UNIVERSITEIT VAN PRETORIA
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Social contagion of migration from South Africa

A research project submitted by

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A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

10 November 2010

Abstract

This research aims to identify to what extent the primary drivers of migration gain influence due to social contagion effects – in other words, to what extent the metaphor of an "epidemic" can be used to describe emigration. The scope of the research is limited to the migration of individuals from South Africa to countries abroad.

A model is developed as a means with which to analyse the premise that social contagion influences migration due to its effect on the underlying driver's thereof.

Results obtained through analysis of secondary data reveal the primary drivers of migration, their trends and their relative influence within the population. Results obtained through simulation revealed that the impact of general crises attributable to a particular determinant of migration is fleeting and that increased rates will subside in time. In contrast, as random isolated events related to the primary drivers of migration increase in frequency and intensity, so too does migration. In addition, drivers disseminated through social contagion discouraging migration from South Africa are found to be capable of negating the influence of the determinants of migration.

Keywords: Migration, Social Contagion, Crime,

Deceleration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Masters of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other university. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Name: Graham Nash

Signature:

Date: 10 November 2010

Acknowledgements

I would like to thank and acknowledge the role of the following people and organisations that were instrumental in the completion of this research:

Doctor Helena Barnard, my supervisor, for your inspiration and guidance throughout this research project.

Tonielle, my wife, for your unwavering support, patience and understanding.

The Homecoming Revolution, for your generous assistance in helping me obtain the required data for this research project.

UTi Mounties Division, for the time and support extended to me to complete this research project.

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1. Chapter 1:- Problem Definition

"Migration is inherently spatial, involving the redistribution of individuals, families, and groups within and between countries. Through migration different communities are linked together in more or less formal networks of flows and the implications of these streams may impact on both the migrants and the places through which they move. Migrants are often among the most entrepreneurial and dynamic members of society, while others may be exploited and abused during forced relocation." (Boyle, 2009)

Globally, debate rages as to what the net effect of migration is on the country of origin. Hence, the departure of desperately needed skills from South Africa's (SA's) shores is cause for alarm as the country strives to differentiate itself from other developing countries and achieve set growth targets.

The central challenge presented in critically understanding this complex phenomenon is a lack of credible data. Journalists and academics have increasingly questioned official statistics after empirical findings indicated that departures are far higher than the data published by Central Statistical (Meyer, 2000). Thus data integrity as well as factors influencing individual decisions to relocate, which typically vary by individual, have received significant attention within migration research.

Past migration research has focused on the impact of migration upon migrants; the spatial patterns of migration and how they might be explained; the impacts on the origins and destination that migrants move between; as well as the various economic, social, and political implications of such movements (Boyle,

2009). As a result, migration research is theoretically and empirically diverse. However to date there has been comparatively less focus on the underlying forces that perpetuate migration, for instance how the dynamics of social contagion influence migration.

The aim of this study is to explore by means of simulation the premise that one of the key underlying forces perpetuating migration within SA is social contagion. The concept of social contagion may be defined as the spread of affect or behaviour from one crowd participant to another with one person serving as the stimulus for the imitative actions of another (Lindzey, 1985). A model will be developed as a means with which to analyse the veracity and nature of such forces, thereby offering additional insights into migration from SA. Key determinants of migration applicable to social contagion theory will be identified and their context qualified in order to facilitate their inclusion into the model. The scope of the research is limited to the migration of individuals from SA to countries abroad. Both temporary and permanent migrants are considered, with distinctions made in terms of demographic attributes.

The proposed research will offer valuable insights with respect to the mechanisms at work in an individual's decision to relocate abroad. An in-depth understanding of the primary determinants of migration will be determined within the South African context as well as the extent to which individuals are exposed to them through social contagion. In addition, the individual's vulnerability with respect to such influences will be established. In effectively modelling social contagion in terms of migration, a deeper understanding of the

intrinsic cycles at work is to be gained through simulation and analysis, learning's which otherwise may be ignored.

Many skilled workers actively participating within the South African business environment have close friends and direct family living abroad. The proposed research is relevant and intriguing as it explores the effect that social contagion has on shaping and influencing their decisions, thus offering insights into the choices individuals have made and will make in the future.

2. Chapter 2:- Theory and Literature Review

The theory reviewed in this section defines migration and describes the factors influencing an individual's decision to relocate abroad; as well as the impact that migration has on the business environment within the country of origin. The determinants considered by Lucas (2005) in his book, 'International Migration and Economic Development' are explored and evaluated within the South African context. In addition the concept of social contagion theory is discussed and a generalized model of social and biological contagion introduced.

2.1 Migration

The National Geographic Society (2005) defines human migration as the movement of people from one place in the world to another for the purpose of taking up permanent or semi-permanent residence. Generally, migration occurs across a political boundary with people choosing to move or being forced to move; this is known as 'voluntary' and 'involuntary' migration respectively. Migration is not a contemporary trend, having occurred throughout history, beginning with the movements of the first human groups from their origins in the East. (National Geographic Society, 2005)

Migration patterns are generally characterised as intercontinental (between continents), intracontinental (between countries on a given continent), or interregional (within countries). A significant interregional migration pattern is from rural areas to urban areas, generally motivated by the promise of better opportunities within cities and large towns (National Geographic Society, 2005). Table 1 lists and describes the various types of migration that occur.

Table 1: Types of Migration (National Geographic Society, 2005)

Migration Type	Description
Internal Migration	Relocation to a new home within a state/province, country, or continent.
External Migration	Relocation to a new home in a different state/province, country, or continent.
Emigration	Leaving one country to move to another (e.g. the Dutch settlers emigrated from Holland).
Immigration	Moving into a new country (e.g., the Dutch settlers immigrated to SA).
Population Transfer	Occurs when a government forces a large group of people out of a region, usually based on ethnicity or religion, also referred to as an involuntary or forced migration.
Impelled Migration	Occurs when individuals leave their country because of unfavourable situations such as warfare, political problems, or religious persecution, also referred to as "reluctant" or "imposed" migration.
Step Migration	Comprised of a series of short, less extreme migrations from a person's place of origin to a final destination. For example, moving from a farm, to a village, to a town, and finally to a city.
Chain Migration	Involves a series of migrations within a family or defined group of people. Chain migration results in the clustering of people from a specific region into certain neighbourhoods or small towns, this is referred to as a migration field.

The focus of the study is on external migration, namely emigration. It involves both intercontinental and intracontinental migration, and is applicable to internal migration, for example interregional migration. As a number of determinants are considered in the study, both voluntary and involuntary migrations such as impelled migration are included.

Ravenstein is credited as providing a basis for modern migration theory through his work in developing the 'laws' of migration (Ravenstein, 1885). The laws are summarised as:

I. Under 'normal' conditions, migratory movement will be gradual and proceed in steps.
II. Generally migration will transpire over short distances.
III. Each migration flow produces counter flow, although not necessarily of the same volume.
IV. Growth as a consequence of migration is greater than organic growth within large towns. This occurs at the expense of rural areas as long-range migrants usually move to urban areas.
V. Females appear to predominate among short-journey migrants, but males are more migratory over long distances.
VI. Migration increases with economic development, and may be attributed primarily to economic causes.

2.2 Why do individuals migrate?

There are numerous reasons which may influence an individual to migrate. Reasons for migration may be characterised as either push or pull factors. Push factors represent reasons for emigrating due to unpleasant circumstances, for

instance food shortages; whilst pull factors represent reasons for immigrating as a result of something desirable, for example a better food supply. (National Geographic Society, 2005)

Lucas (2005) states that approximately 97% of the world's population live within their country of origin and suggest that people typically prefer to stay within familiar surroundings with friends and family. He notes that this characteristic offers valuable insights into two established patterns in international migration, that being the tendency to not move far and the inclination to move to destinations where others have gone before. Lucas (2005) explores geography, social networks and economics as determinants of migration.

2.2.1 The Influence of Geography

Geography has a significant influence in terms of the destination and extent to which individuals migrate. This premise is supported by the fact that the primary sources of migrants to the European Union (EU), United States of America (USA) and East Asia are from nearby countries (Lucas, 2005). This however cannot be attributed solely to transportation as these may indeed be insignificant when one considers the potential income opportunities that may exist in the destination country. Lucas (2005) speculates that the underlying cause may be due to a lack of information with respect to available opportunities as well as an increasing sense of alienation in more distant lands. This aligns with the concept of 'distance decay' which refers to the inversely proportional relationship between the distance of a location and the understanding thereof. Thus, individuals are more likely to settle in a closer

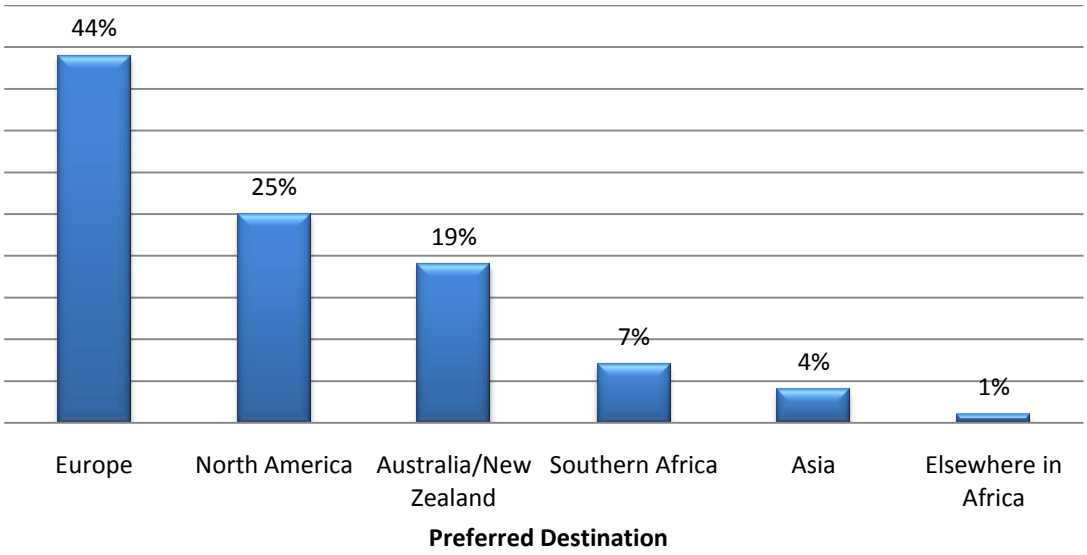
place about which they have more knowledge than in a farther place about which they know and understand little. (National Geographic Society, 2005)

Lucas (2005) does however argue that there are factors pertaining to the origin and destination countries that will mitigate the influence of geography in migration, for example:

- A common language between home and destination.
- Colonial connections
- Familiar religious or ethnic structures.

Within the South African context, the before mentioned factors appear to mitigate the influence of geography and as a result Ravenstein's (1885) second law does not seem to hold in terms of external migration. The results of a survey regarding 'emigration potential' among a representative sample of 4784 postgraduate and final-year undergraduate students at South Africa's tertiary educational institutions by Mattes (2007) support this and are represented in the figure below:

Figure 1: Preferred Emigration Destinations of South African Students (Mattes, 2007)



2.2.2 The Influence of Social Networks

An individual's access to social networks plays an important role in influencing their decision to migrate to a foreign country. Lucas (2005) attributes this to the support that may be leveraged prior to moving with respect to credible information regarding opportunities and conditions pertaining to the destination. In addition, social networks can provide a migrant with support in terms of initial housing costs and contacts as well as accelerate the process of obtaining a job. This is applicable in the South African context as the "Where are they Survey?" conducted by the Development Bank (DBSA) and 'Homecoming Revolution' exposed. The survey revealed that 15% of the 6938 (adult) respondents living abroad had parents living abroad too.

Saxenian (1999) notes the influence of social networks on skilled Asian immigrant workers as she comments on the social and professional networks they have created in the Silicon Valley. The ease of communication that the internet provides has assisted in a proliferation of network opportunities for South Africans. Examples of sites include "South African Kiwi"; "Allo' Expat South Africa", "Facebook" and the "South African Business Club".

2.2.3 The Influence of Social and Economic Factors

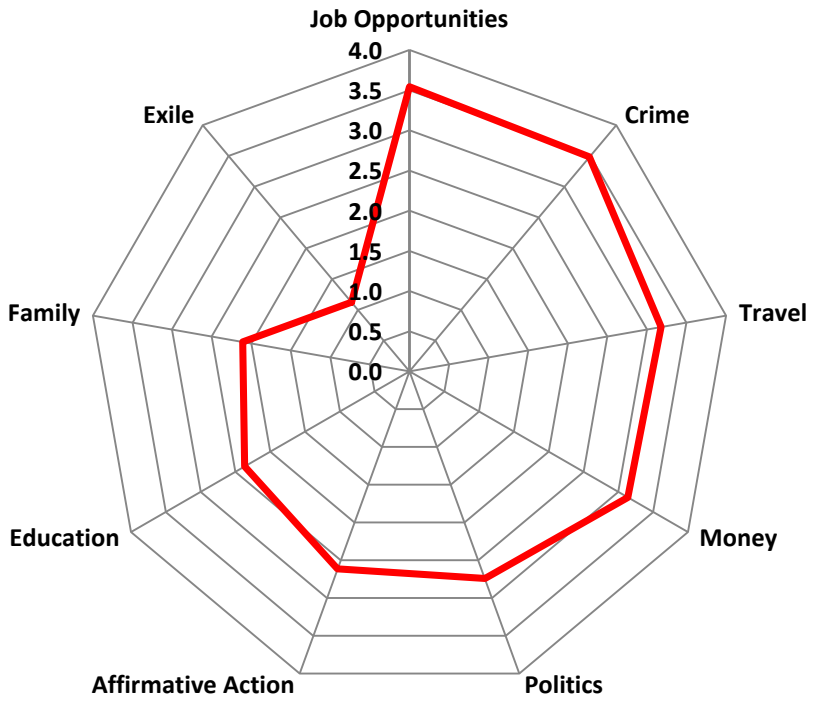
A great deal of influence is determined by the value to be gained from the potential economic opportunities that a destination may offer a perspective migrant. Opportunities are dependent on the employability of a migrant, with language proficiency and skill levels key factors. Lucas (2005) notes that long term economic prospects are likely to dominate decisions to relocate permanently, whereas temporary migration decisions are influenced by the

current economic situation. Bohlman (2010) remarks that despite SA being the largest economy on the African continent, many socioeconomic problems still persist, hence driving individuals to migrate.

Issues such as the crime rate, economic recession, job insecurity, low remuneration, lack of opportunities, and the fear of stagnating or receding in terms living standards are factors attributed to migration from South Africa (Kharwa, 2008). An argument reinforced by political parties such as the Democratic Alliance (DA), "*If one considers the popularly floated statistic that for every skilled person in South Africa ten jobs are created, and the fact that, in the UK alone, there is estimated to be living 1 million South African expatriates, then the impact of crime becomes clear*" (DA, 2007).

Respondents to the before mentioned, "Where are they Survey?" were asked to rate potential reasons for leaving SA. Ratings for each option ranged from one to five where one represented a low priority and five represented a high priority, (it should be noted that 'not applicable' was also offered as a choice). The options of 'job opportunities' and 'crime' jointly yielded the highest rating with an average response of 3.5. Responses to 'travel' and 'money' followed closely with averages of 3.2 and 3.1 respectively. At the end of the spectrum was the option of 'exile' with an average of 1.1. The results are illustrated in Figure 2.

Figure 2: Primary reasons for leaving South Africa



2.3 The Impact of Migration on the Business Environment

The migration of skilled workers out of SA can have negative effects on SA's business environment as skilled people leaving the country impact the economy through the loss of vital skill sets, both directly and indirectly.

Indirect costs include that of replacing skills through training and development or alternatively importing skills. In addition, the costs of lost opportunities also burden the economy and its potential growth. Kharwa (2008) argues that migration affects the SA economy and its people and ultimately stagnates the country's economic progression on a significant scale. Direct costs include the exporting of assets as migrants transfer their money and assets to the respective destination county. Australia's Immigration Department estimates

that its business skills visa generated about R180 million of investment from South African immigrants in 2003/4 (Lundy, 2006).

The effects of migration are also detrimental to the economy of the origin country in the long term (Wong, 1999). This is supported by Bohlman (2010) who argues that GDP is negatively affected by skilled emigration from SA, resulting in a loss in competitiveness affecting export-oriented industries, as well as the investment sector through declining rates of return.

It should be noted that whilst migration can be detrimental to an economy, the underlying causes of migration also serve as factors influencing the business environment. The prevalence of crime in SA makes its omission as a binding constraint to the objectives of the Accelerated and Shared Growth Initiative (AsgiSA) painfully obvious. AsgiSA is a development strategy designed to improve the South African economy's performance (AsgiSA Annual Report 2007). Deputy President Phumzile Mlamo-Ngcuka launched the initiative in February 2006. The 'South Africa Investment Climate Assessment', (ICA), is a survey conducted by the World Bank (WB) with the purpose of evaluating the investment climate within SA. The survey claims that 30% of enterprises in SA regard crime as an obstacle to growth; positioning crime as the fourth greatest constraint to growth identified (World Bank, 2007). It may be argued that it is the perception of crime rather than the act itself that gives rise to crime being perceived as an obstacle to growth; however the fact remains that there are tangible costs incurred by firms in SA because of crime. The ICA reports that the average firm in SA has direct losses attributed to crime and the cost of security equal to approximately 1.1 percent of sales. This is in contrast to

countries with which SA may compete for foreign direct investment (FDI) such as Brazil, China, Poland, and even Russia with less than 1 per cent.

There is however an argument within the literature that states that skilled emigration can have a positive effect on the origin county. Potential benefits arise in the temporary migration of workers who enhance their skills and experience and then return their knowledge and skills to the country of origin (Bohlman, 2010). The South African Network of Skills Abroad (SANSA) is an organisation created to facilitate this type of knowledge transfer. The organisation was established in 1998 and by the end of 1999 had already gathered approximately 1800 members in 57 countries (Lundy, 2006). Saxenian (2005) supports this argument in her assessment of Silicon Valley's foreign-born migrants, typically from Asia. She establishes that the same individuals who left their home countries for better lifestyles abroad are now reversing the brain drain, transforming it into "brain circulation" as they return home to establish business relationships or to start new companies while maintaining their social and professional ties to their destination country. In addition, the findings suggest that these individuals are often among the earliest returnees and typically serve as advisors to domestic policy makers.

An unexpected benefit of migration is argued by Stark (1998), that being the possibility of a greater aspiration for education within the origin country because of the realisation of greater financial opportunities through emigration. If migration is managed appropriately, then the average skill of workers within the origin country will rise, thus boosting the economy.

Other benefits due to the migration of workers (skilled and unskilled) are that of cash remittances to their home country (Ozden, 2006). Emigrants may also contribute to their origin country despite living abroad. Lundy (2006) offers the Starfish Charity as such an example. The Starfish Charity is an organisation set up by South African professionals in London who raise funds for those affected by HIV and AIDS in South Africa.

2.4 Social Contagion Theory

2.4.1 Definition

Whilst most people are not familiar with the term 'social contagion', it is a phenomenon that is likely to have affected us all in some respect, albeit subconsciously. For example familiar 'conditions' such as happiness (Landau, 2008) and obesity (Rushin, 2007) have been acknowledged as being potentially socially infectious. Contagion processes occur in both the social and biological sciences (Dodds & Watts, 2005), thus the premise is that behaviour and emotion can traverse populations just as diseases are able to propagate.

Within modern social psychology contagion is a topic which falls under the domain of 'social influence'. Levy and Nail (1993) declare that there is a distressing lack of consensus within the area of social influence in terms of fundamental, key and central concepts. Consequently, definitions of social contagion differ significantly throughout the literature. This trait may also be attributed to the heterogeneous nature of the phenomena involved within contagion theory (Levy & Nail, 1993). This gives credence to Marsden's (1998) argument that social contagion research currently lacks a conceptual framework

or organising principle and may be characterised as a body of evidence without theory.

Two prominent yet diverse definitions of social contagion within the literature are those suggested by Wheeler (1966) and Levy and Nail (1993). Wheeler's definition contrasts the concept of social contagion with other social influences such as conformity and imitation. The definition suggests that social contagion has only occurred should an individual adopt a particular behaviour under the following conditions:

a) The individual has been exposed to operations that are known to trigger such behaviour within the group to which the individual belongs.
b) The individual has the ability to behave in this manner.
c) The individual is not exhibiting the behaviour.
d) The individual has observed such behaviour in another individual.

Levy and Nail (1993) define social contagion as the spread of affect, attitude, or behaviour from Person A (the "initiator") to Person B (the "recipient"), where the recipient does not perceive an intentional influence attempt on the part of the initiator. Thus, the definition offered by Levy and Nail specifies that for contagion to have occurred the recipient must perceive the actions of the initiator as unintentional. In contrast, Wheelers definition does not refer to non-intentionality but rather suggests that the individual undergoes a loss of inhibition, triggered by the external stimuli arising from those with whom the individual interacts.

Marsdon (1998) notes the distinction between the definitions with respect to the emphasis on non-intentionality versus disinhibition, and refers to the definition offered by 'The Handbook of Social Psychology' (Lindzey, 1985) as the clearest and most inclusive of the definitions available within the literature. Hence, social contagion is defined as the spread of affect or behaviour from one crowd participant to another with one person serving as the stimulus for the imitative actions of another.

2.4.2 Emotional and Behavioural Contagion

Research conducted with respect to social contagion generally falls into one of two categories, either emotional contagion or behavioural contagion.

2.4.2.1 Emotional Contagion

Emotional contagion refers to the spread of mood and affect through populations by simple exposure (Marsden, 1998). Kimura and Daibo (2008) examined the concept of emotional contagion from the perspective of interpersonal relationships. Their findings support the notion that emotional responses are significantly stronger in close relationships, (for example the friend or family member), as opposed to more casual relationships for both positive and negative episodes. Emotional responses were also found to be stronger based on the authority of the initiator, suggesting that social power in interpersonal relationships impacted emotional contagion. Thus the implication is that the degree of intimacy in an interpersonal relationship influences emotional contagion.

Barsade (2002) evaluated group emotional contagion within organisations using a simulated managerial exercise in which all participants acted as managers on a salary committee, negotiating the allocation of a limited sum of bonus money to their employees. The study found that a contagion of mood does exist amongst group members and that there was no difference in mood contagion when considering unpleasant and pleasant emotions. The study also confirmed that positive emotional contagion, (an increase in positive mood), will lead to greater cooperativeness on both an individual and group level as well as mitigate group conflict. Within the study emotional contagion was measured by both participants' self-reports as well as observers' ratings of the mood via video-tape ratings of the participants interacting in the group exercise. Barsade (2002) used dual measures as methodologically, the video-coder data allows better access to the mood being expressed by participants in real time, while self-report of mood allows a different type of access to participant's internal feelings states.

In a separate study it was found that depressive symptoms and mood is also contagious (Joiner, 1999). Marsden (1998) cites several example of emotional contagion, for example mood (Hsee, Hatfield, & Chemtob, 1992), anxiety (Behnke, Sawyer, & King, 1994) and fear (Gump & Kulik, 1997).

2.4.2.2 Behavioural Contagion

Behavioural contagion refers to the spread of behaviours through populations by means of simple exposure and is comprised of contagions in several distinct forms. Marsdon (1998) provides a description of several of the dominant issues in behavioural contagion research, as summarised in Table 2.

Table 2: Branches of Behavioural Contagion (Marsden, 1998)

Behavioural Contagion	Description
Hysterical contagion	Hysterical contagion involves the spread of physical symptoms within a population in the absence of an identifiable pathogen.
Rule Breaking Contagion	Evidence suggests that an individual's exposure to rule violations increases their likelihood of engaging in similar or identical behaviour.
Deliberate Self Harm/Suicide Contagion	'Deliberate Self Harm' contagion is an accepted risk factor in suicide research. As a result, the US government has initiatives in place minimising the effects of suicide contagion.
Financial Contagion	Financial contagion is observable in the behaviour of the stock market as a result of selling and buying trends that occur globally.
Consumer Behaviour	Contagion with respect to consumer behaviour refers to the spread of consumer fashions and fads through populations.
Aggressive Behaviour	A phenomenon that has been shown to operate in both local and dispersed collectivises.

2.4.2.2.1 Goal Contagion

An important trend in behavioural contagion to be noted is that of goal contagion. Goal contagion refers to the hypothesis that individuals may automatically adopt and pursue a goal that is implied by another person's behaviour (Aarts, 2004). Aarts, Hassin and Gollwitzer (2004) exposed participants to behavioural information implying a specific goal and gave them the opportunity to act on the goal in a different way and context. The results of the study established the goal contagion phenomenon by showing that the behavioural consequences of goal contagion possess features of goal directedness and are characterized by persistence. It was also found that people do not automatically adopt goals when observed goal pursuit is performed unacceptably, as the goal is then perceived as unattractive.

Loersch, Aarts, Payne and Jeffers's (2008) research into the subject revealed that goal contagion is more likely between people who belong to the same groups. In addition goal contagion was proven to manifest itself irrespective of whether participants observed or read about the behaviour of others. The study also verified that the effects were motivational as it was demonstrated that failing at a goal relevant task increased negative affect, but only for those who viewed the motivated behaviour of someone from their own group.

2.4.2.3 The Role of Memory in Social Contagion

Social contagion relies on memory; this is easily apparent when one considers language contagion. In Sutherland's (2007) article "Social Contagion: "I'll Have What She's Having", reference is made to the familiar occurrence where one

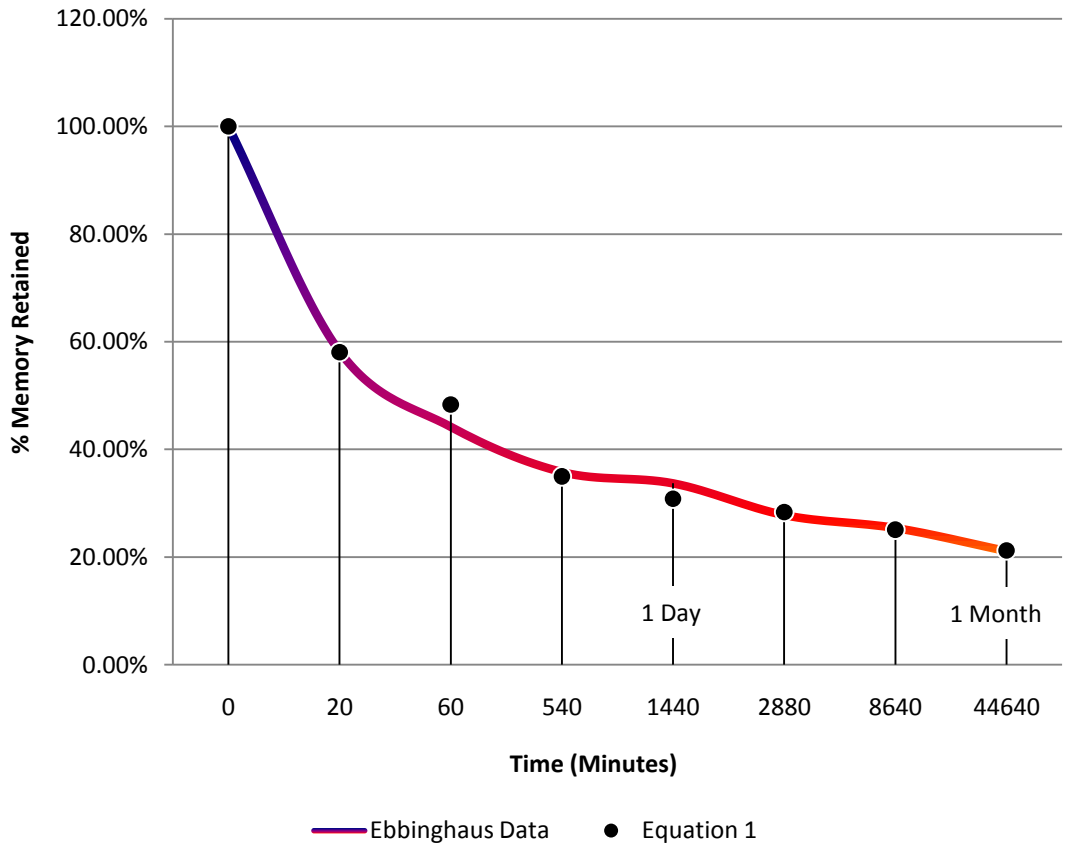
hears an expression and later surprises oneself by uttering the same expression. This scenario often unfolds without any conscious effort to use the phrase. Sutherland (2007) remarks that this phenomenon is not limited to new words and expressions, as existing ones get used more often after we hear others using them. He rationalises this by virtue of the notion that when we reach into our minds to articulate a thought, the resultant process is an 'internal agenda'; and as we can only think of one expression at a time, we reach for the first one that comes to mind that is reasonable. Anderson (2003) reinforces this, documenting that the more recently and the more often a word appears in a newspaper, the greater the probability it will re-appear in the next day's issue. In addition Sutherland (2007) notes that this type of contagion has also been found in studies of peoples' conversations as well as their emails.

This suggests that how much one forgets is as significant to social contagion as is what we remember. Ebbinghaus pioneered research into the rate at which one forgets in the years 1879-80. Ebbinghaus conducted a series of experiments designed to discover the rate of forgetting both meaningless and significant material, during the first thirty days after it had been learned (Finkenbinder, 1913). Despite being over 100 years old, Ebbinghaus' results are still relevant today. He found that forgetting proceeds rapidly during the first twenty minutes after learning, and then gradually slows down. The curve describing Ebbinghaus' data is known as the 'forgetting curve'. Several equations have been derived with the ability of characterising the 'forgetting curve', for example the Wickelgren power law (Wixted & Carpenter, 2007) as well as equation 1 below, used by Miao (2008).

$$b = \frac{1}{1 + \alpha \times log^{\beta}(1 + t)} \quad (1)$$

A comparison of Ebbinghaus' data versus the values obtained by Miao (2008) using Equation 1 are illustrated in the Figure 3.

Figure 3: The Forgetting Curve



2.4.3 Social Contagion Models

Even though there is considerable variety in the literature on contagion, it is possible to develop a generalized model of social and biological contagion. The model incorporates individual memory of exposure to a contagious entity, variable magnitudes of exposure (dose sizes) as well as heterogeneity in the susceptibility of individuals. The model is described in detail, laying a foundation for future models.

2.4.3.1 Model Description

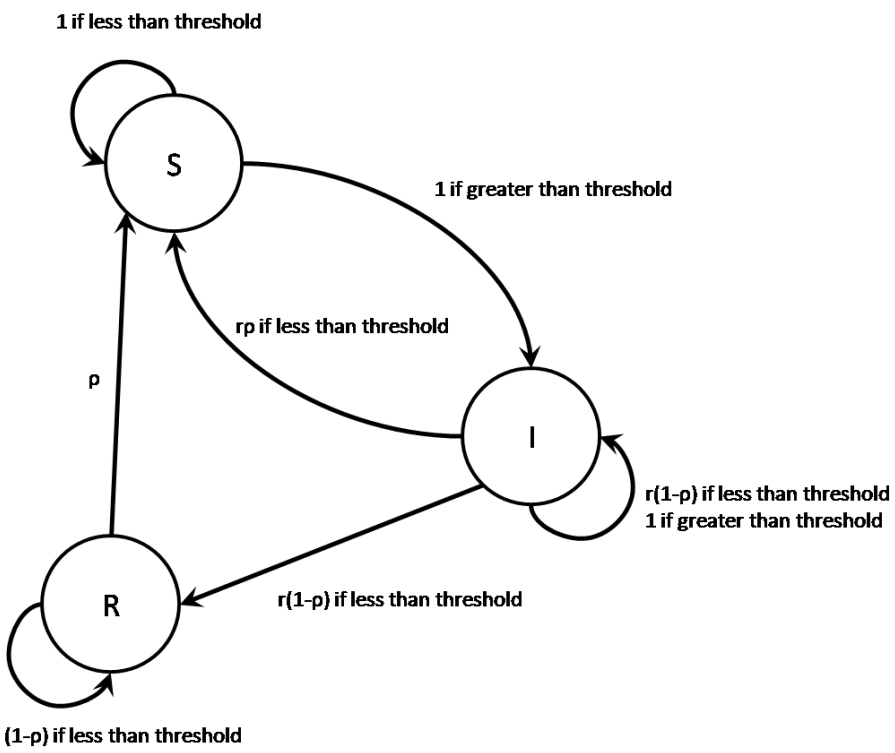
Dodds and Watts' (2005) generalized model consists of a population of N individuals, each of which is assumed to occupy one of three states: Susceptible (S); Infected (I); or Recovered (R). As the names suggest, individuals falling into the 'susceptible' classification are vulnerable to being infected after exposure to an 'infected' individual. Individuals who are 'removed' have recovered after being infected and are only vulnerable to infection should they fall into the susceptible state. Individuals maintain a memory of doses received from their last *T* contacts and the sum of individual *i*'s last *T* doses (*i*'s dose count) is denoted at the tth step by:

$$D_{t,i} = \sum_{t'=t-T+1}^{t} d_{t',i} \tag{2}$$

In the event that a susceptible individuals dose count exceeds a specified threshold d^* the individual will move into an infected state. Infected individuals whose dose count drops below the threshold may recover with probability *r* at each time step. Once in the recovered state, individuals may become

susceptible with probability ρ. The dynamics described are illustrated in the following figure:

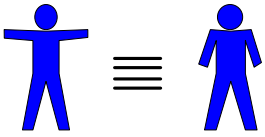
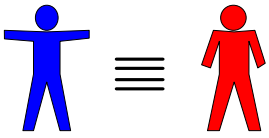
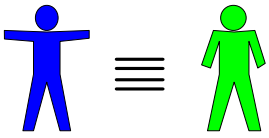
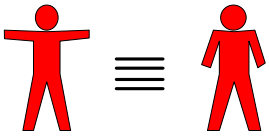
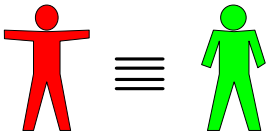
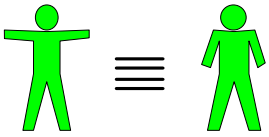
Figure 4: Generalised Model – State Transition Probabilities (Dodds & Watts, 2005)



It should be noted that these states may be developed further, as per the rumour transmission model presented by Kawachi (2008). In this model, the states that an individual may occupy are that of susceptible (X), spreader (Y), or stifler (Z).

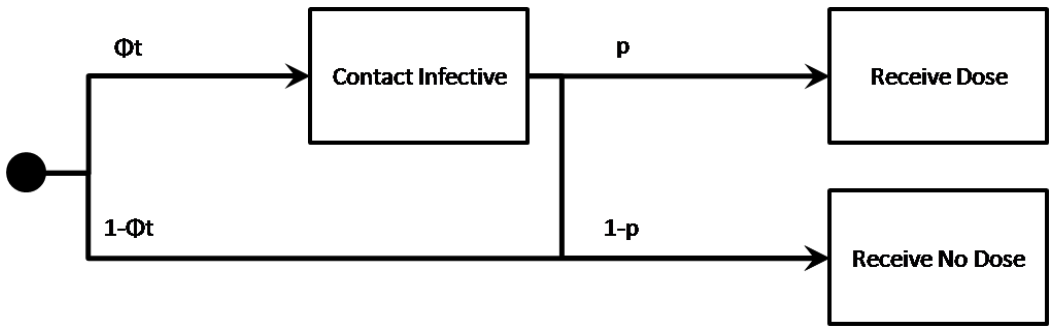
A 'susceptible' individual is one who is not aware of the rumour whilst a 'spreader' knows about the rumour and spreads it actively. Individuals who know about the rumour but do not spread it are known as 'stiflers'. The alternative interactions between the members of the states are summarised in Table 3.

Table 3: Interactions of the rumour transmission model (Kawachi, 2008)

Interaction	Potential Results
	• No outcome is applicable as neither individual is aware of the rumour.
	• X believes the rumour resulting in X transitioning to a Y state, or • X disbelieves the rumour and transitions to a Z state, or • X withholds whether to believe the rumour, and remains in an X state.
	• X disbelieves Z resulting in X transitioning to a Y state, or • X believes Z and transitions to a Z state, or • X withholds whether to believe Z, and remains in an X state.
	• Y loses interest in the rumour and transitioning to a Z state, or • Y loses interest in the rumour and transitioning to an X state, or • X remains interested in the rumour and remains in an X state.
	• Y believes Z resulting in Y transitioning to a Z state, or • Z believes Y and transitions to a Y state, or • Both individuals are not influenced and both remain in their respective states.
	• Z loses interest in the rumour and forgets it, transitioning into an X state, or • Both individuals reinforce each other and remain in a Z state.

In Dodds and Watts (2005) model, at each (discrete) time step *t*, each individual *i* come into contact with another individual chosen uniformly at random from the population. The probability that individual *i* comes into contact with an infected individual is the current fraction of individuals infected in the population at time *t*, denoted Φ_t. If the contact is infected, an event occurring with probability *p* results in *i* receiving a 'dose' d drawn from a fixed-size distribution *f*, otherwise *i* receives a dose of zero, as represented in the figure below.

Figure 5: Generalised Model – Dose determination (Dodds & Watts, 2005)



Within the generalised model, the probability that a susceptible individual who comes into contact with *K* infected individuals in *T* time steps will become infected is the infection probability, denoted by P_{inf}. The quantity P_k is the expected fraction of a population that will be infected by *k* exposures. (Dodds & Watts, 2005)

$$P_{inf}(K) = \sum_{k=1}^{K} \binom{K}{k} p^k (1-p)^{K-k} P_k \tag{3}$$

Where $K = 1, \dots, T$ and

$$P_k = \int_0^\infty d\, d^*\, g(d^*) \int_0^\infty d\, d^*\, f^{k*}(d) \tag{4}$$

The infection probability $P_{inf}(K)$ provides the 'dose-response' curve averaged over all members of the population and dose sizes distribution, where that K contacts with infected individuals will result in k actual exposures with probability $\binom{\mathbf{K}}{\mathbf{k}}\mathbf{p}^{\mathbf{k}}(\mathbf{1}-\mathbf{p})^{\mathbf{K}-\mathbf{k}}\mathbf{P}_{\mathbf{k}}$ (Dodds & Watts, 2005). Table 4 summarises the parameters used within the model.

Table 4: Parameters of the Generalised Contagion Model (Dodds & Watts, 2005)

Parameter	Description
T	Length of memory window.
p	Probability of exposure given contact with infective.
r	Probability of moving from infected state to recovered state.
ρ	Probability of moving from immune state to susceptible state.
$f(d)$	Distribution of dose sizes d.
$g(d^*)$	Distribution of individual thresholds d^*.
$\bar{d}^*$	Uniform threshold of homogenous population.

2.4.3.2 Model Findings

The behaviour of the model was subsequently explored by Dodds and Watts (2005) through analysis and simulation with respect to three qualitative types of dynamics:

- **Permanent Removal (ρ=0) Dynamics**

This is analogous to so-called 'Susceptible-Infected-Recovered' (SIR) models in mathematical epidemiology in which individuals either die or acquire permanent immunity. (Chicken Pox)

- **Temporary Removal (1>ρ>0) Dynamics**

This is analogous to so-called 'Susceptible-Infected-Recovered-Susceptible' (SIRS) models where recovered individuals become susceptible again after a certain period of immunity, (Common Cold)

- **Instantaneous Replacement (ρ=1) Dynamics**

This is analogous to 'Susceptible-Infected-Susceptible' (SIS) models where recovered individuals immediately become susceptible again after recovery, (Social Smoking).

In the case of the SIS Model, with a homogenous population whereby all doses are equal and of unit size, Dodds and Watts (2005) established that only two universal classes of dynamics are possible. The first is 'Epidemic Threshold Dynamics' where initial outbreaks either die out or else infect a finite fraction of the population, depending on whether or not the infectiousness p exceeds a specific critical value p_c. The second is that of 'Critical Mass Dynamics' where a finite fraction of the population can only ever be infected in equilibrium if the initial outbreak size itself constitutes a finite "critical mass".

In the case of the SIS Model with a heterogeneous population composed of individual thresholds and arbitrarily distributed dose sizes, Dodd's and Watts (2005) discovered in addition to the two classes of dynamics found in the homogenous model that an intermediate class also exists. This class is referred to as 'Vanishing Critical Mass Dynamics' where the size of the required critical mass diminishes to zero for *p* less than one.

Analysis of the SIR and SIRS versions of the model found that their behaviour resembled that of the simpler SIS version to some extent. In addition Dodd's and Watts (2005) were also able to determine where the transitions between these classes occur as well as the conditions required for more complicated kinds of contagion models.

Within the context of migration, both epidemic threshold dynamics and critical mass dynamics may be applicable subject to the determinants of migration at work. For instance, critical mass dynamics may be at play in the impelled migration of a group of individuals, where the entire group will only migrate once a certain proportion of the group decides to leave. In the case of migration due to frequent yet isolated incidents, (for example instances of crime), epidemic threshold dynamics may be at play as the individuals decision to migrate is dependent on the intensity of the incident as well as the tolerance of the individual exposed. This goal of this study is to explore the influence of epidemic threshold dynamics on migration, in terms of how the drivers of migration are disseminated within a population through social contagion.

2.5 Summary

The literature review establishes the positive and negative impacts of migration within the business environment, thereby emphasising the need for further research into the subject. Potential determinants influencing migration are reviewed and their complexities discussed, providing a basis to which social contagion is applicable.

The concept of social contagion was introduced as well as the pools of research that have been developed thus far within the field. Examples of applicable research are highlighted, for instance that of emotional contagion and goal contagion. Notable features include the influence within interpersonal relationships on emotional contagion as well as the increased likelihood of goal contagion amongst people who belong to the same groups.

Lastly, a generalised model of contagion theory is described and the results thereof discussed. In light of the theory, this study will investigate migration in terms of the primary drivers of migration, determinants which can be disseminated and gain influence as a result of social contagion effects.

3 Chapter 3:- Research Questions

In this chapter, the precise purpose of the research is defined in the form of research questions.

It has been established that emigrants may choose to leave their country of origin for a number of reasons. The research aims to identify to what extent those reasons gain influence due to social contagion effects – in other words, to what extent the metaphor of an "epidemic" can be used to describe emigration.

The research is divided into two parts. Part A is concerned with identifying and evaluating the primary drivers of emigration within the South African context. Thus, the research aims for part A is to:

- Identify the primary drivers, (relevant to social contagion theory), which play a role in influencing an individual's decision to leave SA.
- Determine the respective weight or influence of each driver.

Part B is concerned with investigating through simulation how the drivers of migration identified gain influence through social contagion and the impact thereof on migration. Thus, the research aims for part B is to:

- Establish the impact on drivers of migration as a result of general and isolated crises.
- Establish how drivers discouraging migration and those encouraging migration may interact.

4 Chapter 4:- Research Methodology

This chapter provides details of and defence of the methodology used, the definition of the population, the unit of analysis, the sample size and sampling method, the research instrument and details of how the data was collected as well as the process of data analysis. The limitations of the research are also discussed.

4.1 Research Design and Type

This research analyses the role that social contagion theory plays within the migration of individuals from SA. A 'model building' approach was adopted to simulate the dynamics between social contagion theory and the determinants that drive migration. Where applicable, the nature of the determinants of migration was established using available literature and through analysis of secondary data, specifically the Homecoming Revolution/DBSA database (DBSA dataset). Using evidence from this dataset, parameters were developed for a model of social contagion in emigration. The basis of the model developed is that of the generalised model of social and biological contagion (Dodds & Watts, 2005), and is extended to include features of the rumour transmission model proposed by Kawachi (2008).

4.2 Research Method, Technique and Tool

4.2.1 Population

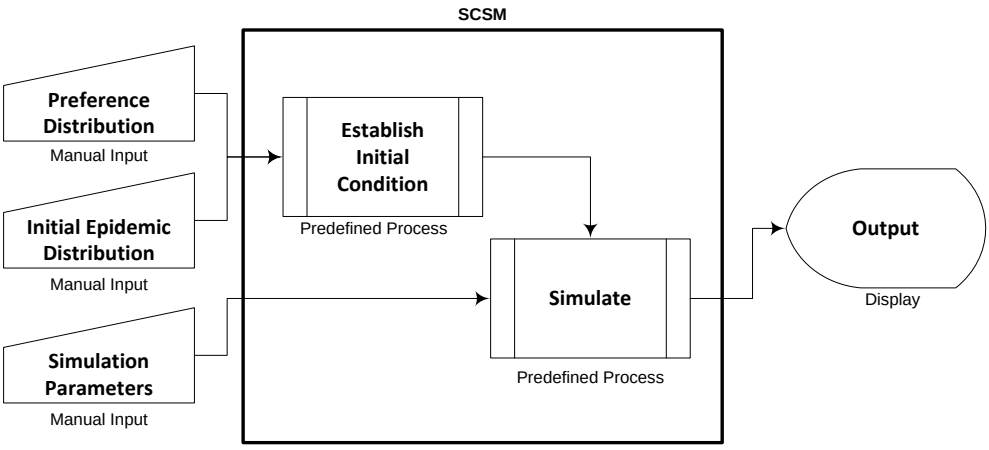
The relevant population is that of all South Africans of the age 20 and older. STATSSA (2001) reports that this population is in the order of 25 million people (25,472,775), representing approximately 57 per cent of SA's total population.

Due to the scale of the relevant population, a population distribution was utilised. A population distribution is a frequency distribution of the elements of a population.

4.2.2 Social Contagion Simulation Model (SCSM)

The Social Contagion Simulation Model (SCSM) developed in this research was written using the mathematical programming language, MATLAB. MATLAB is a tool widely used within industry and academia for technical computing in engineering and science. A phased approach was adopted in developing the model. To begin with, Dodds & Watts' generalized model of social and biological contagion (2005) was developed and then evolved to incorporate elements of the rumour transition model (Kawachi, 2008). The final model required an initial condition as an input. The condition was based on a given population who are exposed to an initial epidemic distribution. In addition, the population is comprised of individuals who have different preferences for leaving SA. The inputs and outputs of the model are illustrated in the proceeding figure.

Figure 6: SCSM Input and Output



The preference distribution was established through analysis of the determinants of migration from SA and a 'population initiator tool' (PIT). PIT was developed to generate a population representative of the target population subject to a number of demographic attributes. The development of PIT was necessitated by the fact that the available literature did not provide population data combining all the attributes of the South African population considered. The tool was developed using Access 2007 and Visual Basic for Applications (VBA).

Scenarios driven by user defined contagion parameters were then simulated using the SCSM. Simulations involved the random interaction between individuals through which they engage and discuss migration. The resultant output of the model is the percentage of the total population represented by the four states of the model.

4.2.2.1 Determinants of Migration

Secondary data was used to identify the drivers of migration by demographic group within the South African context. Responses generated by the 'Homecoming Revolution' and DBSA's "Where are they Survey?" performed in 2007 were utilized. The original purpose of the survey was twofold, the first being to identify relevant skills information about South African in the Diaspora, and secondly to get the relevant people to put their skills on the National Skills Database. Hence the survey determines the extent and type of skills disposed by South Africans abroad as well as the reasons for them not to return, in an effort to improve the effectiveness of the AsgiSA National Skills Database. (DBSA & Homecoming Revolution, 2006)

The questionnaire was distributed in a viral format, with the information from the survey collected into the DBSA database, (see Appendix I for questionnaire). The Homecoming Revolution utilized their network to encourage potential candidates to complete the questionnaire and provided the necessary web linkage. The findings of the survey were presented at the 'Knowledge Management Africa' conference in 2007 in Kenya, (DBSA & Homecoming Revolution, 2006).

The data complied with the 'secondary data criteria' described by Zikmund (2003) in terms of its applicability to the research objectives. Thus the data assists in answering the questions set out in the problem definition and is of the time period of interest. The data is also applicable to the relevant population as the questionnaire was answered by South Africans predominately over the age of 20, and characterises respondents by race, gender and level of education.

The survey asked respondents to rate a number of determinants of migration from SA from one to five, where one and five represented low and high ratings respectively. Respondents were also able to rate a determinant as 'not applicable'. The primary reasons considered by the respondents are listed in the proceeding figure.

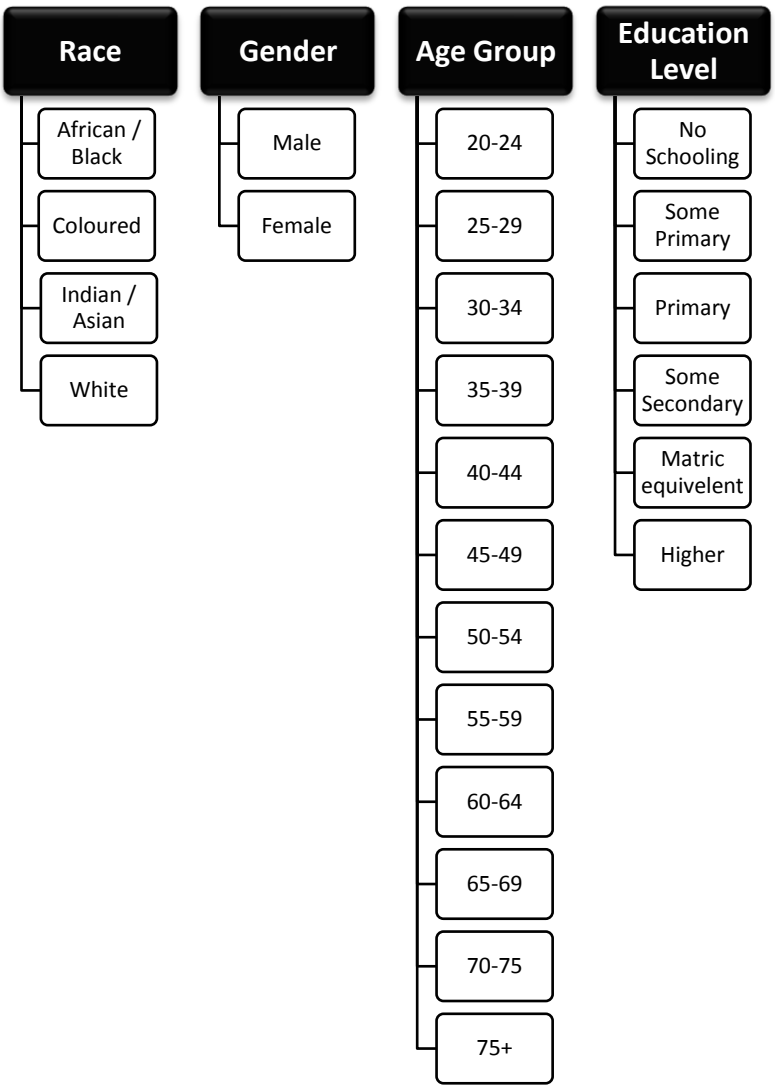
Figure 7: "Where Are They?" Survey - Determinants of Migration

4.2.2.2 Population Initiator Tool (PIT)

PIT produces populations of a user specified size with defined demographic attributes pertaining to 'race', 'gender', 'age' and 'level of education'. PIT assigns the elements of the demographic attributes to individuals within the population by comparing randomly generated numbers to the cumulative percentage of predefined frequency tables. Thus for each individual within the population a 'random' number is generated using VBA's 'rnd()' function. The 'rnd()' function produces a 'random' value greater than zero and less than one, it should however be noted that the 'random' number generated is not truly a random number. Whilst the numbers appear random it is possible to regenerate exactly the same sequence of 'random' numbers, as they are generated by a mathematical algorithm. Consequentially, before calling the rnd() function, the 'randomize' statement is used to initialize Microsoft's random-number generator with a seed based on the computer system's timer. This avoids the same number sequence being generated as each successive call to the 'rnd()' function uses the previous number as a seed for the next number in

the sequence (Microsoft, 2007). The characteristics of the population and their respective elements are described in the figure below:

Figure 8: PIT Population Characteristics



South Africa's 2001 Census data (STATSA, 2001) was used to establish the required frequency tables (see Appendix II). The subsequent distributions are illustrated in Figure 9 and Figure 10.

Figure 9: Demographic Attributes

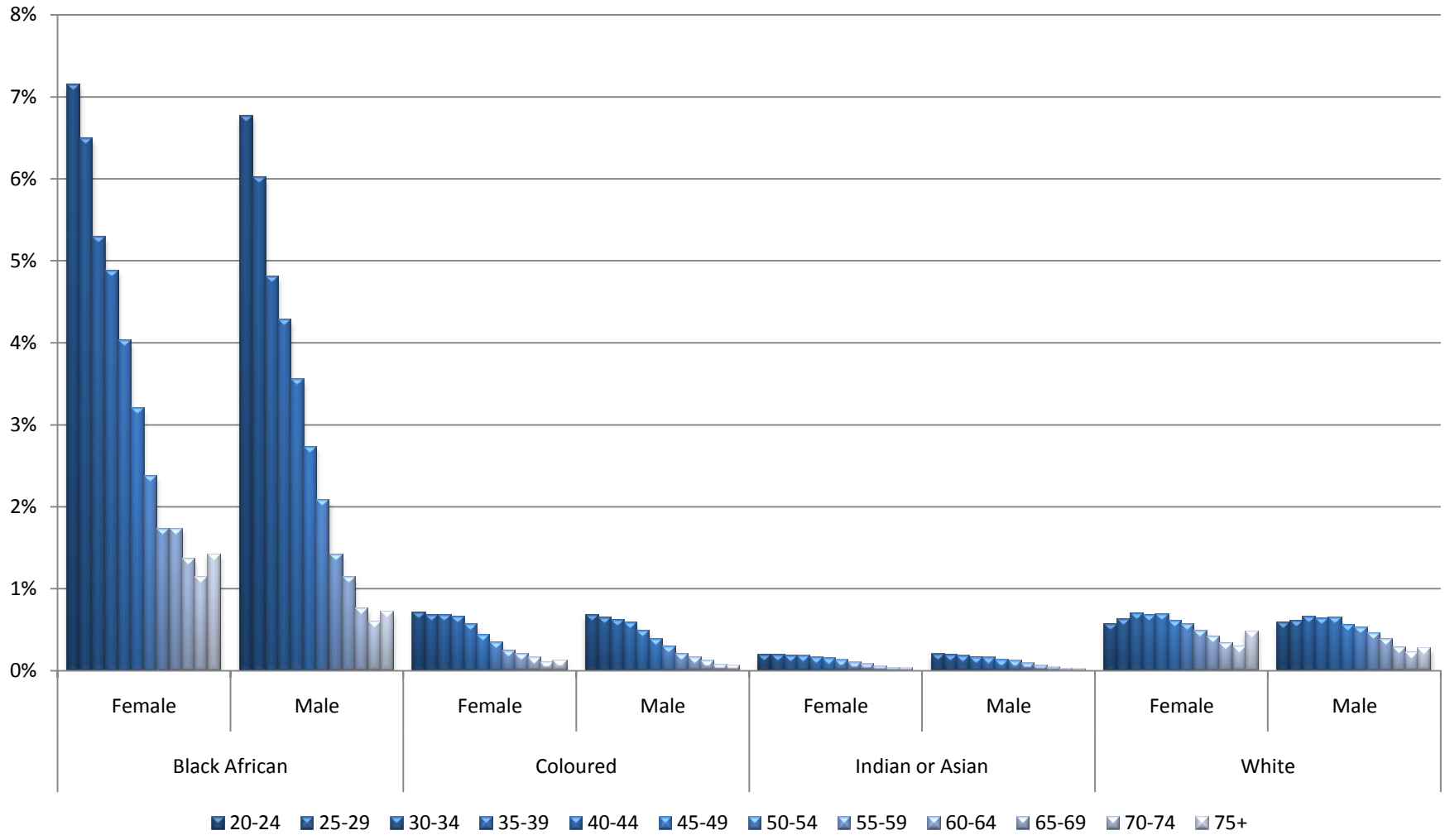
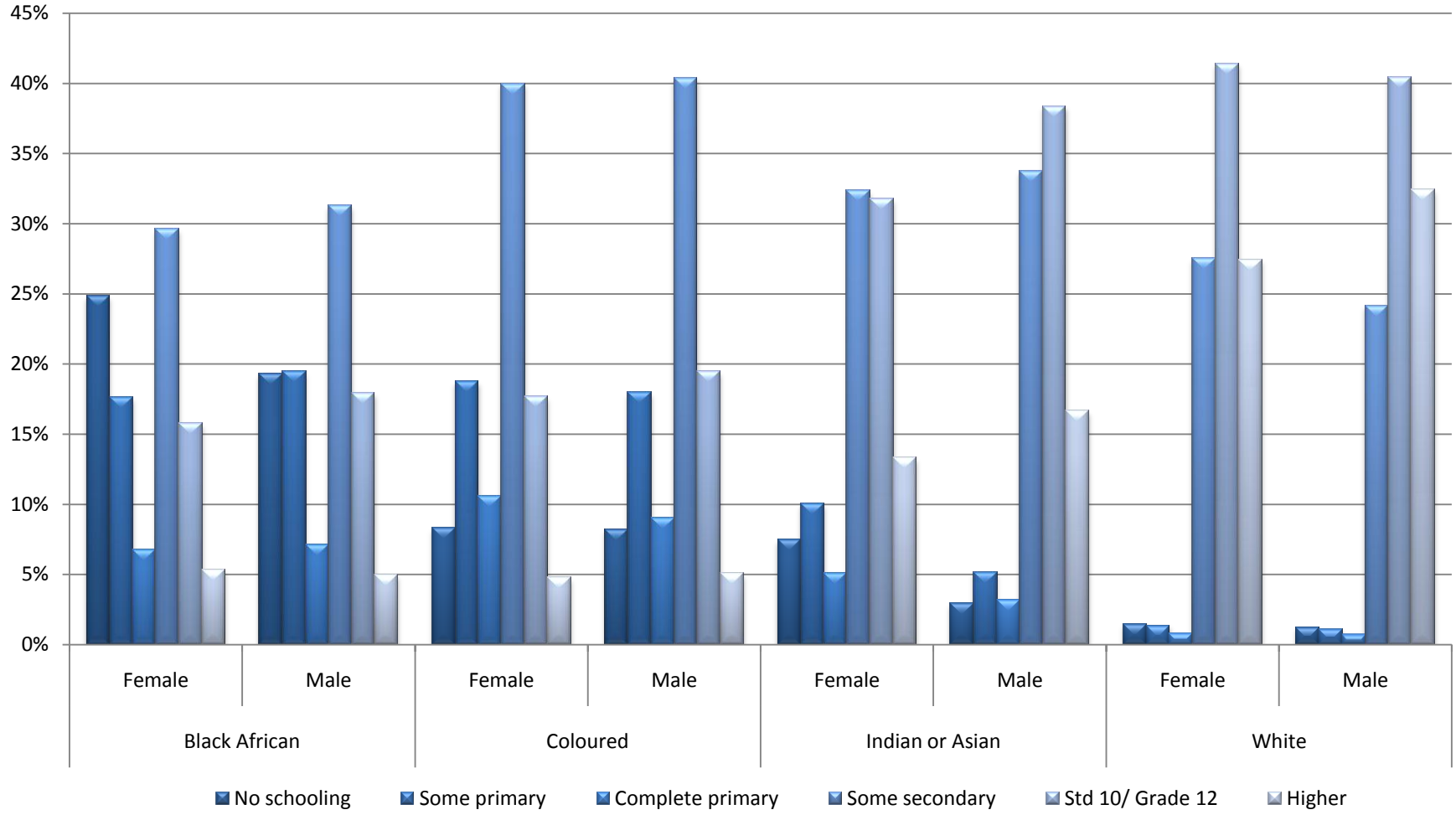


Figure 10: Education levels



4.2.2.3 SCSM Model Workings

SCSM considers a population of N individuals but differs from the generalized model in that it assumes that each individual may occupy one of four states, as the 'stifler' state of the rumour transition model is included. We have made this adaptation, which draws on the insights from Kawachi (2008) on rumour transmission, in order to better reflect the fact that not all social contagion has a negative effect. Unlike the rumour transition model however, the recovered state of the generalized model is retained, hence the states considered are that of the spreader, stifler, susceptible and recovered.

Within the context of migration, a spreader will expose a susceptible individual to a rumour encouraging emigration, either through general discussion or in regard to a particular determinant of migration, for example 'crime'. Based on the demographic group to which an individual belongs, an individual may have an affinity towards a particularly themed rumour. For instance an individual in their twenties may be more inclined to migrate for travel, whilst an individual in their forties may in general be more inclined to emigrate for reasons such as crime. Education may also play a role, as an individual with a higher education may choose to migrate for global job opportunities, whilst individuals with a lower education may predominately choose to migrate for simply more money. In terms of race, given SA's past, individuals of a particular demographic group may choose to migrate as a result of the country's politics whist other demographic groups may choose to migrate for reasons such as family. An

individual's propensity to leave based on a particular driver of migration may be brought about through isolated instances, for example a hijacking, or through general crises such as the threat of xenophobia that effect the entire population.

The concept of the stifler status is evolved to be that of an individual who exposes individuals to a rumour discouraging emigration through general discussion. Such discussion may be brought about through positive happenings, such as the SA's hosting of the 2010 Soccer World Cup or by improved crime statistics. Susceptible individuals interact and may be influenced by both spreaders and stiflers. Recovered individuals however are 'immune' to spreaders and stiflers, only returning to a susceptible state after a period of time.

Individuals maintain a memory of both spreader and stifler doses received from their last *T* contacts and the sum of individual *i*'s last *T* doses (*i*'s dose count) is denoted at the tth step by equation five:

$$D_{t,i} = \sum_{t'=t-T+1}^{t} b_{t,i} \times d_{t',i} \tag{5}$$

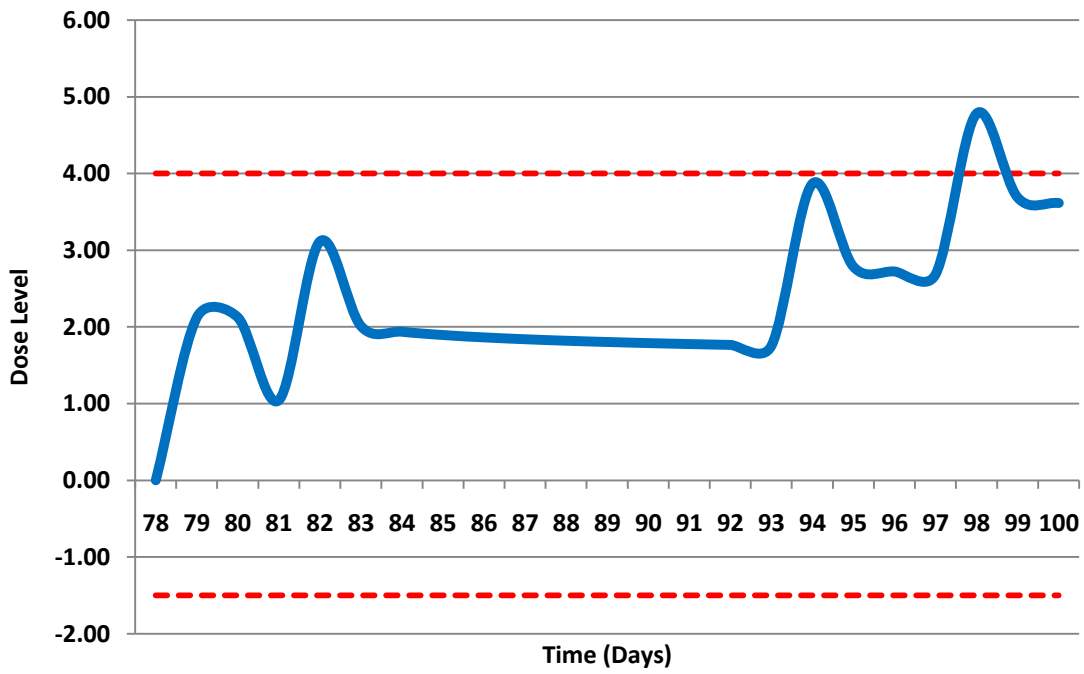
where,

$$b_{t,i} = \frac{1}{1 + \alpha \times log^{\beta}(1+t)} \tag{6}$$

Hence the SCSM incorporates the concept of the forgetting curve when establishing the dose count. Memory is therefore managed slightly differently to that of the generalized model as an individual's memory diminishes with

time, as opposed to remaining constant. The following figure describes the cumulative effect of a specific individual's memory over time. Each peak signifies where an individual initially received a dose whilst the gradual declines illustrate how the memory of the dose fades with time. It should be noted that the memory structures utilized within the model also retain the theme of the rumour perpetuated by the spreader, for example crime, travel etc. Thus, the most prominent determinant of migration driving a spreader can be determined and passed on to the susceptible individual that they infect.

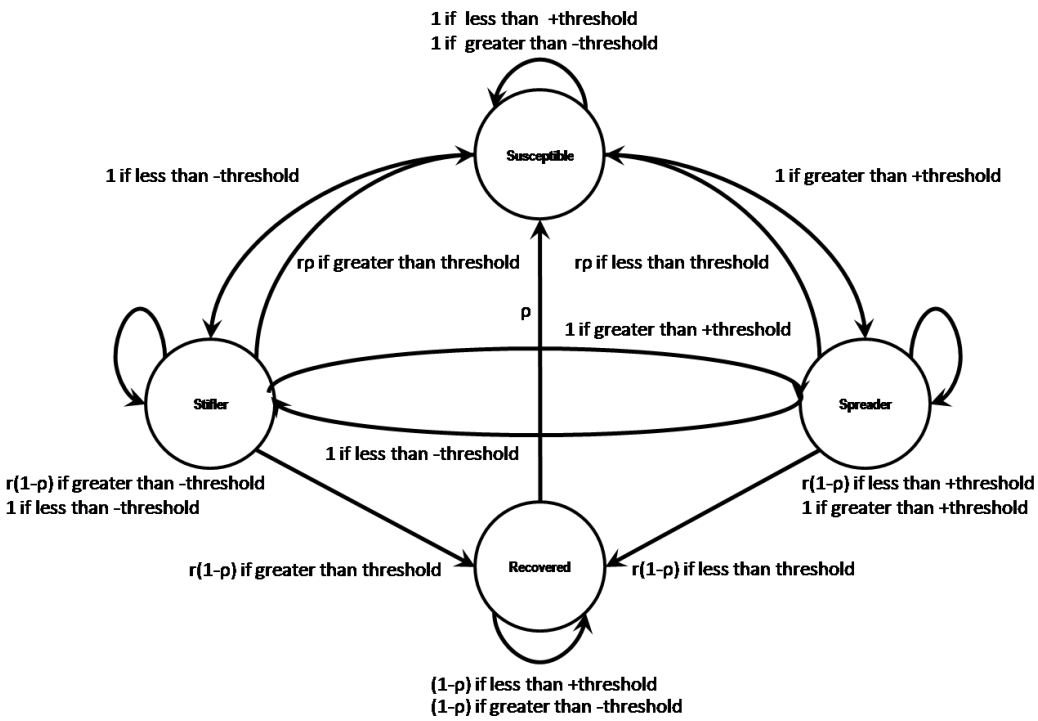
Figure 11: SCSM - Example of Individual Dose Curve



In the event that a susceptible individuals dose count either exceeds a positive threshold $+d^*$ or drops below a negative threshold $-d^*$, the individual will move into the infected state of the spreader or stifler respectively. Infected individuals whose dose count drops below the positive threshold $+d^*$ or rises above the negative threshold $-d^*$, may recover with probability r at each time

step. Once in the recovered state, individuals may become susceptible again with probability ρ. Hence the simulation parameters of the generalized model are retained. The figure below illustrates the described dynamics of the SCSM.

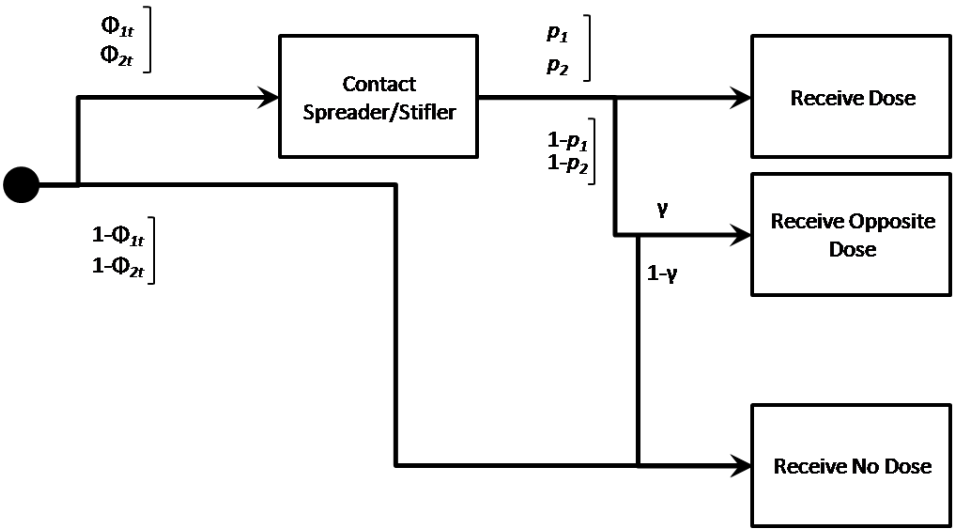
Figure 12: SCSM - State Transition Probabilities



At each (discrete) time step *t*, each individual *i* come into contact with another individual chosen uniformly at random from the population. This event occurs with probability Φ_{1t} and Φ_{2t}, the fraction of spreader and stifler individuals respectively. Subsequently with probability p_1 and p_2 the susceptible individual will receive a dose d_+ or d_-, drawn from a distribution after exposure to a spreader or stifler. In the SCSM, should p_1 or p_2 not be successful, the individual *i* may receive an 'anti-dose' depending on probability γ. Hence individual *i* may oppose a rumour and be influenced in the opposite direction;

otherwise receiving a dose of zero. It should be noted that the model now facilitates the ability of a susceptible individual to oppose a spreader's rumour and receive a stifler dose, and vice versa. This interaction can be eliminated by setting the gamma to zero. The following figure provides a schematic representation of the dose determination of the SCSM.

Figure 13: SCSM - Dose Determination



4.3 Unit of Analysis

The unit of analysis considered is at an individual level. The population is heterogeneous, thus each individual has a unique tolerance with respect to accepting and being influenced by information spread through social contagion. In addition each individual has the ability to convince those with whom they interact about their views with varying degrees of effectiveness.

4.4 Sampling Method

Non-probabilistic convenience sampling was used to obtain the relevant DBSA and Homecoming Revolution's database in an effort to establish parameter

values for the proposed model. The advantage of this approach is the low cost in terms of the time required to obtain it (Zikmund, 2003), and was necessitated as no accurate parameters of the scope of the SA emigrant population exists. This data consists of 6938 responses to questions pertaining to migration.

4.5 Data Analysis

In alignment with the research aims, data analysis fell two distinct parts. Part A involved analysis of the secondary data to determine and evaluate the primary drivers of migration from SA. The data was first cleansed to ensure a cohesive and workable dataset and thereby prevent misleading results later on (Zikmund, 2003). Descriptive analysis was then performed to better understand the nature of the dataset. Subsequent analysis thereafter identified drivers influencing migration by population group and established the respective weight or influence of each driver.

Part B involved analysis of the output of the SCSM for a number of constructed scenarios. Before scenarios were run the integrity of the model was tested by comparing results of the basic SIS model for homogenous and heterogenous populations to the results obtained by Dodds & Watts (2005). Each scenario was designed to establish the sensitivity of each driver in terms of general and isolated crises caused by a particular determinant, as well as to establish how contagions discouraging migration and those encouraging migration interact.

4.6 Data Validity and Reliability

The intended research is susceptible to administrative error in the form of data-processing errors. Zikmund (2003) defines data-processing errors as an error occurring because of incorrect data entry, incorrect computer programming, or other error of data analysis. Thus, each step of the process requires careful validation to ensure the integrity of the research. In addition, due to the nature with which the secondary data was obtained, variability and bias of estimates cannot be measured or controlled, and projecting data beyond the sample would be inappropriate (Zikmund, 2003).

4.7 Potential Research Limitations

Limitations to the research may arise as a consequence of the secondary data used. The data was gathered by means of a survey, a research technique that is susceptible to several errors. Response error may occur in the form of extremity bias as well as auspices bias. Extremity bias occurs when individuals tend to use extremes when responding to questions (Zikmund, 2003). Emotive questions such as ones reasons for emigrating may evoke such responses. Auspices bias occurs when the responses of subjects are influenced by the organization conducting the study (Zikmund, 2003). The Home Coming Revolutions involvement in the gathering of the data could result in such bias as the organisation may only appeal to a particular subset of all emigrants. In addition the data may be prone to sample selection error. An error defined by Zikmund (2003) as a systemic error that because of an error in either the sample design or execution of the sampling procedure

results in an unrepresentative sample. Such an error may occur as there is no established population size of emigrants and thus no idea as to how the sample relates to the actual population.

Limitations to the research may also occur as a result of the computing power available, owing to the fact that the model may be computationally expensive. This becomes increasingly relevant as scenarios involving large populations with numerous interactions are simulated over extended periods.

5 Chapter 5:- Results

This chapter presents the results of Part A and Part B of the research. The first part deals with the results obtained through analysis of secondary data, whilst the second part concerns the simulation results of various scenarios.

5.1 Part A - Determinants of Migration from SA

5.1.1 Survey Analysis

In total, the DBSA dataset is composed of 6939 observations. A data cleansing process was undertaken to arrive at a concise and workable dataset. Four variables within the resultant dataset characterized individuals, namely: race, gender, age at time of departure from SA and education level.

Where applicable, the cleansing process involved the recoding of data for ease of use. For example, the level of education was recoded to align with the data obtained from STATSA. The process also involved the calculation of new fields using the original data, for example the age at an individual's time of departure from SA was calculated using the year of the respondents birth (YOB) and the year they left SA. Only individuals who were at least 20 when leaving SA were included in the final dataset. This was done in an effort to ensure that the individuals considered left SA on their own accord. As a result, of the 6939 observations 962 were not considered due to insufficient data or because the individual was below the age of 20.

In addition, observations with incomplete or unusable responses were removed from the dataset, for example:

- 70 observations in responses to the question of race.
- 199 observations in response to the question of gender.
- 94 observations in response to the question of education level.

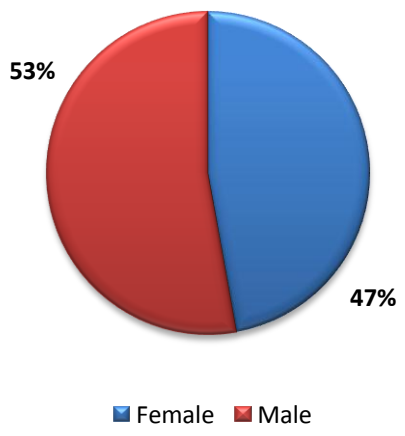
The ratings, which each respondent supplied in terms of the nine predefined primary reasons for leaving SA, were retained in the final dataset, except where a respondent rated all determinants of migration as zero. The net effect of missing values in the before mentioned variables and subsequent observations discarded was a final dataset of 5685 observations.

5.1.2 Descriptive Statistics

5.1.2.1 Gender

The majority of respondents to the DBSA survey are male, however this is minor as male and female respondents are fairly evenly represented in the data.

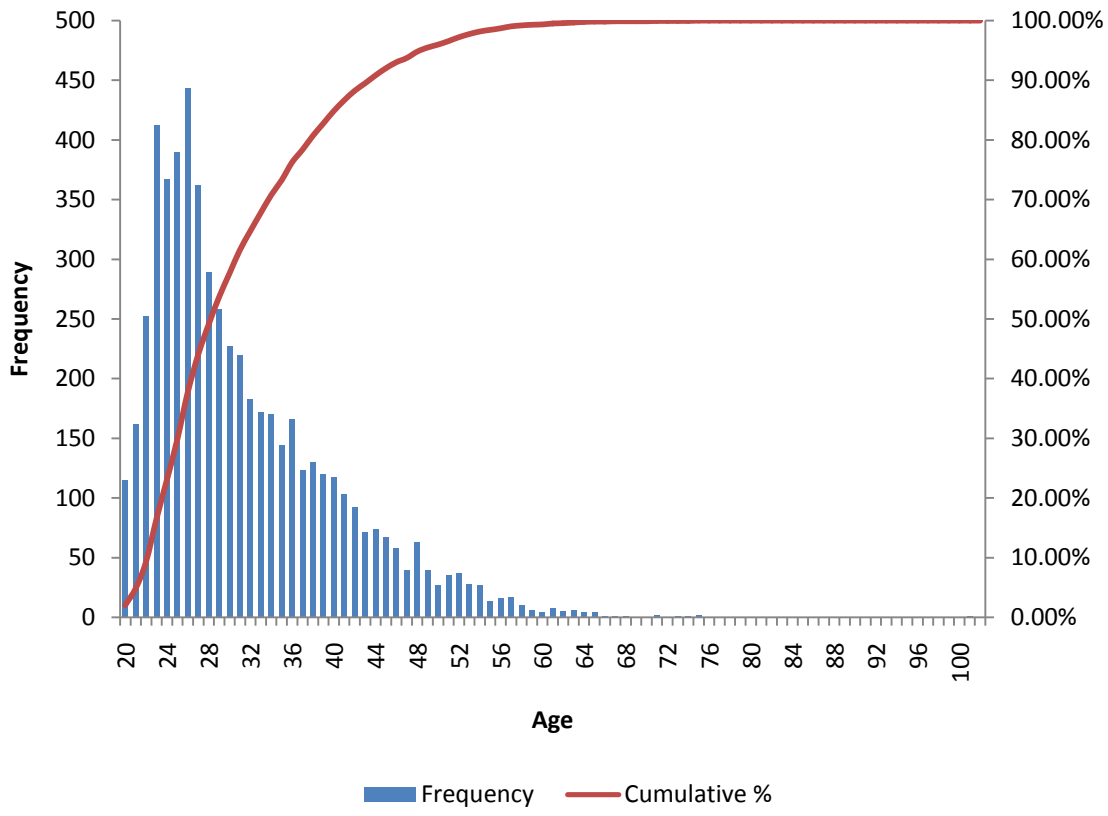
Figure 14: DBSA Data – Gender



5.1.2.2 Age at Time of Departure

Seventy percent of the respondent's left SA between the ages of 20 and 34, with the average age of being 31. Age groups comprised of five year intervals were constructed, the age group of '25-29' years represent over 30% of all respondents. The proceeding figure illustrates the distribution of the respondent's ages in the form of a histogram.

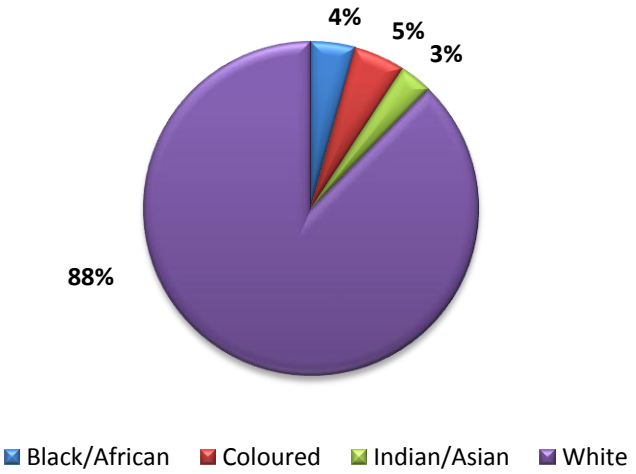
Figure 15: DBSA Data – Age at time of departure from SA



5.1.2.3 Race

Respondents to the DBSA survey are predominately white, with other races only marginally represented, yet evenly distributed.

Figure 16: DBSA Data - Race

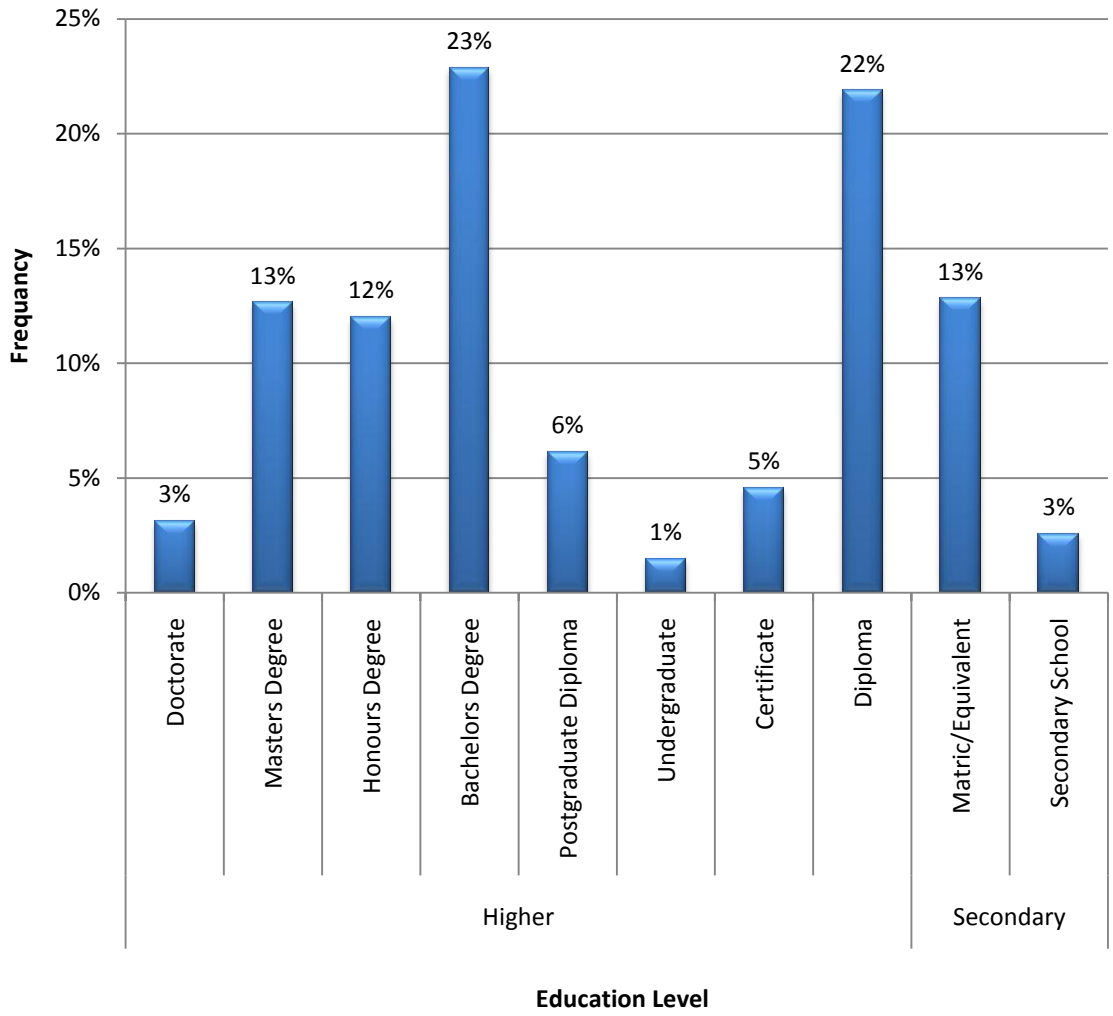


5.1.2.4 Education Levels

The education levels indicate that all respondents are relatively well educated; with approximately 85% of all respondents having obtained a tertiary (higher) education. It should be noted that no respondents had less than a secondary education; hence the dataset is representative of predominantly skilled workers.

The data was recoded using descriptions of 'Higher' or 'Secondary' education levels. This was performed to ensure sufficient representation by education level in later analysis. The following figure reflects the education levels as percentages of the total number of respondents.

Figure 17: DBSA Data - Education levels

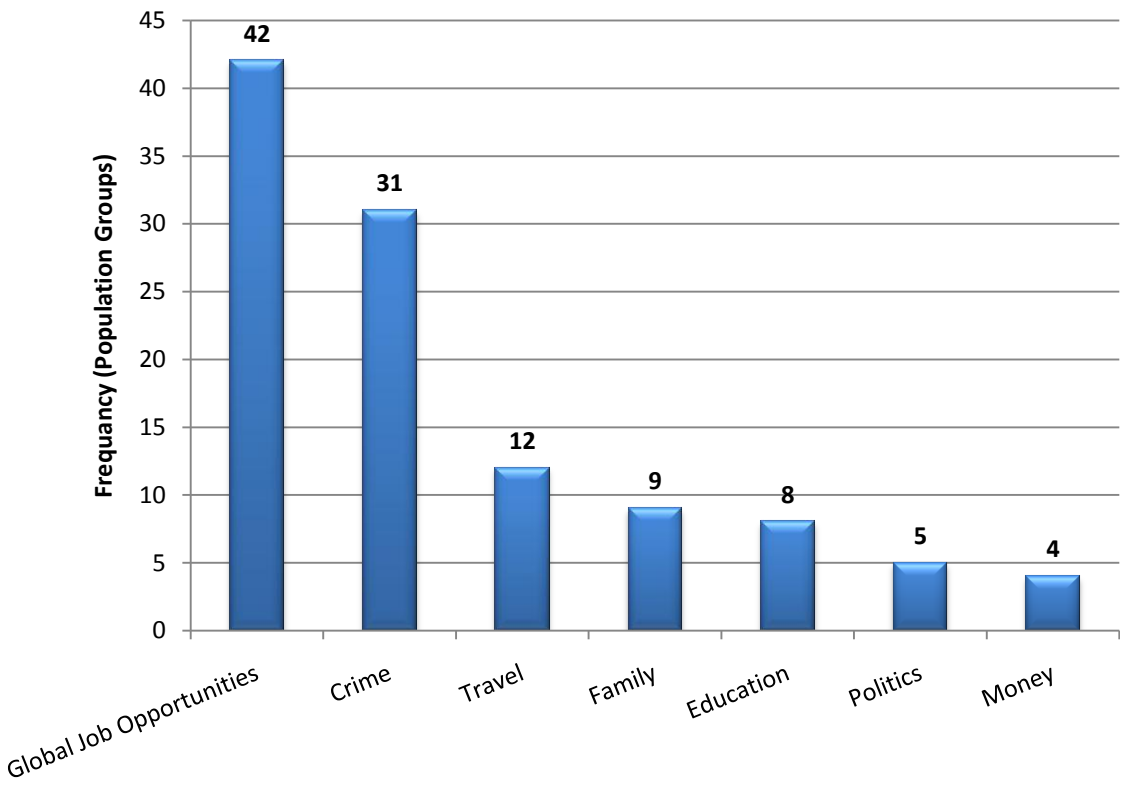


5.1.3 Determinants of Migration

In order to establish the leading determinants of migration, the ratings pertaining to the primary reasons for leaving SA were aggregated with respect to 111 population groups composed of race, age, education level and gender. The determinant with the greatest average value was then selected as the primary reason for leaving SA for each group. Seven of the nine predefined determinants emerged, with global job opportunities (GJO) rated as the leading determinant of migration by frequency across population groups,

followed by crime. Each determinant's frequency with respect to the number of population groups is illustrated in the following figure.

Figure 18: Leading Determinants of Migration Histogram



It should be noted that due to the nature of the sample, not all aggregates may be considered statistically significant as there are instances of fewer than 30 observations in a number of the population groups.

The aggregate value of each determinant of migration for population groups with more than 30 observations is detailed in Table 5. In addition, Figure 19 graphically illustrates the determinants of migration for all groups, with observations of less than 30 denoted with asterixis (*).

Table 5: Aggregate Values of Key Determinants (>30 observations)

Race	Education Level	Gender	Age Group	GJO	Education	Affirmative Action	Politics	Family	Crime	Money	Travel	Exile
Black/African	Higher	Female	25 - 29	4.12	2.52	1.33	1.73	1.21	2.39	3.24	3.55	0.82
Black/African	Higher	Male	25 - 29	4.00	3.60	1.26	1.91	1.71	2.34	3.37	3.43	0.80
Black/African	Higher	Male	30 - 34	3.94	3.13	1.19	1.71	1.87	2.23	3.29	3.39	0.94
Coloured	Higher	Female	25 - 29	3.78	2.69	1.76	1.89	1.87	3.04	3.38	3.89	0.98
Indian/Asian	Higher	Male	25 - 29	4.24	2.49	2.35	2.65	1.43	3.86	3.81	3.70	1.27
White	Higher	Female	20 - 24	3.63	2.15	2.66	2.68	1.93	3.37	3.47	4.06	1.25
White	Higher	Female	25 - 29	3.67	2.26	2.55	2.65	1.87	3.45	3.42	3.79	1.11
White	Higher	Female	30 - 34	3.51	2.51	2.51	2.80	2.36	3.77	3.05	3.08	1.05
White	Higher	Female	35 - 39	3.47	2.66	2.56	2.89	2.47	3.96	2.95	3.05	1.06
White	Higher	Female	40 - 44	3.52	2.87	2.87	2.71	2.31	4.03	3.09	2.89	1.09
White	Higher	Female	45 - 49	3.45	2.33	2.73	2.88	1.90	3.91	2.91	2.63	1.13
White	Higher	Female	50 - 54	3.41	2.09	2.93	2.70	3.00	3.76	3.11	2.52	0.83
White	Higher	Male	20 - 24	3.89	2.32	3.07	3.02	1.81	3.43	3.51	3.85	1.28
White	Higher	Male	25 - 29	4.01	2.19	3.17	2.92	1.79	3.58	3.47	3.67	1.19
White	Higher	Male	30 - 34	3.86	2.34	3.02	2.95	2.01	3.83	3.15	3.00	1.14
White	Higher	Male	35 - 39	3.78	2.56	3.21	3.15	2.25	4.08	3.26	2.81	1.12
White	Higher	Male	40 - 44	3.56	2.59	3.07	2.91	2.22	3.92	2.84	2.48	1.20
White	Higher	Male	45 - 49	3.62	2.26	3.46	3.12	2.22	4.00	2.95	2.27	1.12
White	Higher	Male	50 - 54	3.63	2.03	3.49	3.24	2.54	4.19	3.25	2.64	1.01
White	Higher	Male	55 - 59	3.62	1.79	2.91	2.94	2.76	3.82	2.88	2.06	0.88
White	Secondary	Female	20 - 24	3.56	2.35	2.48	2.80	2.30	3.49	3.49	3.74	1.25
White	Secondary	Female	25 - 29	3.40	2.05	2.57	2.85	2.20	3.79	3.22	3.78	1.22
White	Secondary	Female	30 - 34	3.27	2.63	2.51	2.93	2.75	3.99	2.79	2.85	1.16
White	Secondary	Female	35 - 39	2.75	2.97	2.45	3.05	2.77	3.80	2.91	2.41	1.00
White	Secondary	Female	40 - 44	2.71	2.26	2.42	2.87	2.81	3.90	3.00	2.29	0.71
White	Secondary	Female	45 - 49	2.94	1.84	2.78	2.72	2.22	3.91	3.22	2.75	0.72
White	Secondary	Female	20 - 24	3.73	2.07	2.84	2.98	2.04	3.34	3.48	3.90	1.36
White	Secondary	Female	25 - 29	3.86	2.34	3.12	3.08	2.22	3.59	4.04	3.68	1.41
White	Secondary	Female	30 - 34	3.81	2.45	3.31	3.09	2.64	4.06	3.36	3.03	1.12
White	Secondary	Female	35 - 39	3.63	2.52	3.38	3.33	2.46	4.15	3.29	2.88	1.02

Figure 19: Determinants of Migration by Population Group

			20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+
WHITE	Secondary	Male	Travel	Money	Crime	Crime	Crime*	Crime*	Crime*	Crime*	Crime*	Crime*	Family*	
		Female	Travel	Crime	Crime	Crime	Crime	Crime	Crime*	Family*	Family*	Family*		
	Higher	Male	Global Job Opportunities	Global Job Opportunities	Global Job Opportunities	Crime	Crime	Crime	Crime	Crime*	Crime*	Family*	Education*	Crime*
		Female	Travel	Travel	Crime	Crime	Crime	Crime	Crime	Crime*	Crime*	Politics*	Family*	
AFRICAN/BLACK	Secondary	Male	Politics*	Global Job Opportunities *	Global Job Opportunities *			Family*						
		Female	Global Job Opportunities *			Education*								
	Higher	Male	Eduction*	Global Job Opportunities	Global Job Opportunities	Global Job Opportunities *	Global Job Opportunities *							
		Female	Global Job Opportunities *	Global Job Opportunities *	Money	Education*	Global Job Opportunities *	Money	Global Job Opportunities *					
COLOURED	Secondary	Male	Politics*	Global Job Opportunities*	Global Job Opportunities*	Global Job Opportunities*	Crime*	Family*						
		Female	Global Job Opportunities*	Travel*	Crime*	Global Job Opportunities*								
	Higher	Male	Global Job Opportunities*	Travel*	Travel*	Global Job Opportunities*	Education*							
		Female	Travel*	Travel*	Global Job Opportunities*	Travel*	Crime*	Global Job Opportunities*	Global Job Opportunities*	Travel*				
INDIAN/ASIAN	Secondary	Male	Travel*	Global Job Opportunities*	Education*	Politics*								
		Female	Global Job Opportunities*	Crime*	Education*	Global Job Opportunities*								
	Higher	Male	Education*	Global Job oppourtunities*	Global Job oppourtunities*	Global Job Opportunities*	Global Job Opportunities*	Global Job Opportunities*	Global Job Opportunities*	Global Job Opportunities*				
		Female	Global Job Opportunities*	Global Job Opportunities*	Global Job Opportunities*	Global Job Opportunities*	Crime*	Politics*	Money*	Family*				

Figure 19 graphically illustrates how the themes motivating an individuals decision to migrate from SA change over time. This is particularly evident within the white demographic where there is a clear transition from travel to crime and then later to family as the primary reason for leaving SA, a trend that persists across gender and education levels. One exception to this trend is that of white males aged 20-24 who have obtained a high level of education, in this instance the lure of GJO manifests as the primary reason for leaving SA.

Within other demographic groups, the trends differ and are not as easy to identify due to a lack of data relating to older individuals. GJO lure African/Black males and females from an early age into leaving SA. The absence of crime as a leading determinant within this demographic is noticeable. In the case of young Black/African males and females with a higher education level, (a population group of more than 30 respondents), crime in fact ranked only fourth as the primary reason for migrating (Table 5), in stark contrast to their white counterpart's who rated crime as first.

Travel is credited as the primary reason for migration from SA amongst young (25-29) coloured males and females across education levels. The exception is that of males who have obtained a secondary education, who rate GJO as the most important factor. Crime emerges as a leading factor for females with secondary and higher education level at the ages of 30-34 and 40-44 respectively.

For Indian/Asian respondents GJO emerged as a significant factor in driving individuals to migrate from SA. For those with a secondary level of education,

education itself becomes the foremost reason for leaving SA for both males and females of the ages 30-34.

The relative weight or influence of the leading determinants of migration from SA on the population of interest was determined by establishing a 'preference frequency'. Leading determinants with greater than 30 observations were assigned by individual to a population of 10000 produced using PIT. The percentage of individuals likely to be effected by such determinants, with respect to the total population of interest, is summarised in the table below:

Table 6: Determinants of Migration by % of Population

Determinant	Share of Population
Crime	4.9%
GJO	1.4%
Travel	1.4%
Money	0.5%

From the results in the table above, crime has the greatest impact on the entire population. The table illustrates that whilst a determinant may affect and influence several population groups, its effect in terms of the entire population may be negligible. For instance GJO influenced the largest number of population groups, however when the size of these population groups are considered; its effect on the entire population is negligible.

5.2 Part B - Scenario Analysis

5.2.1 Model Calibration

To ensure the integrity of the SCSM model, the model was reduced to the simplest case of the generalized model of social and biological contagion (Dodds & Watts, 2005) – that being the homogenous and heterogenous cases of the SIS version of the model with ρ equal to one and T set to two. In both cases the simulation was run with a population of 1000 individuals over 400 time steps (days) for values of p ranging from zero to one in increments of 0.0125. The initial condition of each simulation is that the entire population is infected.

For the homogenous population, dose sizes and thresholds are uniformly set to one. Whilst in the case of the heterogenous population, normal distributions are utilized for individual threshold and dose sizes. A normal distribution with a mean of 4 and standard deviation of 0.25 were used to assign doses, whereas a normal distribution with a mean of 1.5 and standard deviation of 0.1 was used to assign thresholds.

Thresholds were allocated to individuals at the onset of the simulation and remained unchanged for the duration of the simulation, whilst dose sizes were allocated to individuals as they received them. The distributions of doses and thresholds for the heterogenous population scenario are illustrated in the proceeding figures.

Figure 20: Normal Distribution of Dose Sizes

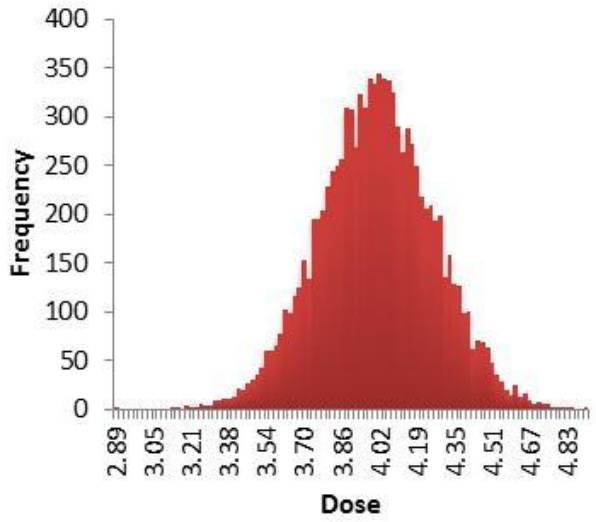
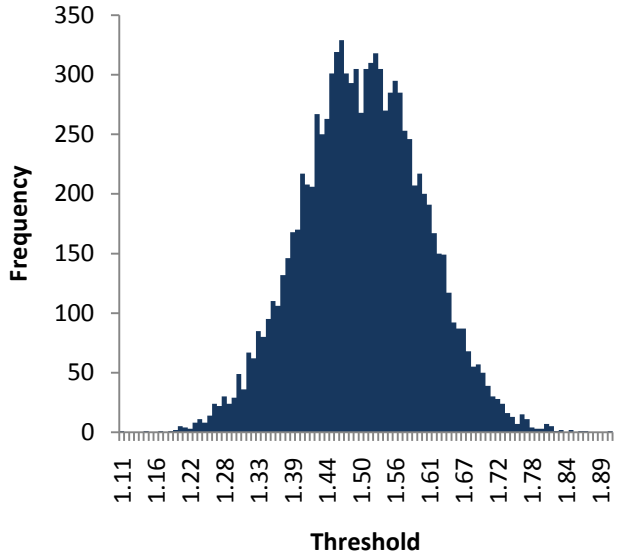


Figure 21: Normal Distribution of Threshold Sizes



Thus individuals will generally be allocated thresholds of between 1.4 and 1.6 and expect to receive doses of 3.75 to 4.25. However extremes may occur and an individual with a threshold of only 1.2 could receive a dose of 4.7. This means that with no further exposure, based on the forgetting curve the individual will only have the opportunity to recover after two days. The

percentage of infected individuals for values of p ranging from zero to one are graphically illustrated in the proceeding figures:

Figure 22: Homogeneous SIS – Generalised Model

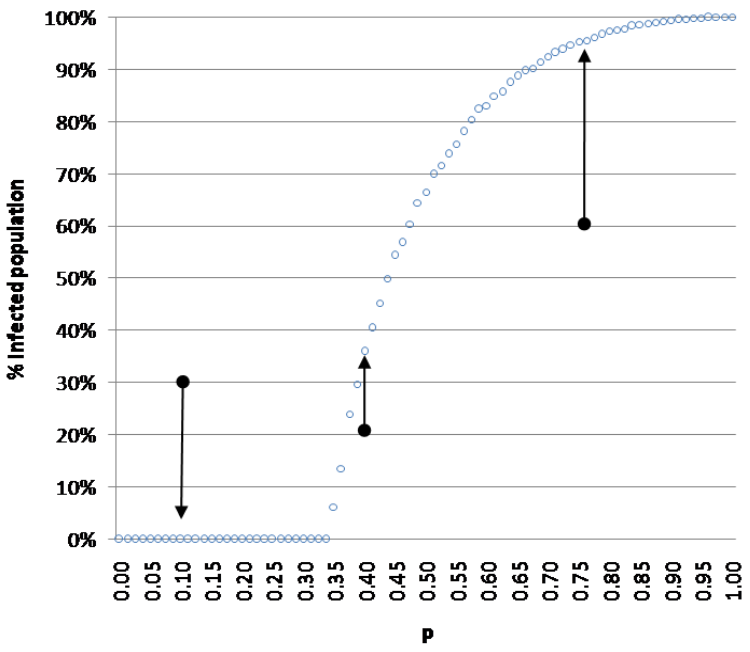
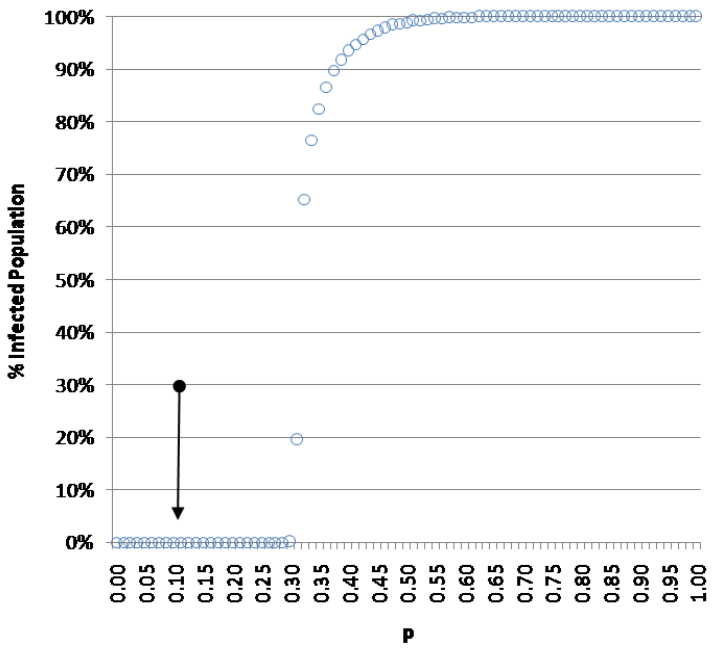


Figure 23: Heterogeneous SIS – Generalised Model



As in Dodds and Watts (2005) results the trajectories of initial conditions are included in the preceding figures to illustrate how the level of an epidemic evolves for different values of p. The trajectories indicate the percentage of the population to be infected, given a particular value of p and initial percentage of the population infected.

Both figures illustrate the presence of epidemic threshold dynamics where initial outbreaks either die out or else infect a finite fraction of the population, depending on whether or not p exceeds a specific critical value p_c. In the case of the heterogeneous SIS model, the rising branch of the epidemic threshold model has a negative rather than a positive slope and comprises unstable rather than stable points (Dodds & Watts, 2005).

5.2.2 Baseline Scenario

A baseline SIRS scenario for the heterogenous population is developed as a frame of reference for further analysis. The parameter settings used in the baseline scenario are detailed in Table 7.

Table 7: Baseline Model - Parameter Values

Parameter	Description
T	10
p	0.6
r	0.5
ρ	0.7
$f(d)$	Normal distribution μ=4, σ=0.25
$g(d^*)$	Normal distribution μ=1.5, σ=0.1
γ	0

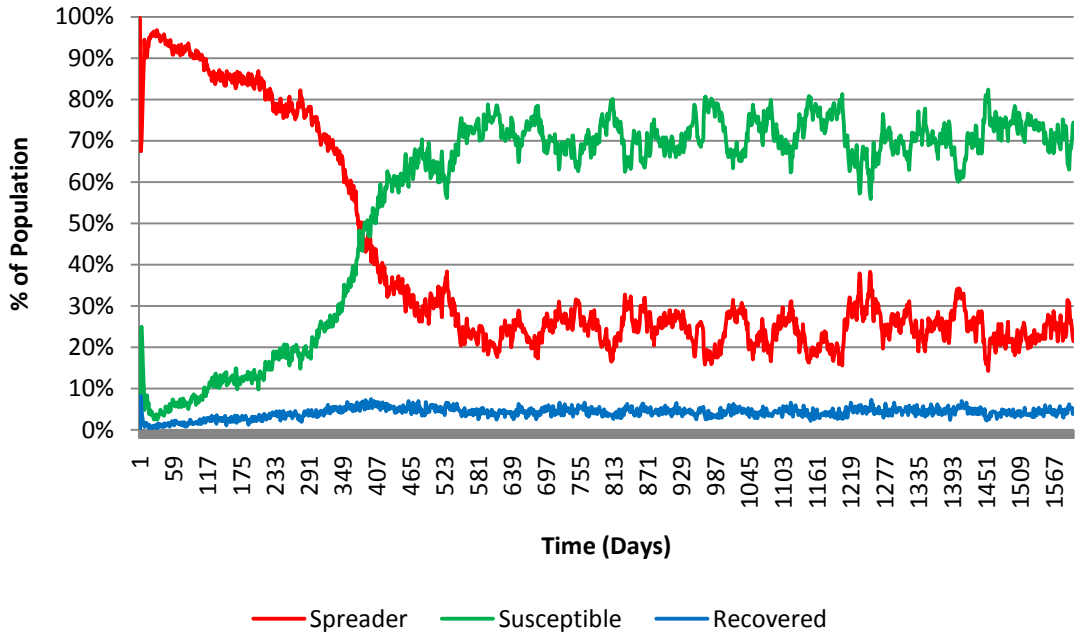
T is set to ten and dose sizes and thresholds are distributed using normal distributions as described earlier. The simulation is run over 1600 time steps (days) with a population of 1000 for ten iterations. The initial condition of the

simulation is that all individuals are infected. In addition to a general rumour advocating migration, themed rumours are able to occur. The population is assigned affinities towards determinants of migration as per the percentages indicated in Table 6. The following heuristics are assumed with respect to themed rumours:

- Should an individual be exposed to a general rumour, it is assumed that the individual will be inclined to perpetuate the rumour in terms of their own natural affinity towards a determinant of migration, e.g. travel. Thus it is assumed that whilst general discussion may fuel an individual's decision to migrate, they will in general perpetuate the rumour in terms of the determinant towards which they are most sensitive.
- An individual will perpetuate rumours in terms of the determinant of migration to which they are inclined with a probability of 0.5, versus an alternate determinant to which they are exposed to. Thus an individual who is naturally inclined to discuss crime as a reason for leaving SA may revert to discussing GJO with probability 0.5 should they be successfully exposed.

An example of a single iteration of the baseline scenario is illustrated in the proceeding figure. The figure graphically illustrates the percentage of individuals within each state of the model over time.

Figure 24: Baseline Scenario - Single Iteration Example



In Figure 24, the initial epidemic in which the entire population is infected reaches a state of equilibrium over time. After approximately day 550 the model stabilizes and the spreader, susceptible and recovered states fluctuate around 24%, 72% and 4% respectively. The model behaves predictably as illustrated in the proceeding table, which details the average percentage of the population by state over the last 1000 time steps (days), for each iteration of the baseline model.

Table 8: Baseline Scenario - State %

Iteration	Infected	Susceptible	Recovered
1	24%	72%	4%
2	24%	72%	4%
3	25%	70%	4%
4	24%	71%	4%
5	24%	71%	4%
6	24%	72%	4%
7	25%	70%	5%
8	25%	70%	4%
9	23%	73%	4%
10	25%	71%	4%
Average	**24%**	**71%**	**4%**

The average percentages of the population in each state of the model are consistent over the 10 iterations of the scenario. Thus, the baseline model provides a point of reference from which to compare the results of future scenarios. Table 9 details the average number of successful exposures per day by determinant for the baseline model over the last 1000 time steps (days).

Table 9: Baseline Scenario- Average Successful Exposures per Time Step (Day)

Iteration	General	Crime	GJO	Travel	Money
1	118.93	9.07	3.74	2.99	1.24
2	119.65	9.21	3.72	3.02	1.29
3	125.21	9.43	4.02	2.94	1.48
4	121.73	9.57	3.83	3.27	1.26
5	121.62	9.30	3.97	3.17	1.22
6	120.59	8.83	3.83	3.01	1.22
7	127.57	9.66	4.04	3.15	1.37
8	127.56	10.03	4.05	3.18	1.28
9	112.68	8.59	3.61	2.94	1.32
10	123.13	9.43	4.15	3.17	1.23
Average	**121.87**	**9.31**	**3.90**	**3.09**	**1.29**

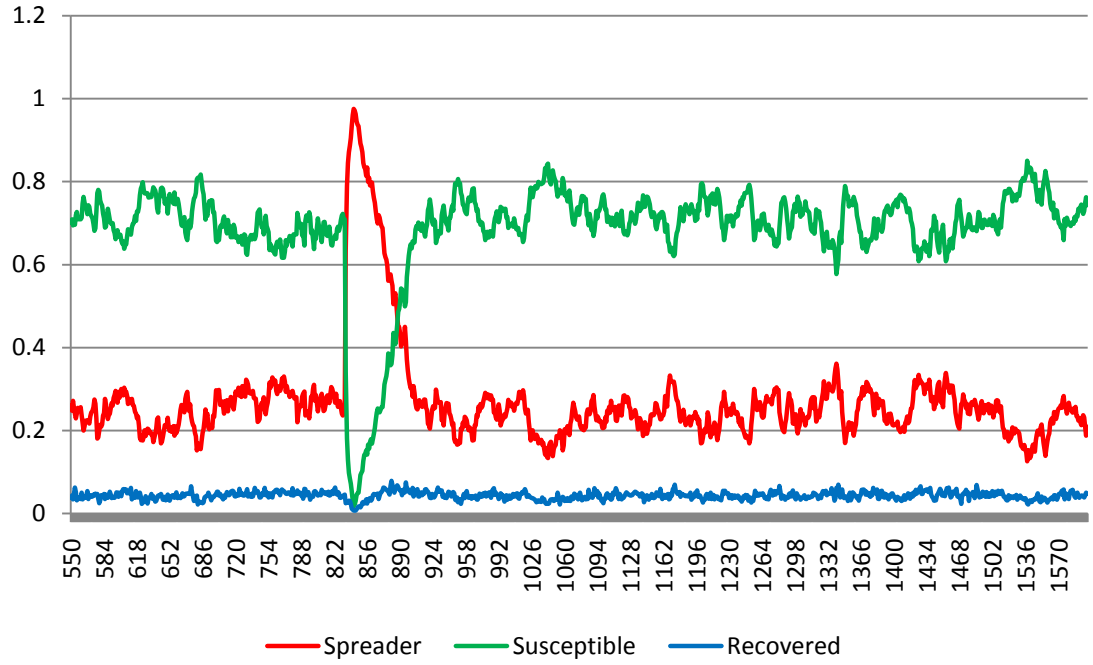
The average number of successful exposures appears to align to the ratio of individuals within the population who possess natural affinities to the respective determinants of migration.

5.2.3 General Crises

In order to determine how the dynamics of the baseline model will react to a general crisis, whereby a significant percentage of the population is exposed to a particular determinant of migration, the following scenario is constructed. A general crisis is introduced to the baseline model over 10 days (833 to 843). The crisis results in each individual being exposed to a determinant of migration and receives a dose with a probability of 0.5. The scenario is run for 10

iterations for each determinant of migration respectively. A single iteration of a general crisis occurring because of crime is illustrated in the proceeding figure.

Figure 25: General Crises - Crime



The figure illustrates how in contrast to the baseline model a sudden peak in the percentage of the population represented by the spreader state disrupts the state of equilibrium between time steps 833 to 843. Consequentially a dip occurs with respect to the percentage of susceptible individuals. However, this anomaly is fleeting and the model returns to a state of equilibrium.

The proceeding table lists the average percentage of the population by state over the last 1000 time steps (days) for each general crises, versus the baseline model where no crises unfolds.

Table 10: General Crises - State Representation

Scenario	Spreader	Susceptible	Recovered
Baseline (no crisis)	24.35%	71.27%	4.38%
Crime	27.63%	67.97%	4.41%
Travel	27.17%	68.45%	4.37%
Money	27.82%	67.76%	4.42%
GJO	27.17%	68.50%	4.33%

Table 10 illustrates that for each case of general crisis, the equilibrium to which the model returns is slightly higher than that of the baseline model. The percentage of spreaders increases by approximately three percent, subsequently reducing the percentage of susceptible individuals by the same value. This holds irrespective of the determinant causing the general crisis. The percentage of individuals within the recovered state remains consistent for all crises including the baseline model. It should be noted that upon investigation it was found that the average percentage of the population by state over the last 500 time steps (days) for each general crises reverted back to that of the baseline scenario, with 24% percent of the population represented by spreaders. The table below details the average number of successful exposures per day by determinant for the baseline model over the last 1000 time steps (days).

Table 11: General Crises - Average Successful Exposures per Time Step (Day)

Scenario	General	Crime	GJO	Travel	Money
Baseline (no crises)	121.87	9.31	3.90	3.09	1.29
Travel	134.04	12.19	3.06	6.01	0.23
Money	138.80	8.27	4.00	3.61	4.65
GJO	138.02	9.97	4.26	2.57	0.69
Crime	138.51	9.24	4.28	4.29	1.90

With the increase in the number of infected individuals, the average number of successful exposures per day for the general determinant is higher than that of the baseline model. The number of successful exposures of the determinant from which the crises are caused, increase in respect to the baseline model, with the exception of crime.

5.2.4 Isolated Crises

The dynamics of the baseline model are tested against isolated individual crises, whereby individuals are randomly exposed to a particular determinant of migration. Isolated crises are introduced to the baseline model from day 833. The crisis results in an individual being exposed to a determinant of migration with probability 0.33 and probability 0.03 of actually receiving a dose. Each scenario is run for 10 iterations for each determinant of migration respectively. A single iteration of a general crisis occurring as a result of global job opportunities is illustrated in the figure below:

Figure 26: Isolated Crises - Global Job Opportunities

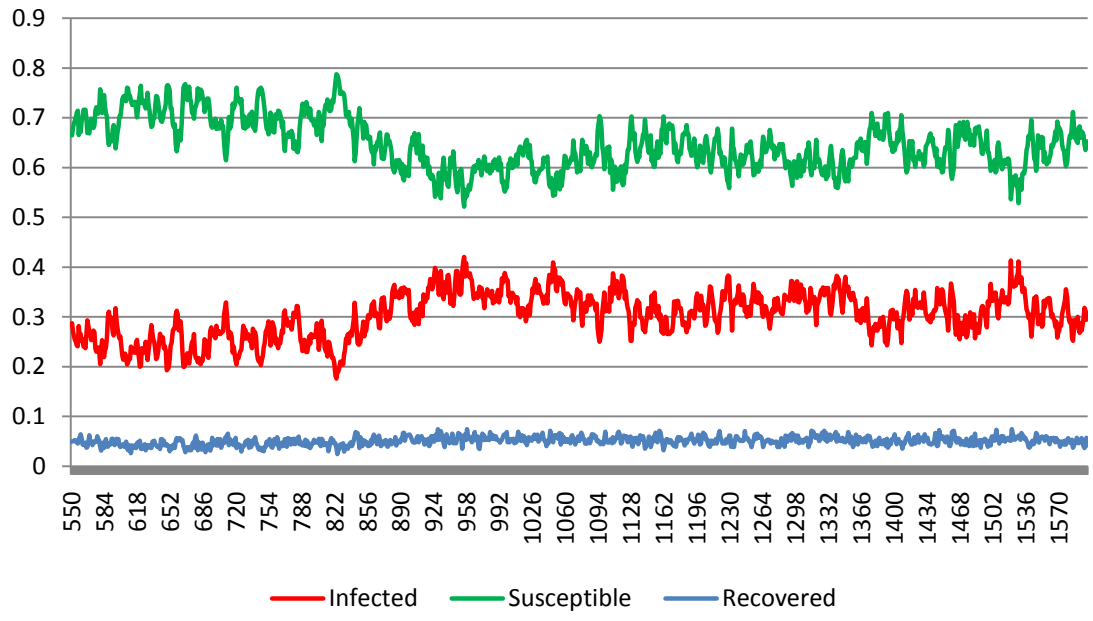


Figure 26 illustrates that once individuals start becoming exposed to random isolated crises (day 833); the gap between the percentage of spreader and susceptible individuals is reduced. Hence the percentage of infected individuals increases, with the percentage of susceptible individuals decreasing. This trend persists for the remainder of the simulation. The proceeding table below details the average percentage of individuals by state over the last 1000 time steps (days) for each isolated crises scenario versus the baseline model:

Table 12: Isolated Crises - State Representation

Scenario	Spreader	Susceptible	Recovered
Baseline (No Crisis)	24.35%	71.27%	4.38%
Crime	31.18%	63.66%	5.15%
Travel	31.29%	63.53%	5.18%
Money	31.05%	63.81%	5.14%
GJO	31.43%	63.40%	5.17%

The percentage of spreaders in the population increased by approximately seven percent. The increase occurs irrespective of the determinant from which the isolated crises occur. The table below details the average number of successful exposures per day by isolated crises versus the baseline model over the last 1000 time steps (days):

Table 13: Isolated Crises - Average Successful Exposures per Time Step (Day)

Scenario	General	Crime	GJO	Travel	Money
Baseline (No Crisis)	121.87	9.31	3.90	3.09	1.29
Travel	153.49	11.18	5.76	6.59	0.49
Money	149.94	16.97	4.28	2.97	2.17
GJO	151.59	13.41	6.85	5.92	0.68
Crime	153.05	14.32	4.26	4.83	0.49

The results indicate the number of successful exposures of the determinant from which the crises are caused, increase in respect to the baseline model. It

appears that where isolated incidents occur in the case of a particular determinant; they do so at the detriment to one of the other determinants. For example, where isolated events occurred in the case of GJO, it did so to the detriment of money.

5.2.5 General & Isolated Crises

In reality both general and isolated crises occur, thus a scenario was constructed incorporating general and isolated crises. These types of crises were introduced to the baseline model in the same manner that they were in previous scenarios. The scenario (termed G&I) was run for 10 iterations, a single iteration of the scenario involving a general crisis of crime coupled with isolated crises of global job opportunities is illustrated in the figure below:

Figure 27: G&I Scenario

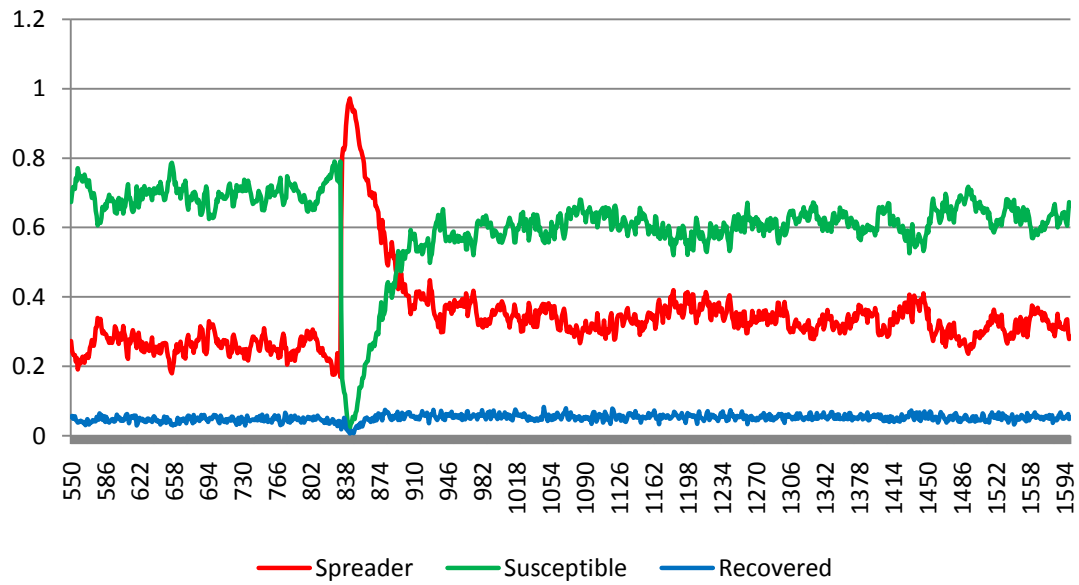


Figure 27 illustrates how as the system begins to recover from the general crises, it reverts to new equilibrium comprised of a greater percentage of the population represented by the spreader state.

The table below details the average percentage of the population by state over the last 1000 time steps (days) for the G&I and the baseline scenarios over the last 1000 time steps (days):

Table 14: G&I Scenario - State Representation

Scenario	Spreader	Susceptible	Recovered
Baseline (No Crises)	24.35%	71.27%	4.38%
G & I	34.10%	60.80%	5.10%

The general and isolated crises return a higher percentage of spreader individuals than the baseline scenario. From the percentage increase it appears that the full effect of both the general and isolated crises is accumulated in the G&I scenario. The table below details the average number of successful exposures per day of the G&I scenario versus the baseline model by determinant.

Table 15: G&I Scenario - Average Successful Exposures per Time Step (Day)

	General	Crime	GJO	Travel	Money
Baseline	121.87	9.31	3.90	3.09	1.29
G & I	168.89	16.60	3.45	3.77	1.29

The table reveals that the general determinant increases significantly along with crime. Despite isolated crises relating to GJO, the number of successful exposures decreases slightly with travel increasing and money remaining constant.

5.2.6 Success vs. Crisis

The effect of forces discouraging migration were analysed by introducing the stifler state to the G&I scenario where both general and isolated crises exist. Hence the G&I scenario is once again run for 10 iterations with a general crisis

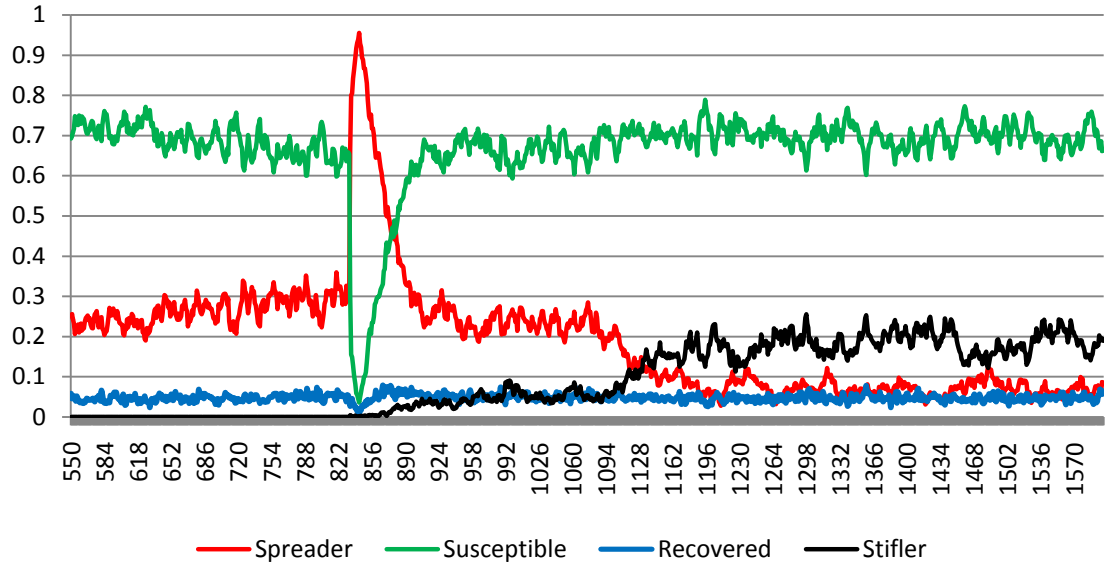
pertaining to crime and isolated instances of GJO affecting individuals within the population. The stifler state was perpetuated using two mechanisms. Firstly, the parameter value γ was set to 0.05, thereby enabling individuals to disagree with an individual with whom they interact. Hence, a susceptible individual may interact with a spreader, receive a stifler dose, and vice versa. Secondly, individuals were deemed to have the same probability of being exposed to the stifler state as they are to isolated crises; thus, individuals were exposed with probability 0.33 and received a dose with probability 0.03. The threshold and doses with respect to the stifler state are of the same magnitude as the infected state, but have negative as oppose to positive values. Two versions of this scenario were analysed:

- **Version 1**: The spreaders probability of infection p_1 is equal to that of the stifler's probability of infection p_2. Thus, it is assumed that an individual is as likely to believe and spread rumours encouraging migration as they are those discouraging migration (Barsade, 2002).

- **Version 2**: The stifler's probability of infection p_2 .is greater than that of the spreaders probability of infection p_1. Hence $p_2 = p_1 + 0.05$. This case describes the situation where individuals are potentially more patriotic and are more likely to believe and spread rumours discouraging migration, as they are those encouraging migration.

The proceeding figures illustrate single iterations for each version of the scenario:

Figure 28: Success vs. Crisis (p2 = p1)



The figure above illustrates how the stifler state is able to gain momentum over time despite the general and isolated crises unfolding. Whilst the spreader state is not eliminated, it is drastically reduced.

Figure 29: Success vs. Crisis (p2 > p1)

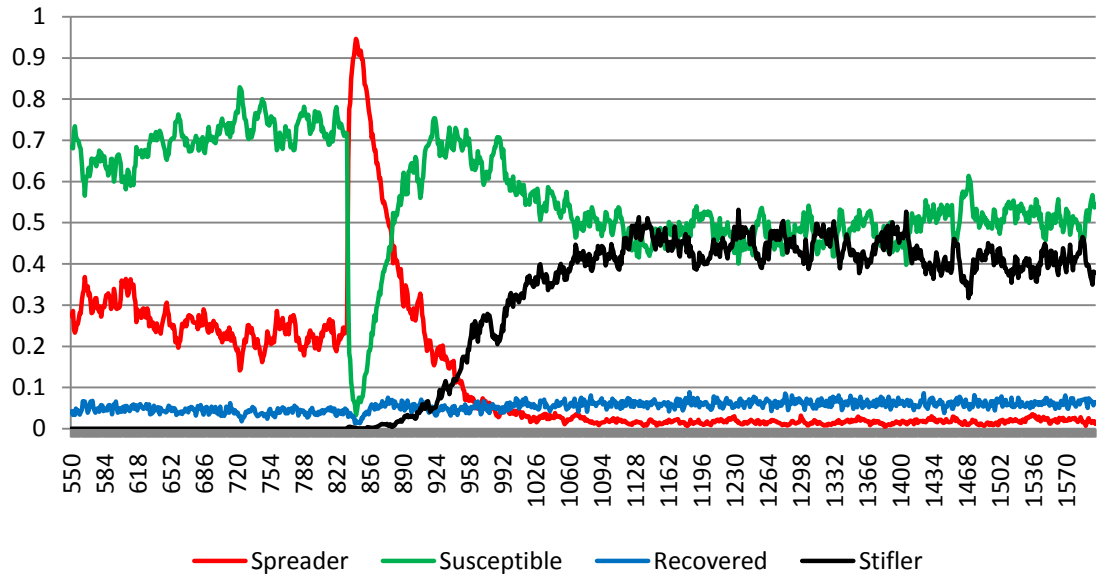


Figure 29 illustrates how the stifler state not only gains momentum but maintains levels similar to that of the susceptible state. The spreader state drops below that of the recovered stare with little variation. The table below details the average percentage of the population by state over the last 1000 time steps (days):

Table 16: Success vs. Crisis - State Representation

Scenario	Infected	Susceptible	Recovered	Stifler
Baseline (no crises)	24.35%	71.27%	4.38%	0%
G & I	39.6%	55.0%	5.4%	0%
Version 1 (p_2=p_1)	19.4%	67.9%	4.6%	8%
Version 2 (p_2>p_1)	12.5%	55.8%	5.5%	26%

From the table above, both versions of the 'success vs. crisis' scenario result in the percentage of the population represented by the spreader state of the G&I scenario to decrease below that of the baseline scenario. Thus the effect of the stifler state discouraging migration more than counteracts the spreader state where p_2 =p_1 and as expected where p_2>p_1. The table below details the average number of successful exposures per day over the last 1000 time steps (days):

Table 17: Success vs. Crisis - Average Successful Exposures per Time Step (Day)

Scenario	General	Crime	GJO	Money	Travel
Baseline (no crises)	121.87	9.31	3.90	3.09	1.29
G & I	190.69	16.57	5.86	6.26	5.00
Version 1 (p_2=p_1)	95.34	12.90	1.48	2.12	0.61
Version 2 (p_2>p_1)	63.61	9.08	1.79	1.31	0.07

In both versions of the success vs. crisis scenario, the number of successful exposures attributed to general discussion drops to below that of the baseline

scenario. In addition the number of successful exposures for each determinant also decrease, although crime only marginally.

6 Chapter 6:- Results Discussion

This chapter discusses the results of Part A and Part B of the research obtained in the previous chapter. Consequentially it is presented in terms of Part A and B, with discussion for each preceded by a summary of the results obtained.

The objective of this study is to identify to what extent the reasons for migration from SA gain influence due to social contagion effects. Part A is concerned with identifying and evaluating the primary drivers of emigration within the South African context. Thus, the research aims for Part A is to:

- Identify the primary drivers, (relevant to social contagion theory), which play a role in influencing an individual's decision to leave SA.
- Determine the respective weight or influence of each driver.

Part B is concerned with investigating through simulation how the drivers of migration identified gain influence through social contagion and the impact thereof on migration. Thus, the research aims for Part B is to:

- Establish the impact on drivers of migration as a result of general and isolated crises.
- Establish how drivers discouraging migration and those encouraging migration may interact.

6.1 Part A – Determinants of Migration from SA

6.1.1 Result Summary

Through analysis of the secondary data, (the DBSA dataset), the primary reasons for individuals leaving SA were identified. Once cleansed the sample was comprised of 5685 observations. Whilst the distribution in terms of gender was relatively evenly distributed, the majority of respondents were male. The distribution of race was skewed to that of whites, which accounted for 88% of all respondents. In terms of respondent's age when they left SA, the average age was 31 with 70% of all respondents between the ages of 20 and 34. The dataset was also comprised of predominantly well-educated individuals as 85% of respondents had undergone tertiary education. Thus, the typical respondent within the dataset was a white male, aged 31 with a tertiary education.

The sample was divided into 111 population groups based on race, gender, age group and education level. For each group, a key driver of migration from SA was established by aggregating the ratings of the primary reasons for leaving SA, and then identifying the determinant with the highest average. Analysis of these determinants revealed that individual's reasons for leaving SA transformed, as they grow older. For example, within the white demographic there is a transition from travel through to crime and later family as primary reasons for leaving SA. Finally, the relative weight or influence of each determinant of migration with resect to the population of interest was determined, (where the group consisted of more than 30 observations). Crime emerged as the most influential determinant in terms of the relevant population.

6.1.2 Result Discussion

Objective One: Identify the primary drivers, (relevant to social contagion theory), which play a role in influencing an individual's decision to leave SA.

The results obtained through analysis of the DBSA dataset identified several primary drivers of migration from SA, namely - global job opportunities, crime, travel, family, education, politics and money. Given these factors prevalence within the relevant literature and media, the findings were not surprising.

Factors such as global job opportunities and money relate to the economic factors driving migration from SA discussed by Kharwa (2008) such as economic recession, job insecurity, low remuneration and the fear of stagnating or receding in terms of living standards. The results are further supported by Lucas (2005) who noted that long term economic prospects are likely to dominate decisions to relocate, a concept dating back to Ravenstein's sixth law of migration that states that an increase in migration is attributed primarily to economic causes (Ravenstein, 1885). Perhaps the most publicised and well-documented factor influencing migration from SA is that of crime. Crime not only drives individuals to emigrate (Kharwa, 2008; DA, 2007) but is a constraint to economic growth (World Bank, 2007).

The primary drivers of migration identified are relevant to social contagion theory on a number of levels. Each driver has the ability to stir emotional responses within an individual, hence the mood and concern that they affect can be distributed through a population by simple exposure (Marsden, 1998).

For example, emotions affiliated with crime may be that of anxiety and fear, whilst global job opportunities, money and travel may be associated with emotions of optimism and hope. Kimura and Daibo (2008) document that emotional responses are significantly stronger in close relationships such as family structures thus enabling a driver such as family easily permeate through contagion.

A notable aspect of the results obtained in identifying the primary drivers of migration was the trends uncovered, as individuals grow older. The trends revealed how the primary drivers of migration change as an individual's needs and priorities develop with age. It is speculated that the clustering of the same drivers of migration within the various groups suggests that social contagion is occurring, as the literature suggests that contagion is likely between people who belong to the same groups (Loersch, 2008).

The trends revealed the scarcity of push factors, (for example crime), within the african/black, asian/indian and coloured communities, in contrast to white communities. It is speculated that this observation can be attributed to SA's political past. The transition from travel to crime and then later to family as the primary reason for leaving SA, a trend that persists across gender and education levels within the white demographic seems reasonable. For instance as young individuals complete their education and have fewer commitments, it seems logical that pull factors such as travel and global job opportunities will drive them to leave SA. As an individual's commitments increase, for example through marriage and children, push factors such as crime will come into the fore. The prominence of family as a primary driver of migration from SA in older

individuals is also plausible, as individuals migrate to reconnect with families living abroad. It should be noted however that the underlying driver under these circumstances is the initial reason that the individual's family left SA, hence such decisions may truly be motivated by crime, travel etc.

Objective Two: Determine the respective weight or influence of each driver.

Subject to their statistical significance (greater than 30 observations), the primary drivers of migration reduced to that of global job opportunities, crime, travel and money. The percentage of the relevant population that each driver effected determined its respective weight or influence. The results brought issues such as crime and global job opportunities to the fore as the two most significant factors influencing migration from SA, followed by travel and money.

The results revealed that the majority of individuals within the population of interest were not unusually sensitive to the drivers identified. Whilst this is largely attributable to the nature of the sample, it appears plausible as it is hypothesized that most individuals are likely to make the decision to emigrate based on individual circumstance and experience, subsequently encouraging migration from SA through discussion on this basis. Individuals who are inherently sensitive to particular determinants of migration do however exist and are likely to fuel and perpetuate such discussion. It is speculated that rumours disseminated by such individuals are likely to be based on the determinant of migration to which they are sensitive. Hence, whilst the influence of the drivers is empirically small, through mechanisms such as social contagion their influence may be exacerbated and their effect far reaching. In addition, if the

primary drivers identified are the root cause of decisions to leave SA based on other determinants, their influence is likely to be far greater than the results indicate.

6.2 Part B – Scenario Analysis

6.2.1 Result Summary

The SCSM was tested by reducing it to the SIS version of the generalised model of social and biological contagion (Dodds & Watts, 2005). This scenario was run for both a heterogenous and homogenous population, with parameters set to evoke epidemic threshold dynamics. The results produced by the SCSM were comparable to that of Dodds & Watts (2005), thereby authenticating the integrity of the model.

A baseline scenario for a heterogenous population was developed and analysed. The weightings of the determinants of migration from Part A were used as proxies for the number of individuals who possess a natural sensitivity towards particular drivers of migration. Whilst volatility in terms of the percentage of the population represented by the spreader, susceptible and recovered states exist within the baseline scenario, the population on average comprised of roughly 24% of the population within the spreader state. The remaining 76% percent of the population was comprised of susceptible and recovered individuals, accounting for approximately 71% and 4% respectively. The baseline scenario produced consistent results and was thus used as a point of reference from which further scenarios are compared.

For each determinant of migration, scenarios involving general crises affecting potentially all individuals within the population were developed. The results reflected an initial increase in the percentage of the population represented by the spreader state; but eventually decreased to that of the baseline scenario.

Scenarios involving isolated crises affecting randomly selected individuals were also developed. The results revealed a significant and sustained increase in the percentage of the population represented by the spreader state. The number of successful exposures related to the determinant to which the crisis was attributed increased, typically to the detriment of one of the other determinants.

A scenario featuring both general and isolated crises (termed G&I) was constructed to more accurately reflect the real world. Again, a sharp increase in the percentage of the population represented by the spreader state resulted because of the general crises. This subsided and the model reverted to equilibrium significantly higher than that of the baseline scenario, maintained by the presence of isolated crises.

The effect of rumours discouraging migration was investigated in the context of the G&I scenario with the introduction of the stifler state. Two versions of this scenario were investigated. In the first case, the probability of receiving a dose from a stifler is set to be equal to that of a spreader. The results demonstrated that the percentage of the population represented by the spreader state decreases to below that of the baseline scenario. In the second case, the probability of receiving a dose from a stifler is set to be greater than that of a spreader. The results from this case were similar to that of the first case, but of

significantly greater magnitude. The results from both cases were also reflected in the number of successful exposures by determinant. In some instances, the number of successful exposures of a determinant decreased to less than one successful exposure per day.

6.2.2 Result Discussion

Objective Three: Establish the impact on the drivers of migration as a result of general and isolated crises.

The results obtained through simulation of general crises caused by particular determinants of migration revealed that irrespective of the determinant, the system would react in the same manner. Each scenario was characterised by a sharp increase in the percentage of the population in the spreader state, however insufficient momentum led to individuals recovering and the system returning to the equilibrium of the baseline scenario. Thus, irrespective of the determinant and its influence within a population, once-off events do not appear to have a lasting effect on the system. The results seem reasonable when one considers past events within SA's history, for example the rolling blackouts that effected Gauteng in 2008. The blackouts became a primary topic of discussion and the cause of negative sentiment towards the government and future of the country. Nevertheless, over time as the blackouts subsided, so too did the negative sentiment.

The results obtained through simulation with respect to crises resulting from isolated events, illustrated that these events can have a lasting effect on the system. Whilst the system remains in equilibrium, it is at a far higher level in terms of the percentage of the population represented by the spreader state.

Within the South African context, random acts of crime effect individuals every day. This elevates crime as a popular topic of discussion, as everyone is aware of someone who has been affected. This notion is supported in the literature by Sutherland's (2007) studies of peoples' conversations and emails. Thus regardless of the determinant and the base from which it comes, if a topic is in consistently 'available for discussion', the equilibrium of the social system will change as discussion grows. Consequentially the number of successful exposures of the determinant increases. The varied effect on the number of successful exposures of the other determinants is not unexpected as it follows that they will lose ground to the most popular determinant.

The results of the simulations show that under epidemic threshold dynamics and all things remaining equal, a system may withstand once off shocks, returning to equilibrium soon thereafter. However, when affected by persistent isolated events, the system is unable to recover and a new 'equilibrium' is achieved. Thus, in respect to migration we can expect to see sharp increases in people leaving SA when general crises occur, with the rate of migration slowing thereafter. Migration from SA will however increase and remain at high levels as the rate of isolated events related to the primary drivers of migration increase in frequency and intensity.

Objective Four: Establish how drivers discouraging migration and those encouraging migration may interact.

The results obtained in introducing the stifler state with a probability of exposure and probability of infection equal to that of the spreader state; reveal that the

stifler state requires a substantial period after its introduction to gain momentum.

Once momentum is achieved the population represented by the spreader state will decrease. The number of successful exposures of determinants encouraging migration is subsequently affected, with exposures related to some determinants reduced to less than one exposure per day. As mentioned before, this concept arises within the literature through the work of Sutherland (2007). Similar results, (but of greater magnitude), are observed where the likelihood of infection by the stifler state is greater than that of the spreader state.

In respect to migration, the results indicate that we can expect to see a decrease in people leaving SA as discussion promoting SA increases. Thus, should positive discussion within SA become a feature of interactions between individuals, an impact on emigration can be realised. However as the results related to general crises confirm, large once off achievements such as South Africa's hosting of the 2010 World Cup are not sufficient to create the momentum required. Rather, persistent isolated 'successes' are required to perpetuate and sustain discussion focussing on reasons not to leave SA and subsequently lower levels of migration.

Thus, in respect to migration we can expect to see sharp increases in people leaving SA when general crises occur, with the rate of migration slowing thereafter. Migration from SA will however increase and remain at high levels as the rate of isolated events related to the primary drivers of migration increase in frequency and intensity.

7 Chapter 7:- Conclusions

South Africa cannot afford to underestimate the consequences of migration as it endeavours to compete globally against the likes of Brazil, Russia, India and China. The net effect of migration on the country of origin is substantial, and thus may either assist or hinder an emerging economy realising its growth potential.

Research into the field of migration is theoretically and empirically diverse, however to date there has been comparatively less focus on the underlying forces that affect the drivers of migration, which are in their own right potential obstacles to growth. The available literature provides evidence that behaviour and emotion are socially infectious and thus the act of migration as influenced by the determinants perpetuating it is susceptible to the mechanisms of contagion theory, a phenomenon falling under the domain of 'social influence'. Contagion processes occur in both the social and biological sciences, the premise being that behaviour and emotion can traverse populations just as diseases are able to propagate (Dodds & Watts, 2005). The aim of this study is to identify to what extent the determinants of migration gain influence due to social contagion effects. In effectively modelling migration in terms of social contagion theory, a deeper understanding of the intrinsic cycles at work is achieved.

The results in conjunction with the available literature revealed that the primary drivers of migration within the South African context are primarily that of social and economic factors. The reason for migration vary by population groups, distinguished by characteristics such as race, gender, education level and age

at the time of departure. The clustering of common drivers of migration within various population groups suggest that social contagion is occurring as contagion is likely between people who belong to the same groups (Loersch, 2008). In addition, trends revealed that the primary drivers of migration change as an individual's needs and priorities develop with age. In addition, the results appear to confirm that the majority of individuals who leave SA are relatively young with have high levels of education.

Crime emerged as the most influential determinant of migration in terms of the relevant population, followed by drivers such as global job opportunities, travel and money. The relative number of individuals who are inherently sensitive to particular determinants of migration although empirically small, have the potential to significantly influence and shape migration through mechanisms such as social contagion.

The percentage of the relevant population that each primary driver of migration effected, determined its respective weight or influence. These weightings were used as proxies for the number of individuals who possess a natural sensitivity towards a particular driver of migration. Future research into the extent to which determinants of migration gain influence due to social contagion effects would benefit from a qualitative approach in an effort to establish individuals and population groups natural sensitivities towards particular drivers.

The results obtained through simulation revealed that whilst general crises attributable to a particular determinant of migration are likely to have a significant impact on the rate of migration within a population; the effect is fleeting and the increased rate will subside in time. In addition, simulation

revealed that as the rate of isolated events (related to the primary drivers of migration) increase in frequency and intensity, so too is migration likely to increase and subsequently remain. A notable finding for both isolated and general crises is that where the number of successful exposures based on a particular determinant increase, it does so to the detriment of another.

The results also indicated that drivers influencing individuals to remain in SA, disseminated through social contagion are able to assist in negating the influence of determinants encouraging migration. This process requires time and cannot rely on momentous once-off achievements but rather small repeated and celebrated successes to decrease levels of migration.

Thus, this research assists in providing insights as to why South Africans migrate from SA, as well as the inherent trends in their decision to do so. The dynamics governing how migration increases or decreases because of social contagion, subject to general and isolated crises are also conceptualised. Lastly, insights are gained as to the nature of factors required to possibly minimise the influence of the determinants of migration.

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9 Appendices

9.1 Appendix I – "Where are they Now?" Questionnaire

Question	Mechanism/Instruction	Available Selection
Surname:	Free Text	
First Name:	Free Text	
Email address:	Free Text	
Present country where you live:	▪ drop down ▪ drop down	▪ Country ▪ City
Race Classification:	African ***drop down*** ▪ Select ▪ Select ▪ Select ▪ Free Text	 ▪ White ▪ Indian ▪ Coloured ▪ Other
Gender	Female/Male	choose
Age Category	***drop down***	▪ 18 – 20 ▪ 20-29 ▪ 30-39 ▪ 40-49 ▪ 50-59 ▪ 60-69 ▪ 70+
What year did you leave South Africa?	***drop down***	▪ 1950 – 2006
Primary Reasons for leaving SA?	*Rate each reason should be buttons where they can choose a rating for each option from 1 – 5 (1 being low and 5 being High and N/A an option as well. If other reason please explain using free text.*	▪ Global Job Opportunities ▪ Politics ▪ Crime ▪ Travel ▪ Exile ▪ Education ▪ Money

		▪ Family ▪ Affirmative Action ▪ Other
Highest Level of Education	***drop down***	▪ Secondary School ▪ Matric/Equivalent ▪ Certificate ▪ Diploma ▪ Postgraduate Diploma ▪ Undergraduate ▪ Bachelors Degree ▪ Honours Degree ▪ Masters Degree ▪ Doctorate
Sector	***drop down***	▪ Academic ▪ Construction ▪ Education ▪ Engineering ▪ Finance & Admin ▪ FMCG ▪ Government ▪ Healthcare ▪ Human Resources ▪ Information Technology ▪ Legal ▪ Logistics & Supply Chain ▪ Management ▪ Management Consultant ▪ Manufacturing ▪ Mining ▪ Non-profit ▪ Public Relations ▪ Property ▪ Retail ▪ Sales & Marketing ▪ Telecommunications

Current Occupation/Profession	Free Text	
Would you be interested in returning to SA?	Yes/No	
The survey now splits – for those that answer Yes to the above question – the following questions now appear:		
Would you be interested in	Select	▪ Starting a Business ▪ Seeking Employment
Would you be interested in assisting with Skills development	Yes/No	
If yes, in which area would you be willing to participate?	***drop down (can choose more than one option)*** ***Other – free text***	▪ Mentoring ▪ Skills training ▪ Projects ▪ Hosting ▪ Education ▪ Business start up ▪ Finance ▪ Other
What year are you looking to return?	***drop down***	▪ 2007 ▪ 2008 ▪ 2009 ▪ 2010 ▪ 2011 ▪ 2012 ▪ 2013 ▪ 2014 ▪ After 2014

For those that answer No:		
Would you be interested in assisting with Programmes and skills development on a project by project basis?	Yes/No	
Reasons for not returning?	*Rate each reason should be buttons where they can choose a rating for each option from 1 – 5 (1 being low and 5 being High and N/A an option as well. If other reason please explain using free text.*	▪ I have a new home ▪ Political situation in South Africa ▪ Present crime levels ▪ Present Education system/levels ▪ Lack of job opportunities ▪ Feelings of alienation ▪ Economic/Financial ▪ Other

9.2 Appendix II – PIT Frequency Tables

Table 18: Demographic Frequency Tables

Race Name	Gender Name	Age Group Name	Count	%
Black African	Male	20-24	1 724 595	6.77%
Black African	Male	25-29	1 531 288	6.01%
Black African	Male	30-34	1 224 441	4.81%
Black African	Male	35-39	1 088 677	4.27%
Black African	Male	40-44	905 055	3.55%
Black African	Male	45-49	695 361	2.73%
Black African	Male	50-54	529 533	2.08%
Black African	Male	55-59	360 393	1.41%
Black African	Male	60-64	289 705	1.14%
Black African	Male	65-69	193 569	0.76%
Black African	Male	70-74	152 239	0.60%
Black African	Male	75+	182 689	0.72%
Black African	Female	20-24	1 820 001	7.14%
Black African	Female	25-29	1 652 881	6.49%
Black African	Female	30-34	1 346 476	5.29%
Black African	Female	35-39	1 242 637	4.88%
Black African	Female	40-44	1 024 074	4.02%
Black African	Female	45-49	814 991	3.20%
Black African	Female	50-54	605 306	2.38%
Black African	Female	55-59	440 864	1.73%
Black African	Female	60-64	441 129	1.73%
Black African	Female	65-69	346 524	1.36%
Black African	Female	70-74	290 314	1.14%
Black African	Female	75+	361 215	1.42%
Coloured	Male	20-24	173 688	0.68%
Coloured	Male	25-29	163 086	0.64%
Coloured	Male	30-34	156 435	0.61%
Coloured	Male	35-39	147 807	0.58%
Coloured	Male	40-44	125 291	0.49%
Coloured	Male	45-49	95 936	0.38%
Coloured	Male	50-54	74 867	0.29%
Coloured	Male	55-59	52 384	0.21%
Coloured	Male	60-64	41 460	0.16%
Coloured	Male	65-69	29 104	0.11%
Coloured	Male	70-74	17 563	0.07%
Coloured	Male	75+	16 086	0.06%
Coloured	Female	20-24	179 973	0.71%
Coloured	Female	25-29	174 107	0.68%
Coloured	Female	30-34	173 624	0.68%
Coloured	Female	35-39	166 680	0.65%
Coloured	Female	40-44	142 838	0.56%

Coloured	Female	45-49	112 686	0.44%
Coloured	Female	50-54	87 380	0.34%
Coloured	Female	55-59	62 116	0.24%
Coloured	Female	60-64	52 494	0.21%
Coloured	Female	65-69	39 428	0.15%
Coloured	Female	70-74	26 386	0.10%
Coloured	Female	75+	31 202	0.12%
Indian or Asian	Male	20-24	51 864	0.20%
Indian or Asian	Male	25-29	51 075	0.20%
Indian or Asian	Male	30-34	46 653	0.18%
Indian or Asian	Male	35-39	43 556	0.17%
Indian or Asian	Male	40-44	39 089	0.15%
Indian or Asian	Male	45-49	33 852	0.13%
Indian or Asian	Male	50-54	30 351	0.12%
Indian or Asian	Male	55-59	22 838	0.09%
Indian or Asian	Male	60-64	15 954	0.06%
Indian or Asian	Male	65-69	9 939	0.04%
Indian or Asian	Male	70-74	6 122	0.02%
Indian or Asian	Male	75+	5 321	0.02%
Indian or Asian	Female	20-24	50 372	0.20%
Indian or Asian	Female	25-29	50 830	0.20%
Indian or Asian	Female	30-34	48 626	0.19%
Indian or Asian	Female	35-39	47 170	0.19%
Indian or Asian	Female	40-44	42 619	0.17%
Indian or Asian	Female	45-49	38 402	0.15%
Indian or Asian	Female	50-54	32 836	0.13%
Indian or Asian	Female	55-59	25 200	0.10%
Indian or Asian	Female	60-64	20 005	0.08%
Indian or Asian	Female	65-69	13 152	0.05%
Indian or Asian	Female	70-74	8 500	0.03%
Indian or Asian	Female	75+	8 410	0.03%
White	Male	20-24	149 147	0.59%
White	Male	25-29	153 675	0.60%
White	Male	30-34	166 959	0.66%
White	Male	35-39	161 467	0.63%
White	Male	40-44	164 199	0.64%
White	Male	45-49	142 454	0.56%
White	Male	50-54	134 748	0.53%
White	Male	55-59	116 707	0.46%
White	Male	60-64	97 389	0.38%
White	Male	65-69	72 151	0.28%
White	Male	70-74	56 625	0.22%
White	Male	75+	69 083	0.27%
White	Female	20-24	144 883	0.57%
White	Female	25-29	157 998	0.62%
White	Female	30-34	177 684	0.70%

White	Female	35-39	173 773	0.68%
White	Female	40-44	176 299	0.69%
White	Female	45-49	153 702	0.60%
White	Female	50-54	142 996	0.56%
White	Female	55-59	124 767	0.49%
White	Female	60-64	107 157	0.42%
White	Female	65-69	84 060	0.33%
White	Female	70-74	73 722	0.29%
White	Female	75+	121 816	0.48%

Table 19: Level of Education Frequency Table

Race	Gender	Age Group Name	Count	%
Black African	Male	No schooling	1 711 616	19.28%
Black African	Male	Some primary	1 727 678	19.46%
Black African	Male	Complete primary	633 225	7.13%
Black African	Male	Some secondary	2 777 580	31.29%
Black African	Male	Std 10/ Grade 12	1 589 637	17.91%
Black African	Male	Higher	437 810	4.93%
Black African	Female	No schooling	2 580 620	24.85%
Black African	Female	Some primary	1 829 995	17.62%
Black African	Female	Complete primary	705 384	6.79%
Black African	Female	Some secondary	3 074 000	29.60%
Black African	Female	Std 10/ Grade 12	1 638 842	15.78%
Black African	Female	Higher	557 568	5.37%
Coloured	Male	No schooling	89 712	8.20%
Coloured	Male	Some primary	196 376	17.96%
Coloured	Male	Complete primary	98 474	9.00%
Coloured	Male	Some secondary	441 169	40.34%
Coloured	Male	Std 10/ Grade 12	212 918	19.47%
Coloured	Male	Higher	55 055	5.03%
Coloured	Female	No schooling	103 663	8.30%
Coloured	Female	Some primary	234 050	18.74%
Coloured	Female	Complete primary	131 852	10.56%
Coloured	Female	Some secondary	499 188	39.97%
Coloured	Female	Std 10/ Grade 12	220 864	17.68%
Coloured	Female	Higher	59 298	4.75%
Indian or Asian	Male	No schooling	10 491	2.94%
Indian or Asian	Male	Some primary	18 422	5.17%
Indian or Asian	Male	Complete primary	11 326	3.18%
Indian or Asian	Male	Some secondary	120 200	33.71%
Indian or Asian	Male	Std 10/ Grade 12	136 803	38.36%
Indian or Asian	Male	Higher	59 375	16.65%
Indian or Asian	Female	No schooling	28 884	7.48%
Indian or Asian	Female	Some primary	38 689	10.02%

Indian or Asian	Female	Complete primary	19 709	5.10%
Indian or Asian	Female	Some secondary	124 946	32.36%
Indian or Asian	Female	Std 10/ Grade 12	122 585	31.75%
Indian or Asian	Female	Higher	51 302	13.29%
White	Male	No schooling	18 435	1.24%
White	Male	Some primary	16 338	1.10%
White	Male	Complete primary	9 971	0.67%
White	Male	Some secondary	358 368	24.14%
White	Male	Std 10/ Grade 12	600 206	40.43%
White	Male	Higher	481 284	32.42%
White	Female	No schooling	24 077	1.47%
White	Female	Some primary	22 194	1.35%
White	Female	Complete primary	13 526	0.83%
White	Female	Some secondary	450 674	27.50%
White	Female	Std 10/ Grade 12	678 745	41.42%
White	Female	Higher	449 642	27.44%