in overcoming two certain aggregate rank problems, Emond and Mason (2002) assert that these problem typically permit:

- ties between objects to occur;
- the relative dominance of individual rankings to be reflected, usually in the form of numerical weights.

This method is chosen in this instance as it effectively overcomes the consensus ranking problem. As a scoring method, it's designed to prevent the overall views of the whole panel from being negated or over-ruled by a single judge/adjudicator/panelist who has a widely differing view. It does this by taking *point swings* or distance, in this case *rank points*, out of the equation.

A method called the *Garret Ranking Method* was also contemplated. It was found unsuitable because it uses a *Garret-score* table, which resembles a normal distribution Z-table or T-table (for establishing a p-value), the researcher was unable to find a suitable way to interpolate values that lay between two data points. The intervals for the data points were not as narrow as a Z-table so much of the ranking organised by this method lay between the data points and the accuracy of the rankings become compromised.

Once correlation is established between the expert rankings- using Kendall's Coefficient of Concordance (or Kendall's W), a consensus expert ranking will be derived. This and the results obtained from using the formula over all the simulated transaction will then be analyzed for to establish their Spearman's Correlation (or Spearman's rho) where the minimum acceptable value to prove correlation is 0.5. Therefore, we propose the null hypothesis is "true" if spearman's correlation is equal to 0.5. Alternatively, we will find the null hypothesis "not true" if spearman's correlation is equal to or greater than 0.5.

Lastly, the *Kruskal-Wallis H-test* is used to assess whether or not there is a statistically significant difference in the means of the two sets of non-parametric rank-order data; it's favoured as it was the most appropriate method of validation of non-parametric data as it most closely resembles the one-tailed ANOVA.

3.9 Data Validation

Data validation will be two-fold. The first validation will be that of the sample data received from the ranking order survey. This data is to be obtained from 6 respondents who serve as the pane of experts. The experts will all confidentially do their ranking survey. In order to assess the validity of creating a formula to assess credit risk the way experts do, the research must first establish a level of correlation between the expert judgement; this to ensure that consensus exits within their thinking. If consensus can be established, then the expert data can be aggregated to produce an average expert ranking for the simulated sample deals.
If the correlation is below 0.5, then there is limited or no consensus between the experts and the data would not be sufficiently valid (data validity) to infer consensus.

This second stage of validation is useful to establish "criterion validity". This type of validity can look at how the observed values determined by the model tie up with measurable and validated values of the expert rankings. As a statistical exercise, criterion validation has to be done through sensible analyses of good-quality data- hence the first stage of validation (Wilson & Stern 2001).

To create an element of replicability in any risk assessment it is important to have the same, or very similar, criteria being evaluated. How we weigh those criteria against our final decision can either be the same- indicating an objective measure, or different- indicating a subjective measure.

In the case of credit risk in real estate finance, one might say that if a prospective borrower wants debt funding to erect a certain type of building in an area, and the financier doesn't wish to have exposure in such area/node, then it is a *non-starter*. When no appetite exists, there can be no deal on the table, no matter the financial standing or level of experience. In such a situation, this would be a *subjective* matter as it completely disregards any other possible merits of the prospective transaction. Should the same client take the very same deal to another financier who also disapproves of the area, but is willing to weigh the risk associated with that area uses an objective measure. The variables used in this research aim to remove the subjectivity and bias attributed with even expert thinking and provide a factual analysis of an area vis-à-vis its suitability for high-density residential development.

The data is qualitative and quantitative in nature. Below are all the variables driving the calculation of the PDR.

<u>Property developer's Experience:</u>

The property developer's experience is a measure of the reliance of the projected net cash flow to service the loan. It is therefore a measure of how sustainable the anticipated cash flows from the property are and an indication of whether the developer can build a project of good specifications so as to keep tenant demand and occupancy high and contain

maintenance costs, which would erode net cash flow. Experienced developers have rental management systems for arrear management, marketing experience and networks to guarantee optimal occupancy and tenant replacement. Without these systems, the potential to collect the projected rental income is placed in jeopardy.

Borrower risk (default probability)

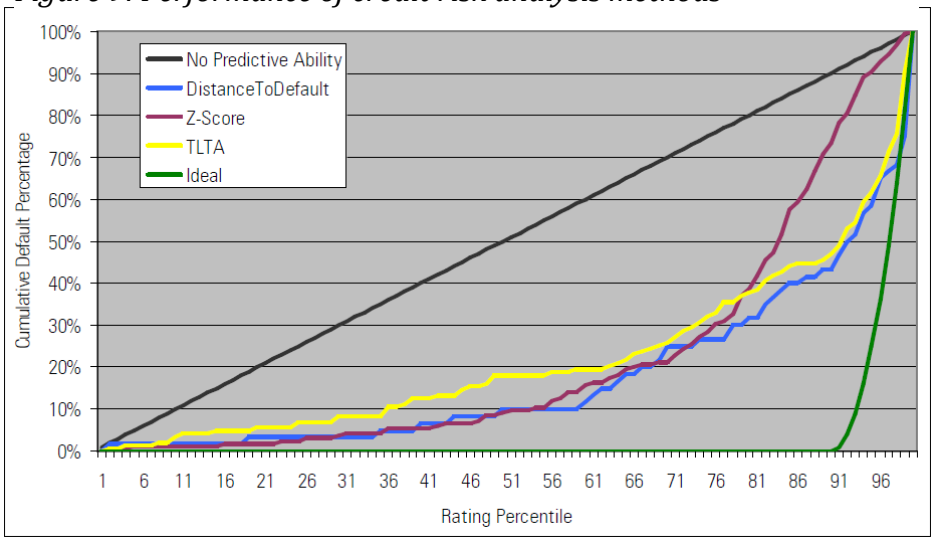
Since its first publication this formula has been the subject of perennial scrutiny, but it has empirically proven itself to be a capable tool as the data it is founded upon is extensive. In 2009, the third edition was unveiled, named the Z"-Score model and tailored for non-manufacturing, emerging markets and private firms. This Z"-Score model has not yet gained traction in the finance industry both in the USA and globally. Literature is scarce and for this reason it will not be used.

Morningstar Inc.[37], undertook a study in 2009 to gauge the effectiveness of Altman's models in comparison to a competing methodology for default probability, namely Merton's Option-Pricing Model (1973). Merton's model is used to calculate a so-called "Distance to Default" and the ubiquitous, yet very rudimentary *Total Liabilities : Total Assets* ratio used only for companies deemed to have very low likelihood of default such as blue chips.

The results were as follows: While the Distance to Default of the Merton's Model has a higher accuracy ratio, some difficulties exist in utilizing it, especially for small firms, difficulties that the Z-Score doesn't have. The first difficulty is that Merton's model assumes that all the firm's assets are dispatch-able to settle outstanding debt, which in reality we know it not to be the case. The second is that Merton's model also needs an accurate value for the standard deviation which is ascribed to a firm. This is only really possible with a business listed on an exchange, so private companies are precluded. The Z"-Score methodology performs almost as well as Distance to Default up until the 75th percentile and then begins to weaken. An Accuracy Ratio (correlation) of 0.6 however, is respectable and largely regarded as a functional fit as it surpasses the least acceptable correlation for functionality which is 0.5.

[37] A global leader in independent financial and investment research and advisory services (Headquartered in Chicago, IL, with offices worldwide including one in South Africa)

Figure 9: Performance of credit risk analysis methods



	Accuracy Ratio
Ideal	1.00
Distance to Default	0.70
TL/TA	0.60
Z-Score	0.60
No Predict	0.00

Source- Miller (2009)

3.10 Study Assumptions

1) The end user (consumer) is rational and seeks to maximize their utility, within their respective budget constraint, by exercising their preference as to where they live in relation to where they work, shop, school, etc. The area they choose is deemed to be the one that maximizes their utility (i.e., the location utility), decision processes is therefore based on Random Utility Maximization ("RUM") (Coppola & Nuzzolo 2011, p. 64). Consistent with the RUM principles we assume the utility is a random variable consisting of two terms: the systematic utility and the random residuals. This is in respect to:
    a) the cost of accommodation (land rent);
    b) seeking to minimize travel distance to and from work (addressing private and public transportation needs);
    c) seeking to minimize the distance to and from everyday amenities; and
    d) if they have dependents, seeking to minimize their proximity to schooling.

2) The model itself is developed under the following key assumptions:

    a) That land is homogenous and therefore its price is determined by the value of highest and best use and its proximity to economically vibrant nodes with strong demand for job seekers;
    b) The number of end users (consumers of affordable housing) is discrete;
    c) That competition for land acquisition is perfect - that the buyer and seller reach a Pareto-optimal selling price;
    d) That the secured loan to finance the development will be denominated in ZAR ("R") and that the necessary forex hedging is in place, undertaken as a zero-sum game between counterparties and maintained throughout finance term;
    e) That building costs, relative to design and specification/finishes, is the same throughout Johannesburg;
    f) That the developer will retain all the improved property for the duration of the finance term (until senior debt fully amortizes);
    g) That the developer will keep rental within the Department of Human Settlements' definition of Affordable Housing; and
    h) The developer and financier(s) are explicitly engaged in the affordable housing market and are operating for the pursuit of a *triple bottom line.*

3.11 Study Limitations

Studies focusing on the modeling of the economic process associated with land use change are temporal. As such, they are considered subjective, from the point where the researcher begins to collect data. From this vantage point, it is argued that these models are primarily "ad hoc," developed without an economic theoretical framework, and therefore are susceptible to certain conceptual and estimation problems (Irwin & Geoghegan 2001, p. 7).

The practical use of this formula should eliminate bias in credit risk assessment that emanates from 'decisions by committee' or 'group think'. It offers a replicable method of unbiased analysis. Its limitation is that it is validated by means of rank order correlation and therefore governed by the extent to which signaling plays a role in each expert's ranking;

with *signaling* the expert decides on the basis of his/her own signal only. The rankings are confidential and the research has not gone on to investigate whether the expert would have

Table 12: Modeling Pitfalls

Seven sins	Fundamental changes required
Too much extrapolation of past trends	Less extrapolation, more fundamental change
Too much belief in stable equilibrium	Less equilibrium, more dynamics
Too much reliance on observed behaviour	Less observed behaviour, more theory
Too much attention to preferences	Less preferences, more constraints
Too much effort on calibration	Less calibration, more plausibility analysis
Too much effort spent on detail	Less detail, more basic essentials
Too much focus on incremental solutions	Less forecasting, more back casting

Source: Adapted from Wegener (2012:7-8)

read the signaling any differently if they had seen the anonymous rankings of other experts? Would they rationally choose to discard it and possibly stick to the wrong ranking? Does ranking done in isolation carry more weight than consultative ranking where the signaling seen by others plays a role in better decision-making (Duranton & Puga 2004, p. 2104)? Below are common pitfalls of modeling, and their generic solutions, the model sought by the research may is designed along the principles espoused in the solutions:

CHAPTER 4: DATA ANALYSIS AND RESEARCH FINDINGS

4.1 Introduction

This chapter discusses and presents the result of the study. The results are provided to satisfy whether the concept has indeed been proven; it provides the basis on which conclusion(s) and recommendations will be formulated. Section 4.2 explains the level of correlation that existed between the rankings given by the experts; this correlation was important to signify whether there was a *meeting of the minds* in terms of expert thinking in order to begin to seek a way of modeling that thinking. Section 4.3 would be the establishing or calibrating the weightings for the variables that would give rise to the null hypothesis of the research being rejected or failed to be rejected.

4.2 Conducting the Pilot

Having set out the variables and the related parameters and intervals, the small-scale piloting of the model was undertaken to assess its functionality. Such functionality would be determined by the model's ability to discern varying outcomes or results for a variety simulated transactions with varying risk drivers. Here the model was to discern just how much risk lay in funding each simulated housing project based on its individual attributes as risk factors. These individual attributes ranged from the financial standing of the obligor, the amount of loan funding that was needed in relation to the projected market value of each particular development, the projected net cash flow, which would pay back the loan to the risks associated with each neighbourhood that the housing project would be located within.

4.2.1 Exploratory Data Analysis

Since affordable housing finance is a voluntary commitment to the Financial Sector Charter[38], all banks that undertake to engage in it do so to primarily fulfil the objective of the Charter's

[38] The Codes of the Financial Sector Charter (the Charter) commits all participants to actively promote a transformed, vibrant and globally competitive financial sector that reflects the demographics of South Africa, and which contributes to the establishment of an equitable society by providing accessible financial services to black people and by directing investment into targeted sectors of the economy.
The Charter came into effect in January 2004 as a result of agreements reached at the National Economic Development and Labour Council (NEDLAC) Financial Sector Summit in August 2002. NEDLAC is the

codes, which are in alignment with the principle of socially responsible investing. As such all commercial banks therefore fulfil the broad definition of 'impact investors' insofar as it pertains to affordable housing development finance.

Findings from Non-Parametric Data Analysis

A decision was taken to have the ranking exercise undertaken in separate interviews with the experts to make the rankings confidential; this would ensure that there was no coerced or "manufactured" consensus— what one would find if rankings were done using the Delphi Technique, for example. The data collected from the expert panel rankings was assessed for correlation or the extent to which the experts agreed in their rankings, this was done using Kendall's Coefficient of Concordance [or *Kendall's W,* as its commonly known] (see Annexure A) which, as the name suggests, assesses the extent to which multiple judges or participants agree with each other's respective responses to the same phenomena. The level or concordance was revealed to be ≈68,6% indicating a strong measure of agreement.

Table 13: Kendall's Coefficient of Concordance

Kendall's W	
W	0,685522
r	0,622626
chi-square	37,01818
df	9
p-value	2,61E-05

The *Consensus Ordinal Ranking System* was used to formulate panel-wide expert ranking. The consensus ordinal ranking method (see Annexure B) established consensus ranking, among all the experts, for the 10 simulated sample transactions. The following simulated deals are arranged from most favourable to least favourable. Below are the results.

Table 14: Results of consensus ordinal ranking

Sample transaction	Deal 3	Deal 6	Deal 10	Deal 7	Deal 8	Deal 1	Deal 2	Deal 4	Deal 9	Deal 5
Consensus rank	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th

multilateral forum which brings together Government, Business, Labour and Community constituencies to approve social, economic and labour market policy. http://www.fscharter.co.za/page.php?p_id=137

4.2.2 Model Calibration and Results

Solving for a ρ>0.5 and therefore rejecting the null hypothesis of ρ=0.5 required an iterative process experiment to obtain an optimal correlation, where the weighting of the three risks and the weighting of the variables which drove the risks were modified until the Spearman's rho of the ranked results of the model and the ranked results of the aggregated expert panel surpassed the acceptable level, which was set at a value of 0.5.

Apart from the Altman Z"-Score variable (which has four intervals), five intervals for the scoring of credit risk were chosen ranging from "poor" to "superior" and were separately depicted in section 3.5 and 3.6. Below is the consolidated table:

Table 15-Property risk matric (all) with intervals

Rating	Superior	Good	Average	Below average	Poor
LTV ratio	0.5≤ x	0.5 < x ≤ 0.65	0.65 < x ≤0.7	0.7< x ≤ 0.75	0.75< x
Bid-rent index	0.5≤ x	0.45≤ x < 0.5	0.35≤ x <0.45	0.25≤ x < 0.35	x < 0.25
Qual. of service delivery index	0.9≤ x	0.75≤ x < 0.9	0.6≤ x <0.75	0.45≤ x < 0.6	x < 0.45
Qual. of roads index	0.6 ≤ x	0.5≤ x < 0.6	0.4 ≤ x <0.5	0.3 ≤ x < 0.4	x < 0.3
Condition of Improvements	Edge® certified	Newly built to NHBRC specification	Existing property renovated to NHBRC specification	N/A	N/A
Interest cover ratio	1.95 <x	1.8 <x≤ 1.95	1.65 <x≤ 1.8	1.5 <x≤ 1.65	1<x≤1.5
Developer's experience(years)	10 ≤ x	6 < x ≤ 9	4 < x ≤ 6	2< x ≤ 4	2 ≤ x

It was decided to leave Altman Z"-Score variable with four intervals as internally defined in the research paper that promulgated it. The intervals as originally classified are specific and would have been diminished if they were translated to the above 5 classifications [see Table 6].

4.2.3 Interpolation of Basel II "PD Calibration" formula

Simultaneous equation substitution yields $a = 5.468462 - 10b$ for solving the PD calibration equation $\frac{1}{1+e^{(a+b*score)}}$. The result for a and b between the parameters 0.0042_{min} and 0.2380_{max} are: a= 3.316069; and b= 0.2152393

Weighting of the variables for analysing property risk and cash flow risks found to positively influence the Spearman's rho when set at these levels:

The prototype formula is expressed in the form:

$$(PDR) = f_i\ (\beta_A X_{A_i} + \beta_B X_{B_i} + \beta_C X_{C_i})$$

Where:

$X_{Ai} = PDR_{(property\ risk)} = \frac{1}{1+e^{(a+b*score)}}$

$X_{Bi} = PDR_{(cash\ flow\ risk)} = \frac{1}{1+e^{(a+b*score)}}$

$X_{Ci} = PDR_{(borrower\ risk)}: f(P) = 1 - Z"Score$

4.2.4 Calibration of property risk factor's variables X_{Ai}

score= ⅕ LTV score; (-10;10) + ⅕ Quality of Roads score; (-10;10) +⅕ Quality of Service Delivery; (-10;10) +⅕ Bid-rent score; (-10;10) +⅕ Condition of improvements score; (-10;10)

4.2.5 Calibration of cash flow risk factor's variables X_{Bi}

score= ⅔ developer's experience score; (-10;10) + ⅓ ICR score; (-10;10)

4.2.6 Calibration of Borrower Risk factor's variable X_{Ci}

No changes were made on the weighting of Altman's Z"-Scores variables. They formula is taken as-is.

$$Z" = 6.56\left(\frac{working\ capital}{total\ assets}\right) + 3.26\left(\frac{retained\ earnings}{total\ assets}\right) + 6.72\left(\frac{EBIT}{Total\ Assets}\right) + 1.05\left(\frac{Equity\ (book\ value)}{total\ libilities}\right)$$

4.2.7 Final calibration of PDR

The following weightings were discovered to provide the acceptable level of correlation, where Spearman's rho was measured to be ρ= 0.5515.

$$(PDR) = f_i(0.3_A X_{A_i} + 0.4_B X_{B_i} + 0.3_C X_{C_i})$$

After experimentation was conducted with respect to the weighting of the risk factors; it was discovered that the weighting proposed in the above formula was optimal in achieving the highest possible Spearman Correlation at 0.5394. Although this proposed weighting is not evenly spread among the factors, its greater reliance on the "cash flow risk" factor, being $X_{Bi,}$ is acceptable as the highest reliance in any specialised lending (or investment financing) should be the target asset's ability to repay the loan. In a property finance and project finance environment this ability to repay the loan would be reflected by the net cash proceeds generated from the asset

The other factors, with weightings of 0.33 each, are critical in establishing the anticipated correlation to the aggregated expert panel rankings with the "property risk" factor's input. In securing that correlation being the answer to research question number 2 and achieving research objective number 2.

4.3 Evaluating the Pilot

The contents of the research methodology were synthesized into a functional MS Excel® spreadsheet for calculating the default probability and therefore the counter-party credit risk of any real world affordable housing finance proposal. A sample of 10 simulated transactions was generated to assess the validity of the model insofar as its ability to rate credit risk similarly to industry experts. The results are provided below.

4.3.1 Findings

This section reports findings on the experimental research as well hypothetical worse-case and best-case scenarios. The latter two scenarios are intended to attest to the accuracy and give context to the PDRs' from experimental research. Table 15 below shows findings from the experimental research. The results indicate the PDRs as calculated by the model.

Experimentation was done with the factor and variable weightings to give acceptable correlation with the known expert rankings. The findings indicate how the final PDR is calculated with the scoring of each variable seen on each simulated transaction (Annexure F)

The PDR is equated to the Moody's rating notch associated with the Basel II PD. It is done this way to bring a level of understanding with regards to the inherent credit risk associated with the financing of such deal. Without further studies conducted (as suggested in the text below) it is meant to give rise to deal pricing negotiations- where interest rates and initiation fees can be set, this would be done by comparative negotiations where transactions with the same credit risk rating would be used as the basis or benchmark for pricing new deals. International financiers or those domestic ones who attract international funds would find this useful as be credit risk would be directly translated to a "language" they are *au fait* with.

The validation of the risk ratings, or PDR, comes by way of the Spearman correlation with the expert panel results. Validation of whether the model can perform in such a way that the means of the two newly correlated data sets is done by the Kruskal-Wallis H-test- if there is no statistically significant difference in the means then the model is seen as one that performs, at a given alpha (α), the same way as an aggregated expert panel would and is therefore functional and its findings are statistically valid.

Table 16- Risk rating outcomes per functional scoring model

	Simulated sample tranaction name	Deal 1	Deal 2	Deal 3	Deal 4	Deal 5	Deal 6	Deal 7	Deal 8	Deal 9	Deal 10
transaction particulars	Total development cost	R 64 740 000	R 64 140 000	R 66 000 000	R 66 270 000	R 65 310 000	R 61 534 000	R 65 025 000	R 65 595 000	R 66 675 000	R 66 180 000
	Borrowers equity (28% of cost)	R 18 127 200	R 16 035 000	R 16 500 000	R 23 194 500	R 14 368 200	R 18 460 200	R 16 256 250	R 14 430 900	R 16 668 750	R 13 236 000
	Secured senior loan	R 46 612 800	R 48 105 000	R 49 500 000	R 43 075 500	R 50 941 800	R 43 073 800	R 48 768 750	R 51 164 100	R 50 006 250	R 52 944 000
	Net income yield	6,7%	6,2%	7,4%	7,2%	6,2%	6,8%	7,5%	7,2%	6,5%	8,5%
	Capitalisation rate	11%	11,25%	10,50%	10,75%	11,25%	10,75%	10,25%	10,50%	10,50%	9,75%
	LTV with property cap rate of	61,2%	64,8%	61,7%	55,0%	68,7%	55,2%	58,9%	63,6%	61,9%	60,8%
	Interest cover ratio	1,78	1,69	1,66	1,91	1,56	1,90	1,70	1,57	1,66	1,56
	Developer's direct experience	8years	4years	12years	5years	2years	8years	8years	5years	3years	11years
Financial Standing (at Group level)	Firm's L-T assets	R 90 250 000	R 57 050 000	R 98 770 000	R 138 910 000	R 54 110 000	R 84 730 000	R 97 600 000	R 77 050 000	R 60 030 000	R 100 630 000
	Firm's S-T assets	R 8 150 000	R 5 590 000	R 10 070 000	R 19 940 000	R 8 340 000	R 11 720 000	R 10 850 000	R 11 400 000	R 6 580 000	R 26 120 000
	Total assets	**R 98 400 000**	**R 62 640 000**	**R 108 840 000**	**R 158 850 000**	**R 62 450 000**	**R 96 450 000**	**R 108 450 000**	**R 88 450 000**	**R 66 610 000**	**R 126 750 000**
	Firm's L-T liabilities	R 52 800 000	R 31 680 000	R 69 400 000	R 107 400 000	R 36 400 000	R 65 000 000	R 55 450 000	R 65 000 000	R 35 000 000	R 63 400 000
	Firm's S-T liabilities	R 3 830 000	R 1 398 000	R 5 160 000	R 10 050 000	R 3 035 000	R 7 535 000	R 5 535 000	R 7 535 000	R 3 335 000	R 7 535 000
	Total liabilities	**R 56 630 000**	**R 33 078 000**	**R 74 560 000**	**R 117 450 000**	**R 39 435 000**	**R 72 535 000**	**R 60 985 000**	**R 72 535 000**	**R 38 335 000**	**R 70 935 000**
	Equity (retained inome + issued capital)	**R 41 770 000**	**R 29 562 000**	**R 34 280 000**	**R 41 400 000**	**R 23 015 000**	**R 23 915 000**	**R 47 465 000**	**R 15 915 000**	**R 28 275 000**	**R 55 815 000**
	Firm's Annual Revenue	**R 12 350 000**	**R 7 410 000**	**R 17 850 000**	**R 19 350 000**	**R 6 990 000**	**R 7 590 000**	**R 7 590 000**	**R 7 590 000**	**R 6 590 000**	**R 19 590 000**
	Firm's EBIT	**R 4 640 000**	**R 2 784 000**	**R 7 760 000**	**R 9 890 000**	**R 1 890 000**	**R 7 060 000**	**R 7 060 000**	**R 7 060 000**	**R 2 760 000**	**R 10 060 000**
Property risk	Variable 1 (LTV) (rounded to next whole numb	2	2	2	4	1	4	3	2	2	2
	Value of score	-5	-5	-5	5	-10	5	0	-5	-5	-5
	Variable 2 (Quality of Roads)	3	3	3	3	5	4	2	3	4	3
	Value of score	0	0	0	0	10	5	-5	0	5	0
	metric 3 (Quality of Service delivery)	3	3	3	3	5	3	2	3	4	3
	Value of score	0	0	0	0	10	0	-5	0	5	0
	Variable 4 (Bid-rent value)	3	4	4	4	5	4	3	4	3	4
	Value of score	0	5	5	5	10	5	0	5	0	5
	Variable 6 (Qual. of improvements to land)	4	4	4	4	4	4	4	4	4	4
	Value of score	5	5	5	5	5	5	5	5	5	5
	Aggregate property risk score	0,00	1,00	1,00	3,00	5,00	4,00	-1,00	1,00	2,00	1,00
	$\beta_A X_{A_i}$ (where β_A=0,2)	17,30%	16,72%	16,72%	15,62%	14,58%	15,09%	17,89%	16,72%	16,16%	16,72%
cash flow risk	ICR score	4	3	3	5	3	5	4	2	3	2
	Developer Experience Score	4	3	5	3	2	4	4	3	3	5
		4,00	3,00	4,33	3,67	2,33	4,33	4,00	2,67	3,00	4,00
	$\beta_B X_{B_i}$ (where β_B=0,65)	15,09%	15,62%	14,92%	15,26%	15,98%	14,92%	15,09%	15,80%	15,62%	15,09%
Borrower risk	Altman's Z"-Score (z one-tail)	2,11	2,31	1,82	1,85	1,83	1,85	2,51	1,72	2,16	3,04
	Default probablity	0,98	0,99	0,97	0,97	0,97	0,97	0,99	0,96	0,98	0,999
	Propability of default (1- P-Value) = $\beta_C X_{C_i}$ (where β_C=0,15)	1,74%	1,04%	3,44%	3,22%	3,36%	3,22%	0,60%	4,27%	1,54%	0,12%
	PDR	***0,1353***	***0,1365***	***0,1356***	***0,1353***	***0,1381***	***0,1320***	***0,1348***	***0,1425***	***0,1362***	***0,1317***
	Model rank	4	8	6	5	9	2	3	10	7	1
	Ordinal consensus rank (from expert panel)	6	7	1	8	10	2	4	5	9	3
	Sprearman's correlation (rho= ρ)	***0,55151515***									

Below are results from the two hypothetical scenario, that is, the worse-case and the best-case scenario, respectively. The worse-case scenario is where (i) the property in question as the worst scoring and (ii) cash flow risk is maximum, and (iii) Z"-score for borrower risks is the least favourable. In contrast, the best-case scenario is where (i) the property in question as the best scoring and (ii) cash flow risk is minimum, and (iii) Z"-score for borrower risks is the most favourable.

Worst-case scenario

Table 16 indicates the highest and therefore riskiest possible outcome, the PDR of 32.54% is above the upper-bound limit of Moody's credit rating of C of 23.8%. This is mathematically possible, yet practically improbable as Z-score of 0.01 would represent a default probability of 49.6%, this represents the lowest possible P-value on the normal standard distribution table.

Table 17- Theoretical maximum risk rating calculation

	Simulated sample tranaction name	Deal 1	Deal 2	Deal 3	Deal 4	Deal 5	Deal 6	Deal 7	Deal 8	Deal 9	Deal 10
Property risk	Variable 1 (LTV) (rounded to next whole numl	1	1	1	1	1	1	1	1	1	1
	Value of score	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
	Variable 2 (Quality of Roads)	1	1	1	1	1	1	1	1	1	1
	Value of score	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
	metric 3 (Quality of Service delivery)	1	1	1	1	1	1	1	1	1	1
	Value of score	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
	Variable 4 (Bid-rent value)	1	1	1	1	1	1	1	1	1	1
	Value of score	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
	Variable 6 (Qual. of improvements to land)	1	1	1	1	1	1	1	1	1	1
	Value of score	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
	Aggregate property risk score	-10,00	-10,00	-10,00	-10,00	-10,00	-10,00	-10,00	-10,00	-10,00	-10,00
	$\beta_A X_{A_i}$ (where β_A=0,3)	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%
cash flow risk	ICR score	1	1	1	1	1	1	1	1	1	1
		-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
	Developer Experience Score	1	1	1	1	1	1	1	1	1	1
		-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
		-10,00	-10,00	-10,00	-10,00	-10,00	-10,00	-10,00	-10,00	-10,00	-10,00
	$\beta_B X_{B_i}$ (where β_B=0,4)	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%	23,800%
Borrower risk	Altman's Z"-Score (z one-tail)	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
	Default probablity	0,504	0,504	0,504	0,504	0,504	0,504	0,504	0,504	0,504	0,504
	Propability of default (1- P-Value) = $\beta_C X_{C_i}$ (where β_C=0,3)	49,600%	49,600%	49,600%	49,600%	49,600%	49,600%	49,600%	49,600%	49,600%	49,600%
	Moody's rating comensurate with PDR	***C***	***C***	***C***	***C***	***C***	***C***	***C***	***C***	***C***	***C***
	PDR	***31,540%***	***31,540%***	***31,540%***	***31,540%***	***31,540%***	***31,540%***	***31,540%***	***31,540%***	***31,540%***	***31,540%***
	Model rank	1	1	1	1	1	1	1	1	1	1
	Ordinal consensus rank (from expert panel)	3	6	10	7	8	1	2	4	9	5
	Sprearman's correlation (rho= ρ)	***#DIV/0!***									

Best-case scenario

Table 17 indicates the lowest and therefore least risky outcome, the PDR of 0.324% is below the lower-bound limit of Moody's credit rating of Baa2 (the sovereign rating of South Africa)- which is 0.42%. This is made possible by the mathematically possible, yet practically improbable, default probability of 0.1%- this represents the highest possible Z-value on the normal standard distribution table of 3.09.

Table 18- Theoretical minimum risk rating calculation

	Simulated sample tranaction name	Deal 1	Deal 2	Deal 3	Deal 4	Deal 5	Deal 6	Deal 7	Deal 8	Deal 9	Deal 10
Property risk	Variable 1 (LTV) (rounded to next whole numl	5	5	5	5	5	5	5	5	5	5
	Value of score	10	10	10	10	10	10	10	10	10	10
	Variable 2 (Quality of Roads)	5	5	5	5	5	5	5	5	5	5
	Value of score	10	10	10	10	10	10	10	10	10	10
	metric 3 (Quality of Service delivery)	5	5	5	5	5	5	5	5	5	5
	Value of score	10	10	10	10	10	10	10	10	10	10
	Variable 4 (Bid-rent value)	5	5	5	5	5	5	5	5	5	5
	Value of score	10	10	10	10	10	10	10	10	10	10
	Variable 6 (Qual. of improvements to land)	5	5	5	5	5	5	5	5	5	5
	Value of score	10	10	10	10	10	10	10	10	10	10
	Aggregate property risk score	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
	$\beta_A X_{A_i}$ (where β_A=0,3)	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%
cash flow risk	ICR score	5	5	5	5	5	5	5	5	5	5
		10	10	10	10	10	10	10	10	10	10
	Developer Experience Score	5	5	5	5	5	5	5	5	5	5
		10	10	10	10	10	10	10	10	10	10
		10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
	$\beta_B X_{B_i}$ (where β_B=0,4)	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%	0,420%
Borrower risk	Altman's Z"-Score (z one-tail)	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00	3,09
	Default probablity	0,999	0,999	0,999	0,999	0,999	0,999	0,999	0,999	0,999	0,999
	Propability of default (1- P-Value) = $\beta_C X_{C_i}$ (where β_C=0,3)	0,100%	0,100%	0,100%	0,100%	0,100%	0,100%	0,100%	0,100%	0,100%	0,100%
	Moody's rating comensurate with PDR	***Baa2***	***Baa2***	***Baa2***	***Baa2***	***Baa2***	***Baa2***	***Baa2***	***Baa2***	***Baa2***	***Baa2***
	PDR	***0,324%***	***0,324%***	***0,324%***	***0,324%***	***0,324%***	***0,324%***	***0,324%***	***0,324%***	***0,324%***	***0,324%***
	Model rank	1	1	1	1	1	1	1	1	1	1
	Ordinal consensus rank (from expert panel)	3	6	10	7	8	1	2	4	9	5
	Sprearman's correlation (rho= ρ)	***#DIV/0!***									

Kruskal-Wallis one-way ANOVA on ranks (see Annexure H)

Below is statistical analysis of the difference, or variance, between and among the two sets of correlated data in Table 16, namely the Ordinal consensus rank (as the independent variable) and the rankings generated by the model itself (as the dependent variable). The table below (inclusive of MS Excel® break-down of methodology) was generated using an advanced data analysis "Tool/Resource Pack" which is used as an Add-in for MS Excel®.

Table 19: Kruskal-Wallis H-test

H-stat	14,62857143
H-ties	14,74497916
df	9
p-value (*acting as "H"-critical value*)	0,09818339
alpha	0,05
significance	no

The test revels that there is no statistical significance at, α=0.05, between the two medians, being the two sets of ranked data and therefore no statistically significant evidence is found to disproved the efficacy of the model to mimic an agreeable panel of credit experts. A hypothesis of whether the difference in variability among the two medians/means[39], given the above conditions, would be rejected as variability is statistically insignificant.

4.3.2 Key Outcomes

The results indicated the interplay of risks identified in the market as key drivers of credit risk. The simulated sample transactions indicate the varying levels of risk among the variables regarded by industry experts as being vital to the health of a residential property transaction. These being (i) the strength of the cash flows in a proposed developer and (ii) the experience the developer has in building and operating similar investments speaks to their ability to ensure that the projected cash flow materializes.

[39] Had the distributions from the two data sets been shaped the same then it would have been the statistical significance of two means rather than two medians - the assumption is that had the correlation been much higher than the observed ρ=0,5515 seen in Table 16, then the variability would have been far more similar and the shape of the distributions would have been similar and the result would have been for means rather than medians.

In the time spent by the researcher[40] in financing property developments this cash flow risk has been noted as the cornerstone of adjudication of funding proposals in my experience is that adjudication of funding proposals (thus borrower/developer risk) is regarded as the one risk that is most difficult to guard against or prepare for. The thoughts among venerable financiers is that they also don't have sufficient or entrenched networks in terms of building professionals and (sub)contractors to negotiate competitive rates. Furthermore- inexperienced developers not only have immature operational infrastructure to manage investments, they also lack appropriate collateral as they are still building up their asset bases. This risk has been keenly observed and placed as a high priority even among the expert panel interviewed for this experimental research.

The risks considered manageable are the risks associated with the financial standing of the obligor and the risks associated with the specification of the proposed residential property development- they are manageable insofar as financiers can, on:

a) Property risk- curtail their exposure to such risks be structuring deal in a particular way such as limiting how much they wish to loan against the envisaged value of the development, a type of development (high-rise or low-rise) or the area development is located in (sometimes referred to as geographical concentration risk); and
b) Obligor/borrower risk- decide that a deal be housed in a separate or ring-fenced juristic entity to as to protect it from being collateralised or exposed to other creditors. These risks are regarded as ancillary but are still highly regarded.

4.4 Summary

The model was built along reasonable and market-related risk drivers. The strength of the model using the worst- and best-case scenarios and the concept's evaluation would have been stronger had a wider panel been selected. This wider range panelists would have allowed a more robust interrogation of the correlation that serves to support or fail to

[40] The researcher was a banker in large commercial bank. The bank had the greatest market share in investment real estate finance and the first to create a specialised unit for affordable housing finance. The researcher served in various roles in the deal origination and client management business unit of the bank including one year as a Relationship and Project Oversight Manager for their affordable housing finance unit.

support the hypothesis. This, however, would have served to go beyond proving functionality and rather to scrutinize the performance of the model. This is beyond the scope of a POC and of this research.

The POC has systematically proceeded to prove functionality of the proposed undertaking by beginning to introduce the undertaking, establishing the success criteria, conducting the pilot and lastly evaluating its efficacy in relation to the success criteria. The impact investment credit risk assessment model has, in the view of the researcher:

a. Has met the user's needs
b. Has performed as publicized
c. Has allowed a prospective end user(s) to enjoy enhanced productivity, insofar as assessing the credit risk of high-density affordable housing finance.
d. Has ultimately proved to be a functional and feasible solution.

The model is ready to be empirically tested.

Chapter 5: Conclusion

5.1 Introduction

This chapter presents the conclusions of the study, recommendations of areas for further study as well as possible avenues for further development of the PoC aimed at improving its (best-in-class project screening credit risk management model's) functionality and performance. It achieves the above by summarizing research's findings related to the 5 research questions as well as suggestions on how to further develop the POC towards implementing a full pilot project and realising it as a functional credit risk assessment tool.

5.2 Research conclusions

The living standards and lifestyles of the working class in developing countries brings sharp attention to the ideological and practical debates around what exactly is considered a *living wage*; whether it's

a) meant to create and sustain decent urban communities where workers and their dependents have great access to social and physical amenities, like good healthcare and education, and promote the reasonable expectation of generational economic mobility. A living wage premised on the fact that employers recognise and internalize that the working class is tremendously burdened by a predatory retail credit market, both formal and informal credit and that a seemingly marginal erosion in purchasing power and disposable income can easily become a catastrophe to even a dual-income family.
b) or is a living wage merely one that ensures survival and the opportunity to afford the bare essentials of an urban life, one that, by extension, concretizes a *hand-to-mouth* status quo among the working class. Does this living wage then keep up with nominal inflation or exceed it? What beyond food, basic shelter and public transport, personal consumables and a below-par education for children does it provide?

Where and how people live, especially the working and lower-middle class has been proven over the past decades to be an apex determinant of generational economic mobility. Although South Africa has had a watershed, insofar as the end of statutory subjugation of the

Black, Coloured and Indian population, the proverbial dust settles on our contemporary economic dispensation, the patterns observed worldwide with respect to generational economic mobility will fully penetrate our society and crystalize. Quality affordable housing, where quality is not merely determined by the housing scheme alone, but by a holistic analysis of the immediate surroundings that the housing scheme will be erecting is beneficial to the evolution of urban agglomeration in a new South Africa. It would also be highly beneficial to the analysis of credit risk when financing such developments. This would signal a fundamental altering of the spatial distribution of income and racial demographics, if successful. This and similar interventions would be, to post-apartheid South Africa, what Greenpeace was to whaling and ocean conservation.

The literature offers sound measures for sustaining rapid and inclusive urbanisation and outlines the benefits of accommodating and aligning the working class to the urban mainstream by building quality housing schemes that they can afford. The said housing schemes should have well-maintained amenities and. If this happens, it would imply another watershed in inclusive social cohesion and rainbow nation building. The literature also supports and demonstrates the depth of socially responsible investment in developing counties and the availability of funds globally to fight the ills that plague communities regarded as the base of the pyramid.

Having conducted a thorough analysis, the research has been able to lay the foundations for such a far-reaching intervention. The assumption that a random utility maximizing consumer has a stronger inclination to live in better located and better functioning neighbourhoods and whether that translates to either a higher propensity to pay accommodation costs on time or a higher level of determination to seek such accommodation[41] has shown itself in the market. The level of correlation among the panel of credit experts has indicated a consensus about risk-drivers in financing these affordable residential developments.

[41] Thereby profoundly driving up demand for well-located housing in what is an already burgeoning segment of the market.

The deepening of financial markets is the catalyst in the growth of the mortgage sector. Such mortgage growth must be absorbed, in a significant way, by the working class and lower-middle income in a way that betters their circumstances and promotes economic mobility for themselves and their dependents. South Africa, especially the economic engine that is Gauteng, was intentionally crafted and engineered to ensure indenture and containment of the working class and the poor in order to ensure that minority capital could flourish unabated. Undeniably, it cannot be left to happenstance to undo such engineering. The literature asserts the potential to augment future spatial and income distribution by changing the environments children and young adults are reared so it stands to reason that attracting impact investment capital to build integrated communities can break cycles of poverty and economic indebtedness.

The credit risk modeling tool developed by the research has been found to be an adequate foundation to attract such impact investment capital as it can translate locally understood and verifiable credit risks into a globally acclaimed financial risk metrics.

With a Spearman's rho of 0.5515, the null hypothesis is rejected. This means that the results support research's hypothesis of evident consensus between the experts and the data to sufficiently infer consensus. To this end, the proof of concept is successfully concluded.

5.3 Avenues for further study

- The research's resultant model could be further developed with *through-the-cycle* data towards the pilot stage, where equations can be operationalized and tested in the field against the credit risk assessment of credit/investment-management committees.

- *Bayesian average ranking*: As the next step, when parametric data begins to emerge, a sampling distribution can be derived and variance developed. A posterior mean and standard error once derived. This would be best achieved through a Monte Carlo simulation.
- *Fuzzy Logic*: Adapted for credit risk assessment, Shang & Hossen (2013) explain that adaptation to be traditional economic or financial risk models are based on probability and classical sets. This is where elements are either included in the set or are not (true or false

and/or right or wrong). Using these sets is widely acceptable in assessing market, credit, insurance and trading risk. In contrast, fuzzy logic models are built upon fuzzy sets, where "an element is included with a degree of truth normally ranging from 0 to 1. They are useful for analyzing risks with insufficient knowledge or nebulous data. Fuzzy set theory allows for an object to be categorized in more than one exclusive set with different levels of truth or confidence as it "explicitly considers the cause-and-effect chain among variables" (p.3).

- *Logit regression model: A* full scale logistic or probit model could be derived in future and would need curated credit-risk monitoring data detailing performance of internally approved loans or externally funded (by peers) affordable rental housing development. The validation of the efficacy of such a model could be calculated with a Brier Score.

- *Multivariate loan interest rate (pricing) model: As* loan and borrower data becomes curated, a population will emerge that will form the basis of a Monte Carlo simulation, whereby one can establish a median interest rate across the portfolio of loans. This median lending rate for successfully approved transactions and the total aggregated credit risk (the total PDR) can become the baseline for deal pricing, where any deal with lower overall credit risk can be priced below the median rate and any deal with a higher level of overall credit risk can be priced at a higher interest rate. The extent of movement from the median interest rate can be done by means of interpolation. Basel IRB methodology could also be used for settling interest rates for transactions provided credible data for calculating or assigning Loss Given Default [42] ("LGD") and monitoring of Migration Risk, where senior debt transactions are approved on the basis that their risk-reward payoffs were acceptable, but unfavourable market or endogenous conditions have materially changed the risk profiles of such approved and on-the-books transactions.

[42] The loss-given-default rate for a security is 100% minus the value that is received at default resolution (which may occur at a single point in time or accrue over an interval of time), discounted by the coupon rate back to the date the last debt service payment was made, divided by the principal outstanding at the date of the last debt service payment. (Moody's Investor Services, u.d)

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Annexure A

Each expert is in a credit risk management role at a South African commercial bank that have extensive exposure to affordable housing development finance. The initials of the respondent as are given below as their names (to identify them), along with a brief outline of their credit risk experience and job title.

Name (initials)	Qualification	Job title and credit risk experience
I.K	B.Comm (Hons) UJ; M.Sc. (Building) *candidate Wits University	Regional Credit Head: Affordable Housing Developments (Nedbank). 11 years' credit risk experience
S.K	B.Comm UKZN (formerly Univ. of Natal); B.Sc (Hons) Wits University	Regional Credit Head: Residential Developments (Nedbank). 14 years' credit risk experience.
M.D	B.Comm (Economics) UJ; B.Comm (Hons) UNISA	Credit Risk Manager: Corporate Real Estate (Standard Bank). 6 years' credit risk experience
Z.P	B.Sc (Hons) Wits University; M.M (Finance & Investments) Wits Business School	Credit Risk Manager: Commercial and Residential Real Estate (Standard Bank). 3 years' credit risk experience.
L.G	B.Sc (Hons) Wits University; M.Sc. (Building) *candidate Wits University	Credit Manager: Commercial and Residential Property (FNB). 2 years' credit risk experience
D.C	Higher Credit Diploma, Credit Risk Management; Certified Associate of the Institute of Bankers (CAIB)	Credit Manager: Real Estate. 15 years' credit risk experience

** ABSA/Barclays Africa and Investec Bank were not consulted as their respective affordable housing development finance unit had been operational for only 6 months and had no specialised credit risk management systems established at the time of research.

Table 20: Primary data analysis

	A	B	C	D	E	F	G	H	I	J	K
13	Deal No	Deal1	Deal 2	Deal 3	Deal 4	Deal 5	Deal 6	Deal 7	Deal 8	Deal 9	Deal 10
14	MD Rank	7	6	1	8	10	2	3	5	9	4
15	ZP Rank	10	9	7	5	4	1	3	2	8	6
16	LG Rank	5	8	2	6	10	1	4	7	9	3
17	IK Rank	4	7	2	9	10	3	6	5	8	1
18	SK Rank	4	7	1	8	10	3	5	6	9	2
19	DC Rank	5	6	2	9	10	4	3	7	8	1
20											
21											
22	**Kendall's Coefficient of Concordance (Kandall's W)**										
23	W	0,685521886	=B25/(COUNT(B14:B19)*(COUNT(B14:K14)-1)								
24	r	0,622626263	=(COUNT(B14:B19)*B23-1)/(COUNT(B14:B19)-1)								
25	chi-square	37,01818182	=FRIEDMAN(B14:K19)								
26	df	9									
27	p-value	2,61224E-05	=CHIDIST(B25;B26)								

Annexure B

Rankings are expressed as an ordered listing of object labels organised in a hierarchy from highest to lowest. To rank data in an ordinal manner a system of linear ordering (ranking) must be undertaken over a set of objects whereby all the objects are ranked and no ties are allowed. If the above restriction of not allowing ties is relaxed to allow unlimited ties, then the result is a weak ordering. Mathematical tools are pivotal of such an undertaking is sought for practical applications. There are some that while useful for a rating or scoring make them un-useful for rankings- two such method is Kendall's Tau (τ_b) and the Borda Count method(Emond & Mason 2002).

The Consensus Ordinal Ranking method is a technique allowing for no ties in ranking *x* number of observations by *n* number judges/panelists. It does this by a tally-count of highest rankings achieved rankings for observation x and then in the case of a ties it then tallies the number of the next-best ranking. It first counts the observation with the highest number of number 1 rankings and if there is a tie it will tally how many of those same observations got a ranking of number 2 and so forth until an untied consensus rank is achieved. It is the same method employed in the Olympic Games for medals tally and subsequent country ranking.

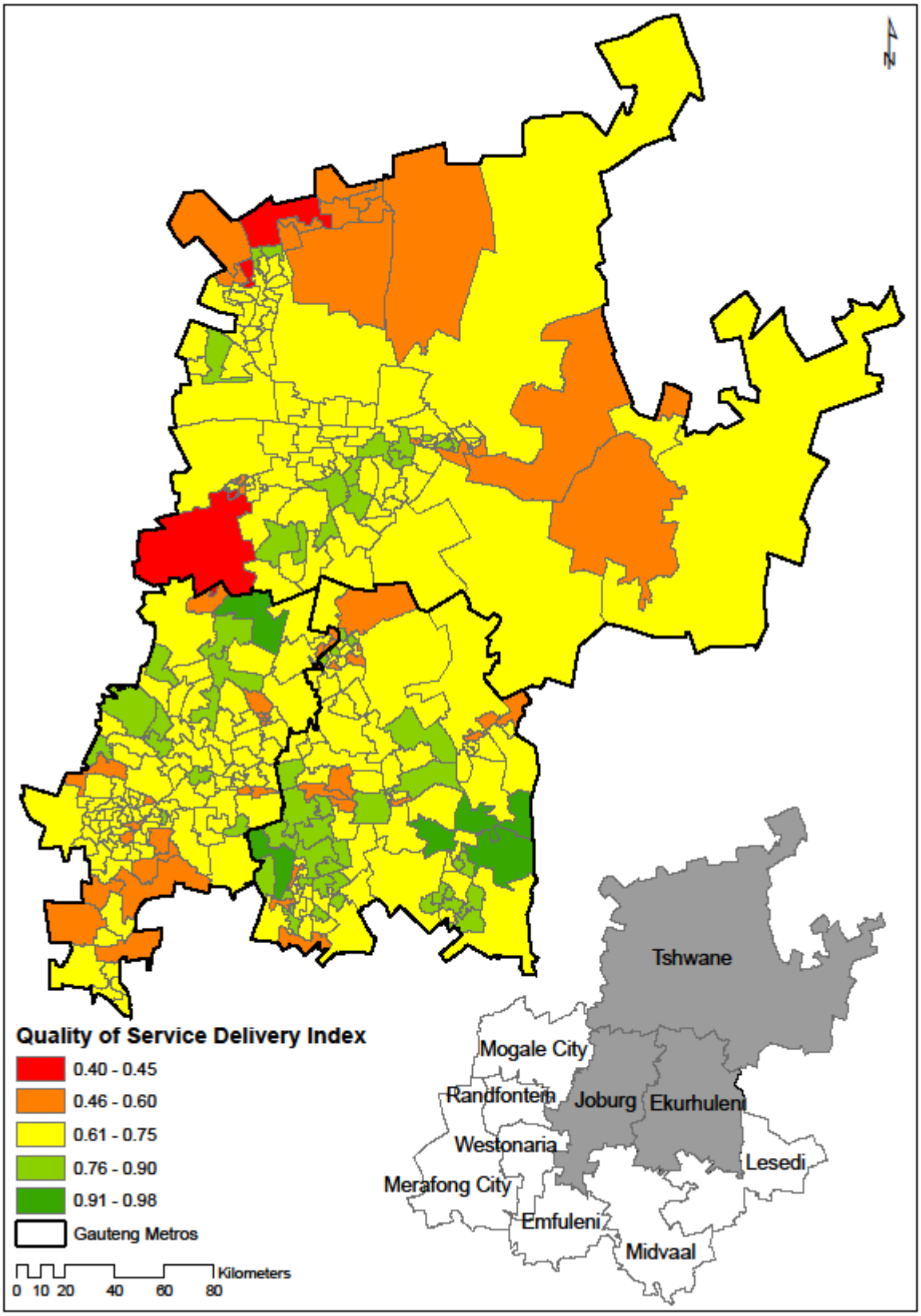
Below the consensus ordinal ranking method was used to rank the 10 observations (simulated sample transactions) ranked by a panel of 6 credit risk industry experts.

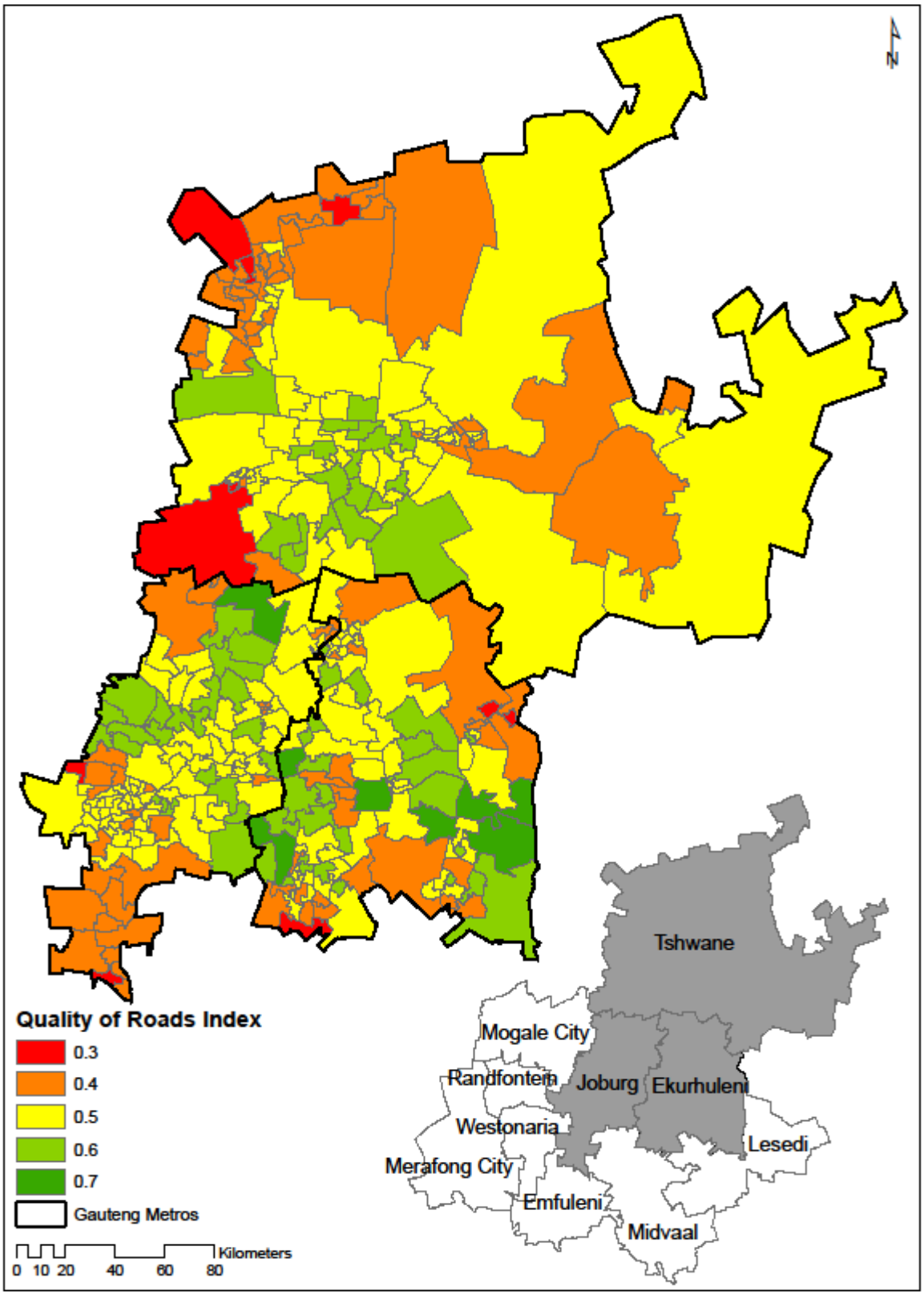
Rank	Deal 1	Deal 2	Deal 3	Deal 4	Deal 5	Deal 6	Deal 7	Deal 8	Deal 9	Deal 10
1st			II			II				II
2nd			III			I		I		I
3rd						II	III			I
4th	II				I	I	I			I
5th	II			I			I	II		
6th		II		I			I	I		I
7th	I	II	I					II		
8th		I		II					III	
9th		I		II					III	
10th	I				IIIII					
Consensus rank	6	7	1	8	10	2	4	5	9	3

Re-organized in ascending order of preference										
Sample transaction	Deal 3	Deal 6	Deal 10	Deal 7	Deal 8	Deal 1	Deal 2	Deal 4	Deal 9	Deal 5
Consensus rank	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th

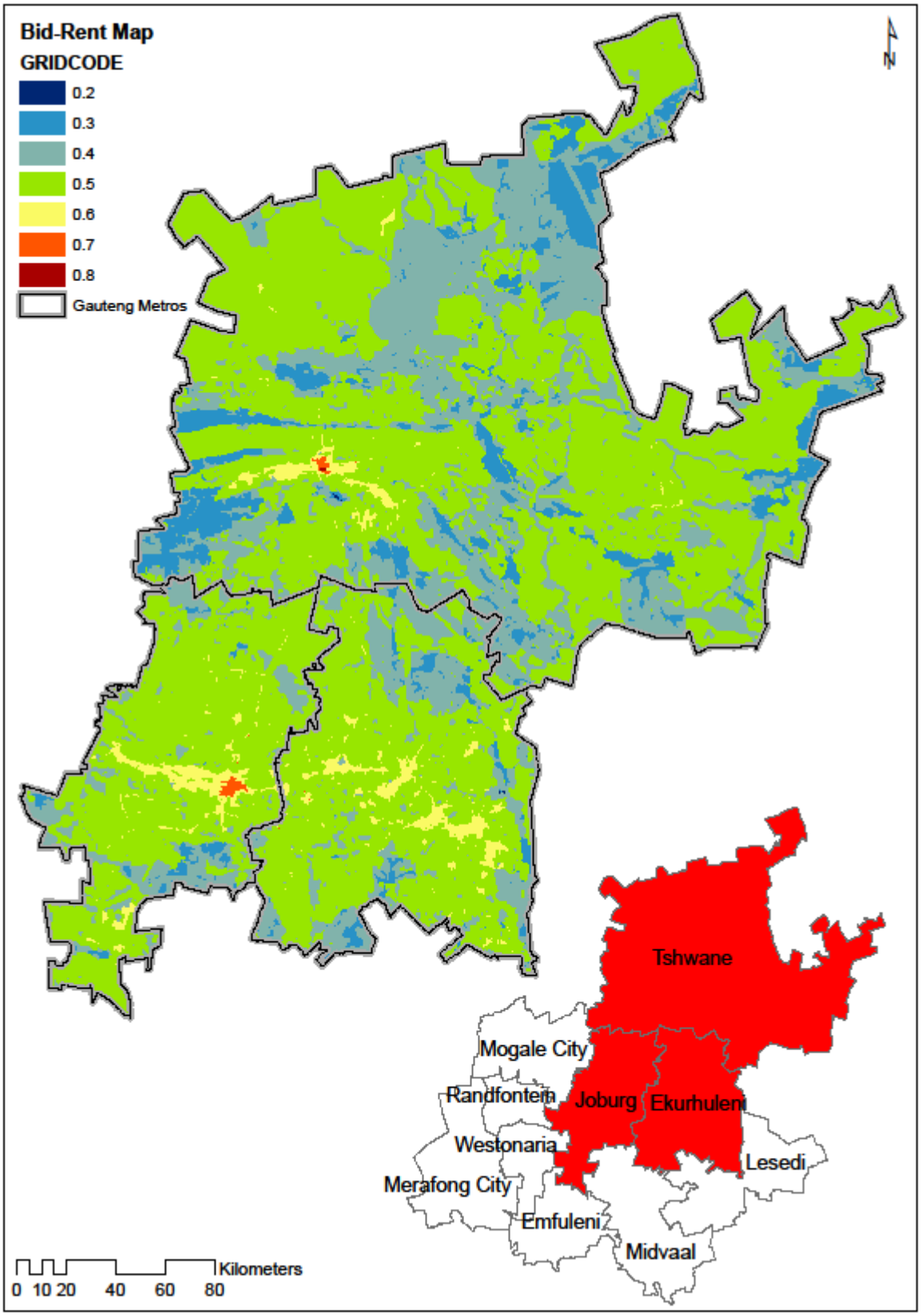
It's evident in the above that deals 3, 6 and 10 had two panelists each assigning them with a number 1 ranking, deal 3 however was ranked number 2 by three panelists while 6 and 7 only achieved one ranking of number 2, each. This process goes on until a ranking is produced based on where the consensus within the group of panelists lay in ranking their preferences, this method was chosen for its ability to counter-act the influence of one "wayward" judge or panelist with a wildly differing opinion from the rest of the group.

Annexure C


N
Quality of Service Delivery Index
0.40 - 0.45
0.46 - 0.60
0.61 - 0.75
0.76 - 0.90
0.91 - 0.98
Gauteng Metros
Kilometers
0 10 20 40 60 80
Tshwane
Mogale City
Randfontein
Joburg
Ekurhuleni
Westonaria
Lesedi
Merafong City
Emfuleni
Midvaal


N
Quality of Roads Index
0.3
0.4
0.5
0.6
0.7
Gauteng Metros
0 10 20 40 60 80
Kilometers
Tshwane
Mogale City
Randfontein
Joburg
Ekurhuleni
Westonaria
Lesedi
Merafong City
Emfuleni
Midvaal

Annexure D


Bid-Rent Map
GRIDCODE
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Gauteng Metros
N
Tshwane
Mogale City
Randfontein
Joburg
Ekurhuleni
Westonaria
Lesedi
Merafong City
Emfuleni
Midvaal
Kilometers
0 10 20 40 60 80

Annexure E

Quality of Life 2013 Survey description

In order to measure quality of life, the GCRO Quality of Life surveys include over 200 indicator questions across a wide range of areas; 54 of those are variables used to construct the quality of life index. These include subjective and objective indicator questions.

All are combined into 10 'dimensions' of quality of life – to try and measure both overall quality of life, and the 'drivers' behind it either rising or falling. These dimensions include work, socio-political, global, security, connectivity, community, family, dwelling, health and infrastructure. Each indicator is allocated a score of 0 or 1 for each individual respondent. These are combined to create each of the ten dimensions, which are scaled out of 1, where the maximum possible score for each dimension is 1. A score of 1 reflects extremely high levels of quality of life, a score of 0 the reverse. When the dimensions are added, perfect quality of life is represented by 10 (out of 10), thus the higher the score the higher the level of quality of life. For more detail regarding the construction of the quality of life index please refer to http://www.gcro.ac.za/gcr/review/2013/gcro/qol/quality-of-life.

The ward level results indicate the areas of lowest quality of life are concentrated in the former townships such as Alexandra, Tembisa, Sebokeng and Mamelodi. These findings confirm the resilience of apartheid inequalities, and the way they are woven into the spatial geography of the city-region. For more information on the 2013 quality of life index and other results from the survey, please refer to the 2013 QoL survey project page. http://www.gcro.ac.za/project/quality-life-survey-3.

Annexure F

Total Number of units:	150	size	Initial rental	Std dev	Annual Income	
(spacious) 1 bed, 1 bath	50	49sqm	R 5 000	R (0)	R 3 000 000	
2bed, 1 bath	70	58sqm	R 6 500	R (0)	R 5 460 000	
amily unit- ground floor) 2bed, 2 bath	30	65sqm	R 7 400	R 300	R 2 664 000	approx.
Total Expense Ratio (incl. all overhead, maintenance & management cost)					30%	
Building Cost (excl. P&G and Land Cost		incl. VAT	R 54 000 000			

Impression of Completed Project

Assumptions

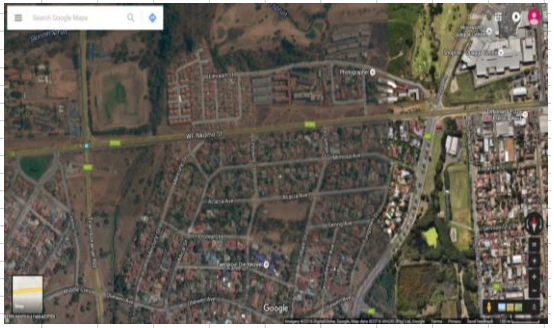
1. Developer is main contractor
2. All Professionals have equal experience, sufficient PI Cover &
3. Building period is 12 months
4. No phasing of construction but 50 units handed over to tenants from month 11
5. Interim payments for work done and certified to be paid on '*balance to complete*' balance
6. Long term loan assumed to be 10 years with no residual at end of term
7. The Developer's (Firm/Group) Long term assets are investment property
8. Retained earnings are half of equity

Deal 1

Location: Suider Street, Wonderboom		cost per opportunity	
Land Cost: R	R 7 500 000	50000	https://www.google.co.za/maps/place/Wolmer,+Pretoria,+0182/@-25.6844075,28.1771
Building Cost	R 54 000 000		
P&G (6%)	R 3 240 000		
Total development cost	R 64 740 000		
Borrowers equity (28% of cost)	R 18 127 200		
Secured senior loan (72% LTC)	R 46 612 800		
Net income yield	6,7%		
Interest cover ratio	1,78		
LTV with property cap rate of 11,%	61,2%		
Developer's direct experience	8years		
Firm's L-T assets	R 90 250 000		
Firm's S-T assets	R 3 250 000		
Firm's L-T liabilities	R 52 800 000		
Firm's S-T liabilities	R 3 830 000		
Firm's Annual Revenue	R 12 350 000		
Working Capital	R 4 900 000		
Firm's EBIT	R 4 640 000		

Deal 2

Location: Acacia Street, Proclamation Hill (Pta West)		cost per opportunity	
Land Cost: R	R 6 900 000	46000	https://www.google.co.za/maps/@-25.7515475,28.1415839,615m/data=!3m1!1e3
Building Cost	R 54 000 000		
P&G (7%)	R 3 240 000		
Total development cost	R 64 140 000		
Borrowers equity (25%)	R 16 035 000		
Secured senior loan (75% LTV)	R 48 105 000		
Net income yield	6,2%		
Interest cover ratio	1,69		
LTV with property cap rate of 11,25%	64,8%		
Developer's direct experience	4years		
Firm's L-T assets	R 57 050 000		
Firm's S-T assets	R 2 650 000		
Firm's L-T liabilities	R 31 680 000		
Firm's S-T liabilities	R 1 398 000		
Firm's Annual Revenue	R 7 410 000		
Working Capital	R 2 940 000		
Firm's EBIT	R 2 784 000		

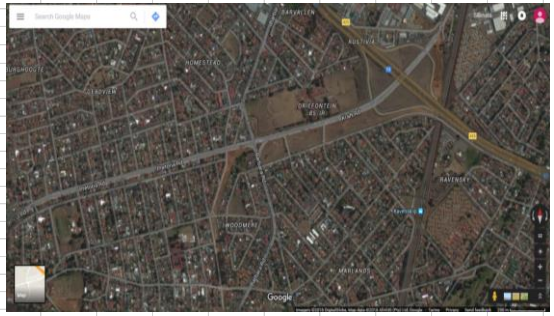


Deal 3

Location: End Street, Clubview (Centurio		cost per opportunity	
Land Cost: R	R 9 300 000	62000	https://www.google.co.za/maps/@-25.8436993,28.1784603,1194m/data=!3m1!1e3
Building Cost	R 54 000 000		
P&G (5%)	R 2 700 000		
Total development cost	R 66 000 000		
Borrowers equity (25%)	R 16 500 000		
Secured senior loan (75% LTC)	R 49 500 000		
Net income yield	7,4%		
Interest cover ratio	1,66		
LTV with property cap rate of 10,5%	61,7%		
Developer's direct experience	12years		
Firm's L-T assets	R 98 770 000		
Firm's S-T assets	R 4 280 000		
Firm's L-T liabilities	R 69 400 000		
Firm's S-T liabilities	R 5 160 000		
Firm's Annual Revenue	R 17 850 000		
Working Capital	R 5 790 000		
Firm's EBIT	R 7 760 000		

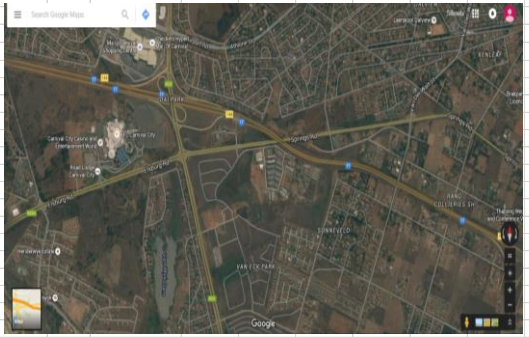
Deal 4

Location: Beech Ave, Woodmere (Germiston)		cost per opportunity	
Land Cost: R	R 7 950 000	53000	https://www.google.co.za/maps/@-26.1820043,28.1879517,1111m/data=!3m1!1e3
Building Cost	R 54 000 000		
P&G (8%)	R 4 320 000		
Total development cost	R 66 270 000		
	7,1%		
Borrowers equity (35%)	R 23 194 500		
Secured senior loan (65% LTC)	R 43 075 500		
Net income yield	7,2%		
Interest cover ratio	1,91		
LTV with property cap rate of 10,75%	55,0%		
Developer's direct experience	5years		
Firm's L-T assets	R 138 910 000		
Firm's S-T assets	R 4 590 000		
Firm's L-T liabilities	R 107 400 000		
Firm's S-T liabilities	R 10 050 000		
Firm's Annual Revenue	R 19 350 000		
Working Capital	R 15 350 000		
Firm's EBIT	R 9 890 000		



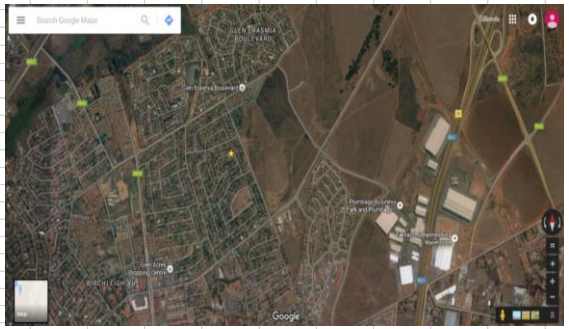
Deal 5

Location: Nedeberg Ave, Sonneveld (Brakpan)		cost per opportunity	
Land Cost: R	R 6 450 000	43000	https://www.google.co.za/maps/@-26.2618519,28.3387643,1647m/data=!3m1!1e3
Building Cost	R 54 000 000		
P&G (9%)	R 4 860 000		
Total development cost	R 65 310 000		
Borrowers equity (22%)	R 14 368 200		
Secured senior loan (75% LTC)	R 50 941 800		
Net income yield	6,2%		
Interest cover ratio	1,56		
TV with property cap rate of 11,25%	68,7%		
Developer's direct experience	2years		
Firm's L-T assets	R 54 110 000		
Firm's S-T assets	R 4 390 000		
Firm's L-T liabilities	R 36 400 000		
Firm's S-T liabilities	R 3 035 000		
Firm's Annual Revenue	R 6 990 000		
Working Capital	R 3 950 000		
Firm's EBIT	R 1 890 000		



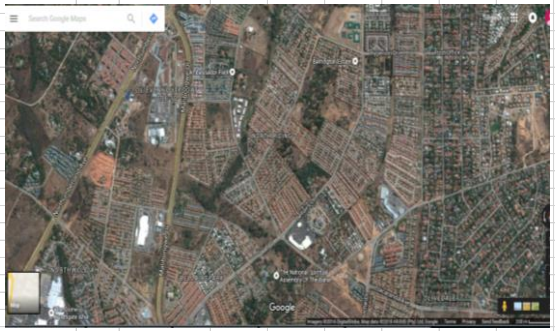
Deal 6

Location: Monument Road, Glen Erasmia (Kempton Park)		cost per opportunity	
Land Cost: R	R 7 425 000	49500	https://www.google.co.za/maps/@-26.0730169,28.2632017,1016m/data=!3m1!1e3
Building Cost	R 54 000 000		
P&G (7%)	R 109 000		
Total development cost	R 61 534 000		
Borrowers equity (30%)	R 18 460 200		
Secured senior loan (70% LTC)	R 43 073 800		
Net income yield	6,8%		
Interest cover ratio	1,90		
LTV with property cap rate of 10,75%	55%		
Developer's direct experience	8years		
Firm's L-T assets	R 84 730 000		
Firm's S-T assets	R 2 770 000		
Firm's L-T liabilities	R 65 000 000		
Firm's S-T liabilities	R 7 535 000		
Firm's Annual Revenue	R 7 590 000		
Working Capital	R 8 950 000		
Firm's EBIT	R 7 060 000		



Deal 7

Location: Bellairs Drive, Northriding		cost per opportunity	
Land Cost: R	R 8 325 000	55500	https://www.google.co.za/maps/@-26.0518038,27.963857,967m/data=!3m1!1e3
Building Cost	R 54 000 000		
P&G (5%)	R 2 700 000		
Total development cost	R 65 025 000		
Borrowers equity (25%)	R 16 256 250		
Secured senior loan (75% LTC)	R 48 768 750		
Net income yield	7,5%		
Interest cover ratio	1,70		
TV with property cap rate of 10,25%	58,9%		
Developer's direct experience	8years		
Firm's L-T assets	R 97 600 000		
Firm's S-T assets	R 1 900 000		
Firm's L-T liabilities	R 55 450 000		
Firm's S-T liabilities	R 5 535 000		
Firm's Annual Revenue	R 7 590 000		
Working Capital	R 8 950 000		
Firm's EBIT	R 7 060 000		

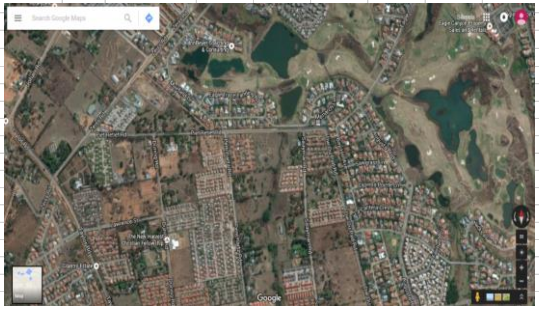


Deal 8

Location: Hendrina Street, Ridgeway (Jhb South)		cost per opportunity	
Land Cost: R	R 7 275 000	48500	https://www.google.co.za/maps/@-26.0518038,27.963857,967m/data=!3m1!1e3
Building Cost	R 54 000 000		
P&G (8%)	R 4 320 000		
Total development cost	R 65 595 000		
Borrowers equity (22%)	R 14 430 900		
Secured senior loan (78% LTC)	R 51 164 100		
Net income yield	7,2%		
Interest cover ratio	1,57		
LTV with property cap rate of 10,5%	63,6%		
Developer's direct experience	5years		
Firm's L-T assets	R 77 050 000		
Firm's S-T assets	R 2 450 000		
Firm's L-T liabilities	R 65 000 000		
Firm's S-T liabilities	R 7 535 000		
Firm's Annual Revenue	R 7 590 000		
Working Capital	R 8 950 000		
Firm's EBIT	R 7 060 000		

Deal 9

Location: Lawrence Street, Honeydew (Roodepoort)		cost per opportunity	
Land Cost: R	R 7 275 000	48500	https://www.google.co.za/maps/@-26.0944563,27.8606422,3447a,20y,180h/data=!3m1!
Building Cost	R 54 000 000		
P&G (10%)	R 5 400 000		
Total development cost	R 66 675 000		
Borrowers equity (25%)	R 16 668 750		
Secured senior loan (75% LTC)	R 50 006 250		
Net income yield	6,5%		
Interest cover ratio	1,66		
LTV with property cap rate of 10,5%	61,9%		
Developer's direct experience	3years		
Firm's L-T assets	R 60 030 000		
Firm's S-T assets	R 2 330 000		
Firm's L-T liabilities	R 35 000 000		
Firm's S-T liabilities	R 3 335 000		
Firm's Annual Revenue	R 6 590 000		
Working Capital	R 4 250 000		
Firm's EBIT	R 2 760 000		



Deal 10

Location: Grand Central Blvd., Halfway House (Midrand)		cost per opportunity	
Land Cost: R	R 8 400 000	56000	https://www.google.co.za/maps/@-25.9955017,28.1306153,1217m/data=!3m1!1e3
Building Cost	R 54 000 000		
P&G (7%)	R 3 780 000		
Total development cost	R 66 180 000		
Borrowers equity (20%)	R 13 236 000		
Secured senior loan (80% LTC)	R 52 944 000		
Net income yield	8,5%		
Interest cover ratio	1,56		
LTV with property cap rate of 9,75%	60,79%		
Developer's direct experience	11years		
Firm's L-T assets	R 100 630 000		
Firm's S-T assets	R 6 170 000		
Firm's L-T liabilities	R 63 400 000		
Firm's S-T liabilities	R 7 535 000		
Firm's Annual Revenue	R 19 590 000		
Working Capital	R 19 950 000		
Firm's EBIT	R 10 060 000		

Annexure G

Moody's rating categories explained

The below graphics was sourced from the 2011 report of The Standing Committee on Ratings Systems & Practices of the Moody's Corporation. It represents the most current definitions and guidelines used by Moody's to conduct analysis and provide credit opinions.

Below are the descriptions of their ratings in descending order. They outline the general credit opinion of obligors who would receive such ratings

Global Long-Term Rating Scale	
Aaa	Obligations rated Aaa are judged to be of the highest quality, subject to the lowest level of credit risk
Aa	Obligations rated Aa are judged to be of high quality and are subject to very low credit risk.
A	Obligations rated A are judged to be upper-medium grade and are subject to low credit risk.
Baa	Obligations rated Baa are judged to be medium-grade and subject to moderate credit risk and as such may possess certain speculative characteristics.
Ba	Obligations rated Ba are judged to be speculative and are subject to substantial credit risk.
B	Obligations rated B are considered speculative and are subject to high credit risk.
Caa	Obligations rated Caa are judged to be speculative of poor standing and are subject to very high credit risk.
Ca	Obligations rated Ca are highly speculative and are likely in, or very near, default, with some prospect of recovery of principal and interest.
C	Obligations rated C are the lowest rated and are typically in default, with little prospect for recovery of principal or interest.

The graphic below indicates the corporate families, or investment group/holdings, and the Basel Committee's Probabilities of Default ("PD") associated with their respective Moody's rating; it has been summarized to indicate only the ratings attainable using the proposed credit analysis model- the best being the sovereign rating of SA being Baa2.

Baa-PD	Corporate families rated Baa-PD are judged to be medium-grade and subject to moderate default risk and as such may possess certain speculative characteristics.
Ba-PD	Corporate families rated Ba-PD are judged to be speculative and are subject to substantial default risk.
B-PD	Corporate families rated B-PD are considered speculative and are subject to high default risk.
Caa-PD	Corporate families rated Caa-PD are judged to be speculative of poor standing, subject to very high default risk, and may be in default on some but not all of their long-term debt obligations.
Ca-PD	Corporate families rated Ca-PD are highly speculative and are likely in, or very near, default on some but not all of their long-term debt obligations.
C-PD	Corporate families rated C-PD are the lowest rated and are typically in default on some but not all of their long-term debt obligations.
D-PD	Corporate families rated D are in default on all of their long-term debt obligations.

The ratings commensurate with particular Moody's credit ratings are provided below. The Basel Committee's Internal Ratings Based approach allows for bespoke but rational and prudently developed methodologies to calculate risk metrics and default probabilities provided they're based on sound principles- this has been expanded upon in the research methodology in the main body. What is described as the PD for the sake of conforming to Moody's ratings policy has been referred to as PDR in the research methodology and analysis- this owing to the stringent nature of PD calculations, sampling, testing and validating.

Investment grade		High yield speculative grade			Highly speculative			Substantial Risk-		
Rating	**Baa3**	**Ba1**	**Ba2**	**Ba3**	**B1**	**B2**	**B3**	**Caa**	**Ca**	**C**
PD	0.42%	0.71%	1.21%	2.12%	3.76%	6.82%	12.61%	12.62% to 23.8%		

Source: Bank of International Settlements (u.d)

Annexure H

	Simulated sample tranaction name	Deal 1	Deal 2	Deal 3	Deal 4	Deal 5	Deal 6	Deal 7	Deal 8	Deal 9	Deal 10
transaction particulars	Total development cost	R 64 740 000	R 64 140 000	R 66 000 000	R 66 270 000	R 65 310 000	R 61 534 000	R 65 025 000	R 65 595 000	R 66 675 000	R 66 180 000
	Borrowers equity (28% of cost)	R 18 127 200	R 16 035 000	R 16 500 000	R 23 194 500	R 14 368 200	R 18 460 200	R 16 256 250	R 14 430 900	R 16 668 750	R 13 236 000
	Secured senior loan	R 46 612 800	R 48 105 000	R 49 500 000	R 43 075 500	R 50 941 800	R 43 073 800	R 48 768 750	R 51 164 100	R 50 006 250	R 52 944 000
	Net income yield	6,7%	6,2%	7,4%	7,2%	6,2%	6,8%	7,5%	7,2%	6,5%	8,5%
	Capitalisation rate	11%	11,25%	10,50%	10,75%	11,25%	10,75%	10,25%	10,50%	10,50%	9,75%
	LTV with property cap rate of	61,2%	64,8%	61,7%	55,0%	68,7%	55,2%	58,9%	63,6%	61,9%	60,8%
	Interest cover ratio	1,78	1,69	1,66	1,91	1,56	1,90	1,70	1,57	1,66	1,56
	Developer's direct experience	8years	4years	12years	5years	2years	8years	8years	5years	3years	11years
Financial Standing (at Group level)	Firm's L-T assets	R 90 250 000	R 57 050 000	R 98 770 000	R 138 910 000	R 54 110 000	R 84 730 000	R 97 600 000	R 77 050 000	R 60 030 000	R 100 630 000
	Firm's S-T assets	R 8 150 000	R 5 590 000	R 10 070 000	R 19 940 000	R 8 340 000	R 11 720 000	R 10 850 000	R 11 400 000	R 6 580 000	R 26 120 000
	Total assets	**R 98 400 000**	**R 62 640 000**	**R 108 840 000**	**R 158 850 000**	**R 62 450 000**	**R 96 450 000**	**R 108 450 000**	**R 88 450 000**	**R 66 610 000**	**R 126 750 000**
	Firm's L-T liabilities	R 52 800 000	R 31 680 000	R 69 400 000	R 107 400 000	R 36 400 000	R 65 000 000	R 55 450 000	R 65 000 000	R 35 000 000	R 63 400 000
	Firm's S-T liabilities	R 3 830 000	R 1 398 000	R 5 160 000	R 10 050 000	R 3 035 000	R 7 535 000	R 5 535 000	R 7 535 000	R 3 335 000	R 7 535 000
	Total liabilities	**R 56 630 000**	**R 33 078 000**	**R 74 560 000**	**R 117 450 000**	**R 39 435 000**	**R 72 535 000**	**R 60 985 000**	**R 72 535 000**	**R 38 335 000**	**R 70 935 000**
	Equity (retained inome + issued capital)	**R 41 770 000**	**R 29 562 000**	**R 34 280 000**	**R 41 400 000**	**R 23 015 000**	**R 23 915 000**	**R 47 465 000**	**R 15 915 000**	**R 28 275 000**	**R 55 815 000**
	Firm's Annual Revenue	**R 12 350 000**	**R 7 410 000**	**R 17 850 000**	**R 19 350 000**	**R 6 990 000**	**R 7 590 000**	**R 7 590 000**	**R 7 590 000**	**R 6 590 000**	**R 19 590 000**
	Firm's EBIT	**R 4 640 000**	**R 2 784 000**	**R 7 760 000**	**R 9 890 000**	**R 1 890 000**	**R 7 060 000**	**R 7 060 000**	**R 7 060 000**	**R 2 760 000**	**R 10 060 000**
Property risk	Variable 1 (LTV) (rounded to next who	2	2	2	4	1	4	3	2	2	2
	Value of score	-5	-5	-5	5	-10	5	0	-5	-5	-5
	Variable 2 (Quality of Roads)	3	3	3	3	5	4	2	3	4	3
	Value of score	0	0	0	0	10	5	-5	0	5	0
	metric 3 (Quality of Service delivery)	3	3	3	3	5	3	2	3	4	3
	Value of score	0	0	0	0	10	0	-5	0	5	0
	Variable 4 (Bid-rent value)	3	4	4	4	5	4	3	4	3	4
	Value of score	0	5	5	5	10	5	0	5	0	5
	Variable 6 (Qual. of improvements to l	4	4	4	4	4	4	4	4	4	4
	Value of score	5	5	5	5	5	5	5	5	5	5
	Aggregate property risk score	0,00	1,00	1,00	3,00	5,00	4,00	-1,00	1,00	2,00	1,00
	$\beta_A X_{A_i}$ (where β_A=0,2)	17,30%	16,72%	16,72%	15,62%	14,58%	15,09%	17,89%	16,72%	16,16%	16,72%
cash flow risk	ICR score	4	3	3	5	3	5	4	2	3	2
	Developer Experience Score	4	3	5	3	2	4	4	3	3	5
		4,00	3,00	4,33	3,67	2,33	4,33	4,00	2,67	3,00	4,00
	$\beta_B X_{B_i}$ (where β_B=0,65)	15,09%	15,62%	14,92%	15,26%	15,98%	14,92%	15,09%	15,80%	15,62%	15,09%
Borrower risk	Altman's Z"-Score (z one-tail)	2,11	2,31	1,82	1,85	1,83	1,85	2,51	1,72	2,16	3,04
	Default probablity	0,98	0,99	0,97	0,97	0,97	0,97	0,99	0,96	0,98	0,999
	Propability of default (1- P-Value) = $\beta_C X_{C_i}$ (where	1,74%	1,04%	3,44%	3,22%	3,36%	3,22%	0,60%	4,27%	1,54%	0,12%

	PDR	***0,1353***	***0,1365***	***0,1356***	***0,1353***	***0,1381***	***0,1320***	***0,1348***	***0,1425***	***0,1362***	***0,1317***
	Model rank	4	8	6	5	9	2	3	10	7	1
	Ordinal consensus rank (from expert panel)	6	7	1	8	10	2	4	5	9	3
	Spearman's correlation (rho=ρ)	***0,55151515***									

MODEL VALIDATION

Simulated sample tranaction name	Deal 1	Deal 2	Deal 3	Deal 4	Deal 5	Deal 6	Deal 7	Deal 8	Deal 9	Deal 10
Ordinal consensus rank *(independent v.)*	6	7	1	8	10	2	4	5	9	3
Model rank (*dependant v.*)	4	8	6	5	9	2	3	10	7	1

Kruskal-Wallis one-way ANOVA on ranks (Kruskal-Wallis H-Test)											
	Deal 1	Deal 2	Deal 3	Deal 4	Deal 5	Deal 6	Deal 7	Deal 8	Deal 9	Deal 10	TOTAL
median	5	7,5	3,5	6,5	9,5	2	3,5	7,5	8	2	
rank sum	19	29	13	25	37	7	13	29	31	7	
count	2	2	2	2	2	2	2	2	2	2	20
r^2/n	180,5	420,5	84,5	312,5	684,5	24,5	84,5	420,5	480,5	24,5	2717
H-stat	14,62857143	=12*M69/(M68*(M68+1))-3*(M68+1)									
H-ties	14,74497916	=C70/(1-TiesCorrection(C61:L62)/(20^2*(20-1)))									
df	9	=COUNTA(C65:L65)-1									
p-value (*acting as "H"-critical value*)	0,09818339	=CHIDIST(C71;C72)									
alpha	0,05										
significance	no	=IF(C73<C74;"yes";"no")									

Annexure I

PDR Calibration for Property and cash Flow Risks

$$PDR = \frac{1}{1 + e^{(a+b * score)}}$$

The parameters a and b must be calibrated. This is done by solving the simultaneous equation where the upper bound is "*a"* and lower bound is "*b"*.

The parameters are calibrated between the absolute minimum default probability achievable, which is the Basel II Probability of Default rating that corresponds to one notch above the Moody's sovereign rating for the Republic of South Africa- being Baa3 and therefore a PD of 0.42%. This is because the Baa2 sovereign rating of RSA represents the "risk-free" credit rating of any indigenous credit transaction and not singular transaction should equal the risk-free rate. The maximum default probability achievable in the Moody's rating scale is 28.3% which represents the worst risk category, being a C rating. To solve the two parameters, the following is necessary:

1) Minimum possible PDR = maximum score (lowest risk attributable to highest score)
2) Maximum possible PDR = minimum score (highest risk attributable to lowest score)

The calibration is therefore done as follows:

1)

$$PDR(1): \quad 0.0042 = \frac{1}{1 + e^{(a+b \text{ x } 10)}}$$

2)

$$PDR(2): \quad 0.238 = \frac{1}{1 + e^{(a+b \text{ x } (-10))}}$$

The simultaneous equation can then be solved by means of substitution, whereby:

3) Equation 1 is calculated and rearranged to make variable "a" the subject:
4) The simultaneous equation is solved by making b the only unknown variable and therefore the result of this calibration yield is the following for the a and b values

Substitution yields $a = -1.9718 + 10b$ for solving the PD calibration equation $\frac{1}{1+e^{(a+b * score)}}$. The result for a and b between the parameters 0.01222_{min} and 0.2390_{max} are: $\boxed{a= 6.0252}$; and $\boxed{b= 0.1620}$

Appendix A

Basel Committee's Internal Ratings-Based Approach

The three factors mentioned below correspond to the risk parameters upon which the Basel II IRB approach is built:

- probability of default (PD) per rating grade, which gives the average percentage of obligors that default in this rating grade in the course of one year
- exposure at default (EAD), which gives an estimate of the amount outstanding (drawn amounts plus likely future drawdowns of yet undrawn lines) in case the borrower defaults
- loss given default (LGD), which gives the percentage of exposure the bank might lose in case the borrower defaults. These losses are usually shown as a percentage

The IRB approach is based on measures of unexpected losses (UL) and expected losses (EL). The risk-weight functions produce capital requirements for the UL portion. Expected losses are treated separately, as outlined in paragraph 43 and Section III.G.

In this section, the asset classes are defined first. Adoption of the IRB approach across all asset classes is also discussed early in this section, as are transitional arrangements.

The risk components, each of which is defined later in this section, serve as inputs to the risk-weight functions that have been developed for separate asset classes. For example, there is a risk-weight function for corporate exposures and another one for qualifying revolving retail exposures.

The treatment of each asset class begins with a presentation of the relevant risk-weight function(s) followed by the risk components and other relevant factors, such as the treatment of credit risk mitigants.

The minimum requirements that banks must satisfy to use the IRB approach are presented:

A bank needs to have a credible, transparent, well-documented and verifiable approach for weighting these fundamental elements in its overall operational risk measurement system. For example, there may be cases where estimates of the 99.9th percentile confidence interval based primarily on internal and external loss event data would be unreliable for business lines with a heavy-tailed loss distribution and a small number of observed losses. In such cases, scenario analysis, and business environment and control factors, may play a more dominant role in the risk measurement system. Conversely,

operational loss event data may play a more dominant role in the risk measurement system for business lines where estimates of the 99.9th percentile confidence interval based primarily on such data are deemed reliable. In all cases, the bank's approach for weighting the four fundamental elements should be internally consistent and avoid the double counting of qualitative assessments or risk mitigants already recognised in other elements of the framework.

Given the continuing evolution of analytical approaches for operational risk, the Committee is not specifying the approach or distributional assumptions used to generate the operational risk measure for regulatory capital purposes. However, a bank must be able to demonstrate that its approach captures potentially severe 'tail' loss events. Whatever approach is used, a bank must demonstrate that its operational risk measure meets a soundness standard comparable to that of the internal ratings-based approach for credit risk, (i.e. comparable to a one year holding period and a 99.9th percentile confidence interval).

The risk weight used to convert holdings [transactions] into risk-weighted equivalent assets would be calculated by multiplying the derived capital charge by the inverse of the minimum 8% [or calibrated/calculated PD] calculated risk-based capital requirement. Capital charges calculated under the internal models' method may be no less than the capital charges that would be calculated under the simple risk weight method using a 200% risk weight for publicly traded equity holdings and a 300% risk weight for all other equity holdings. These minimum capital charges would be calculated separately using the methodology of the simple risk weight approach. Further, these minimum

A bank using a VaR model will be required to back-test its output using a sample of 20 counterparties, identified on an annual basis. These counterparties should include the 10 largest as determined by the bank according to its own exposure measurement approach and 10 others selected at random. For each day and for the sample of 20 counterparties, the bank must compare the previous day's VaR estimate for the counterparty portfolio to the change in the exposure of the previous day's portfolio. This change is the difference between the net value of the previous day's portfolio using today's market prices and the net value of that portfolio using the previous day's market prices. Where this difference exceeds the previous day's VaR estimate, an exception has occurred. Depending on the

number of exceptions in the observations for the 20 counterparties over the most recent 250 days (encompassing 5000 observations).

Given the data limitations associated with Secured Lending ("SL") exposures, a bank may remain on the supervisory slotting criteria approach for one or more of the IPRE or HVCRE sub-classes, and move to the foundation or advanced approach for other sub-classes within the corporate asset class. However, a bank should not move to the advanced approach for the HVCRE sub-class without also doing so for material IPRE exposures at the same time.

Foundation and advanced approaches

For each of the asset classes covered under the IRB framework, there are three key elements:

- Risk components — estimates of risk parameters provided by banks some of which are supervisory estimates.
- Risk-weight functions — the means by which risk components are transformed into risk-weighted assets and therefore capital requirements.
- Minimum requirements — the minimum standards that must be met in order for a bank to use the IRB approach for a given asset class.

For many of the asset classes, the Committee has made available two broad approaches: a foundation and an advanced. Under the foundation approach, as a general rule, banks provide their own estimates of PD and rely on supervisory estimates for other risk components.

The foundation IRB approach shall, when appropriate, such as in the case of material differences, further decompose the said information and provide an analysis of PD ratios and reasons for material differences.

Under the advanced approach, banks provide more of their own estimates of PD, LGD and EAD, and their own calculation of M, subject to meeting minimum standards. For both the foundation and advanced approaches, banks must always use the risk-weight functions provided in this Framework for the purpose of deriving capital requirements. The full suite of approaches is described below. [The research utilised the Foundation Approach.]

Borrower-level PD

[This will be calculated using the Altman Z"Score methodology]

Assets/Transaction-level PD

Risk-weighted price- 1 ÷ (1+e^(a + b * IPRE supervisory slotting score)

Where:

a)

b) Maturity adjustment (b) = (0.11852 – 0.05478 × ln (PD))^2

Reporting under the Foundation Approach

A detailed comprehension of the risk reports generated by the risk system, including information relating to-

(i) the relevant internal ratings;

(ii) the bank's risk profile based on risk grades;

(iii) risk migration across risk grades;

(iv) the relevant risk estimates of the relevant parameters per risk grade;

(v) a comparison between realised and expected PD ratios, LGD ratios and EAD amount

Claims secured by commercial real estate

74. In view of the experience in numerous countries that commercial property lending has been a recurring cause of troubled assets in the banking industry over the past few decades, the Committee holds to the view that mortgages on commercial real estate do not, in principle, justify other than a 100% weighting of the loans secured. [Where Foundation approach needs help, there are supervisory slots available for specialised lending- these are the risk weights.]

Risk weights for High Volatility Commercial Real Estate 0"(HVCRE")

Banks that do not meet the requirements for estimation of PD, or whose supervisor has chosen not to implement the foundation or advanced approaches to HVCRE, must map their internal grades to five supervisory categories, each of which is associated with a specific risk weight. The slotting criteria on which this mapping must be based are the

same as those for IPRE, as provided in Annex 4. The risk weights associated with each category are:

Supervisory categories and Unexpected Loss risk weights for high-volatility commercial real estate

Strong	Good	Satisfactory	Weak	Default
95%	120%	140%	250%	0%

Although banks are expected to map their internal ratings to the supervisory categories for specialised lending using the slotting criteria provided in Annex 4, each supervisory category broadly corresponds to a range of external credit assessments as outlined below.

Strong	Good	Satisfactory	Weak	Default
BBB- (or better)	BB+ or BB	BB- or B+	B to C-	N/A

Basel II Risk Components

PD- the one-year percentage of predicted default probability, calculated by means of a recognised and mathematically sound methodology. Under the foundation approach the bank is able to calculate their own PD using their own back-data.

LGD- Under the foundation approach, senior claims on corporates, sovereigns and banks not secured by recognised collateral will be assigned a 45% LGD.

All subordinated claims on corporates, sovereigns and banks will be assigned a 75% LGD. A subordinated loan is a facility that is expressly subordinated to another facility. At national discretion, supervisors may choose to employ a wider definition of subordination. This might include economic subordination, such as cases where the facility is unsecured and the bulk of the borrower's assets are used to secure other exposures.

Collateral under the foundation approach

In addition to the eligible financial collateral recognised in the standardised approach, under the foundation IRB approach some other forms of collateral, known as eligible IRB

collateral, are also recognised. These include receivables, specified commercial and residential real estate (CRE/RRE).

All documentation used in collateralised transactions and for documenting on- balance sheet netting, guarantees and credit derivatives must be binding on all parties and legally enforceable in all relevant jurisdictions. Banks must have conducted sufficient legal review to verify this and have a well-founded legal basis to reach this conclusion, and undertake such further review as necessary to ensure continuing enforceability. [In South Africa this would be ensuring a valid secured lending contract is signed and that a mortgage bond is successfully registered over the subject asset.]

Overview of Credit Risk Mitigation Techniques for Collateralised transactions:

A collateralised transaction is one in which:

1. banks have a credit exposure or potential credit exposure; and
2. that credit exposure or potential credit exposure is hedged in whole or in part by collateral posted by a counterparty or by a third party on behalf of the counterparty.

Under Basel II, capital is set to maintain a supervisory fixed confidence level [this CI is 99.9% and represents an appropriate significance level for calculating adequate bank capital reserving because of the magnitude and volatility that lies in bank credit portfolios. The academic nature, however, of this research will set the CI at 95% as it seeks to appropriately calculate the Risk-weighted asset of a greenfileds affordable housing development in any of the Metropolitan cities of Gauteng Province and does not take into account capital reserving nor an existing credit portfolio by the lender and the hurdle return rates and risks therein]

Banks may include statistical models and mechanical methods to assign borrower and facility ratings or estimate PD ratios, LGD ratios and EAD amounts, which models and methods-

(i) shall take into account all relevant and material information;

(ii) shall be used appropriately;

(iii) shall have good predictive power;

(iv) shall incorporate a reasonable set of risk predictors and the bank shall have in place clear guidelines and processes to monitor situations in which variables or risk inputs were altered;

(v) shall be materially accurate across a range of borrowers or facilities;

(vi) shall not contain any known material biases;

(vii) shall be subject to a regular validation process of data inputs, including an assessment of accuracy, completeness and appropriateness;

(viii) shall be subject to written policies and procedures for human review and judgement, provided that when human judgement is used to override the model's output, the bank shall separately keep track of the performance of the relevant exposure;

(ix) Shall be subject to regular back-testing.

As a minimum, a bank that adopted the IRB approach- shall in the case of exposures relating to SL, which exposures were mapped into the standardised rating categories specified in paragraph (d)(iii)(C) below, have no less than four borrower grades in respect of borrowers that are not in default and one grade for borrowers that have defaulted;

(iii) shall assign a rating to each obligor and all eligible guarantors, which rating shall be reviewed or approved by a person who does not directly benefit from the extension of credit;

(iv) shall associate each exposure with a facility rating as part of the loan approval process;

(vi) shall review assigned borrower and facility ratings on a regular basis, but not less frequently than once a year, provided that the bank shall review all relevant ratings as soon as material new information comes to the attention of the bank;

(vii) shall have in place an effective process in order to obtain and update all relevant information

The model specification was subject to an important restriction in order to fit supervisory needs: The model should be portfolio invariant, i.e. the capital required for any given loan should only depend on the risk of that loan and must not depend on the portfolio it is added to. Taking into account the actual portfolio composition when determining capital for each loan - as is done in more advanced credit portfolio models- would have been a too complex task for most banks and supervisors alike. Portfolio invariant allocation schemes are also called ratings-based. (Bank of International Settlements, 2004)