CITY UNIVERSITY LONDON – CASS BUSINESS SCHOOL

Brazilian Long Term Care Plan: an Evaluation Based on the Singaporean Model

By

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Lastly, I dedicate this to my family: my reason for being.

Abstract

Long Term Care Insurance (LTC) is becoming known worldwide as an efficient tool to mitigate the dependency costs that ageing populations are facing. As a consequence, LTC insurance schemes are being administered by governments around the world to manage the economic burden that dependency costs might generate in a society.

Due to its relatively recent history, LTC insurance has limited data resources; therefore it is a challenging undertaking for the insurance industry and nations to forecast the costs generated by disabled dependency.

This paper explores the recent and so far successful LTC insurance scheme introduced in Singapore and, in light of this, simulates the impact of establishing a similar LTC scheme in Brazil. Based on Leung (2004), the project applies a multiple state model developed by Rickayzen and Walsh (2002) in order to project the number of people in Brazil who are estimated to require LTC insurance over the next 50 years.

The paper defines the steps necessary to obtain an estimated premium based on the Singaporean assumptions, and also compares different scenarios over the next decades. The pricing and projection exercise is performed by obtaining available data, comparing different assumptions and constructing a method capable of reproducing projected LTC costs in further studies.

Furthermore, the paper obtains an office premium estimate for LTC insurance in Brazil and evaluates the affordability of the product based on the average earnings of the population.

The study concludes that Brazilian national survey data was in valuable for deriving risk rates and premiums for LTC insurance, although restrictions were observed during the estimation process. As an initial approach, the method applied and findings are relevant to LTC schemes implementation in Brazil.

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1. Introduction

1.1 Background of Long Term Care

The world population will be ageing rapidly over the next few decades, which will impact on the methodologies used to finance associated costs in the future. In light of this challenge, families, individuals and the State will be affected by the funding methods used to support the burden of dependency costs. In this context, Long Term Care (LTC) insurance is proposed as a solution to this problem.

The LTC concept is fundamentally a set of products within the range of life and health insurance. It is aimed at providing coverage for individuals in needs of care, particularly at older ages where the incidence of dependant conditions is higher and earnings reduced.

In accordance with Courtemanche and He (2009), the definition of Long Term Care (LTC) consists of a number of social, personal and/or medical services focused on supporting the needs of people living with chronic health or disability conditions. In general, the criteria used to define the aforementioned support involves the analysis of the level of assistance needed for the individual to perform Activities of Daily Living (ADL); for instance eating, dressing, bathing, transferring in and out of bed, toileting and continence.

In most cases, the implementation of LTC arises in developed countries as a complement to the conventional life insurance market and/or social insurance schemes. As mentioned by Scheil-Adlung (1995), there is an extensive range of LTC systems implemented in the developed world. Countries have chosen different approaches and political procedures mostly inspired from existing national programs, such as healthcare and public pensions, rather than the adaptation from other countries' models.

As demonstrated in this research, the expected number of individuals who will need assistance during older ages is extremely high and, in parallel with an ageing society, indicates that funding dependency costs at younger ages might emerge as a solution to dependency costs at older ages. Hence, the insurance nature of the product suggests that LTC could be an effective method and an appropriate instrument to supply the costs caused by increasing longevity.

The product concept, combined with early funding methods, creates an alternative to mitigate the costs of healthcare systems and social security for ageing populations. Due to the characteristics of long term care and social responsibility, both the state and the insurance industry need to price these products conservatively in order to guarantee sufficient reserves to cover expected losses. A reliable product developed through a public-private partnership can strengthen the product in technical aspects and also promote public awareness.

1.2 Trends in Lifespan and Society Behaviour

An increase in life expectancy combined with a decrease in birth rates results in the ageing of a population and, as a consequence, directly impacts the social economic behaviour of a population. This demographic change can be measured by the age dependency ratio.

The age dependency ratio is defined as the ratio of the number of individuals aged 65 or more to the number between ages 15 and 64 years. Figure 1 demonstrates the projected age dependency ratio substantially increasing over the next 40 years.

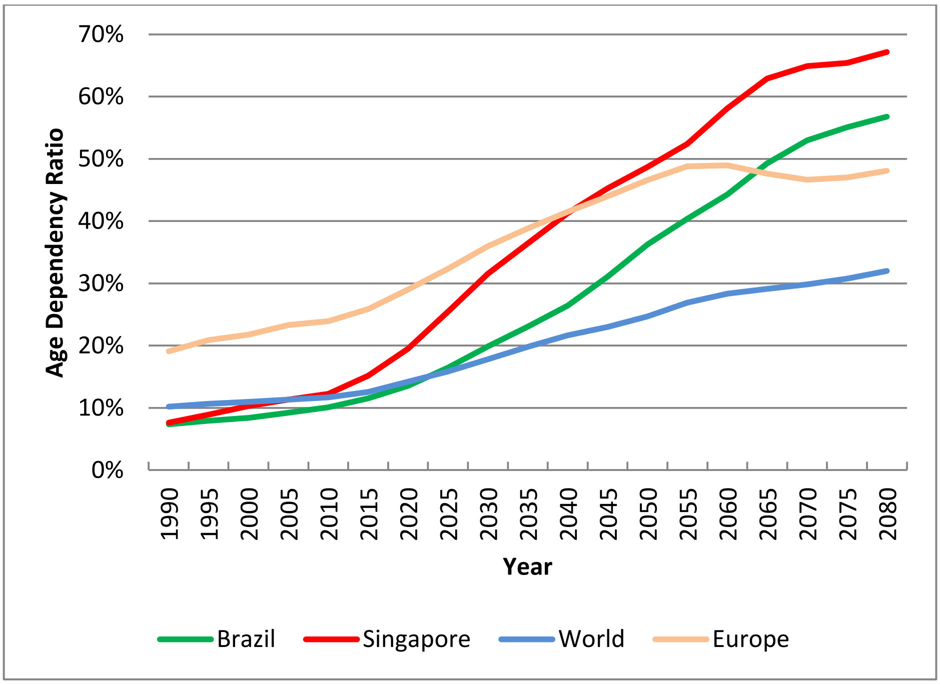

Figure 1 Age Dependency Ratio. Source: UN - World Population Prospects: The 2012 Revision

The graph compares the age dependency ratios of the World, European countries, Brazil and Singapore. All trend lines demonstrate an increasing dependency ratio over the coming decades. The age dependent population in Brazil is expected to be higher than the global trend in the years 2020 to 2025. Also, between 2060 and 2065 the Brazilian dependency ratio will surpass the European ratio, which demonstrates an accelerated ageing process through the early decades of this century.

Singapore already demonstrates an ageing population, with close to 15% of the current population consisting of elderly people, a fairly typical proportion for a developed economy. In line with Lutz (2011), there is empirical evidence that women with higher educational levels have fewer children and there is a relationship between a better educational background and a reduced mortality rate. Furthermore, increased access and awareness of healthy lifestyle choices is also a factor that leads to a country with an ageing population profile.

These forecasts confirm the need to explore solutions related to funding ageing costs all over the World. Brazil, as an emerging economy, should mirror solutions that were implemented to fund costs in aged societies, such as in Singapore, and evaluate its potential impact on the Brazilian market.

1.3 Aim

The aim of this project is to evaluate the application of a Long Term Care insurance scheme to the Brazilian market taking the Singaporean model as a basis, as well as replicating a multiple state model to project the dependant population over the next 50 years.

1.4 Pricing LTC Schemes

Because it is relatively new and has a variety of possible methodologies, pricing LTC insurance causes a greater challenge than pricing traditional life or health insurance schemes.

To implement a pertinent pricing approach, the author followed The Actuarial Education Company (2010) as used by Richardson (2011), and subdivided the pricing process as below:

1. Data collection

2. Setting basic assumptions

3. Fitting an appropriate pricing model

4. Calculating the risk premium

5. Calculating the office premium

6. Reviewing the experience and re-pricing

Different approaches can be found through literature to obtain an appropriate pricing model (item 3). The pricing model will use similar structure and formulae for estimating transitions probabilities to that proposed by Rickayzen and Walsh (2002). However, some adjustments and parallel parameters will be used when applied to Singaporean LTC schemes and Brazil, due to data availability.

1.5 Study Proposal

In order to investigate how the Singaporean model can be adapted for the Brazilian market, the project will focus on developing the pricing process and the assumptions that should be taken during this procedure based on available pricing techniques.

The research will analyze the available data, the necessary assumptions, the model choice and estimate costs such as expenses and claims.

1.6 Sources of Data and Information

The main source used for the proposed empirical study and to develop rates for dependency needs is the microdata from PNAD – National Household Sample Survey, 2008. The PNAD constitutes an annual survey conducted by IBGE – Brazilian Institute of Geography and Statistics.

The institute surveys a representative sample of Brazilian homes, where the main objective is to collect and analyze socio-economic characteristics in society, such as employment, income, housing, education and health conditions. In 2008, the survey had data covering over 400,000 inhabitants.

In addition for mortality assumptions, BR-EMS 2010 will be used and adjusted. According to Costa Silva, Mello and Witt (2010), the study was carried out in 2007 by FENASEG [1] and FENAPREVI[2]. Both institutions are responsible for conducting research in the Brazilian insurance industry. The mortality experience was gathered from 23 companies representing a total market share of 95%. Two tables were developed for the annuitant and life insured population, both split by gender. The data was obtained for an investigation period from 2004 to 2006, with total exposure of approximately 32 million people per year and a total amount of 114,000 deaths were registered, all cross-referenced with government records.

1.7 Problems Regarding the Scheme Implementation

This research imports the method used for Singapore into Brazil. However, no allowance is made for the cultural and political divergences between the two countries. Also, the impact of this program in one of the most populous nations in the world could be different than witnessed in Singapore.

Also the lack of studies on dependency costs in Brazil offers limited insight into the field. Thus, this project contributes to literature by describing the methodology and relevant considerations taken during the process of implementation of LTC in Brazil.

1.8 Structure of the Report

The Singaporean LTC scheme is discussed in chapter 2. Chapter 3 describes the Brazilian outlook and its insurance market. Chapters 4, 5, 6 and 7 gather the necessary data for the pricing process, the assumptions that should be made and the proposed model. Chapter 8 discusses data limitations. Finally, chapter 9 contains the conclusions and further studies that can be carried in the field.

2. Singaporean LTC Scheme

2.1 Singapore in Numbers

Singapore is considered one of Asia’s most successful countries, a so-called “Asian tiger economy”. The country has converted itself from an emerging nation to a role model modern economy over the last few decades. According to the OECD (2011), around one third of the population (which totalled 5.31 million as at June 2012) was born off-shore; with migration mainly motivated by favourable economic conditions and well-structured social welfare measures.

The age distribution has changed rapidly over the years, as can be seen in Table 1 below:

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[1] FENASEG: *Federação Nacional das Empresas de Seguros Privados e de Capitalização*: The national federation of Private Insurance and Capitalization, responsible for coordinating, protecting and legally representing the insurance industry in Brazil.

[2] FENAPREVI: *Federação Nacional de Previdência Privada e Vida:* The National Federation of Private Pension and Life, represents pension funds and life insurance companies in Brazil.

Age Group (years)	1990	2000	2010	2011	2012
Total (%)	100.0	100.0	100.0	100.0	100.0
Below 15	23.0	21.9	17.4	16.8	16.4
15 - 24	16.9	13.0	13.5	13.6	13.7
25 - 34	21.5	17.0	15.1	14.8	14.4
35 - 44	16.9	19.4	16.7	16.4	16.3
45 - 54	9.0	14.3	16.6	16.7	16.5
55 - 64	6.7	7.2	11.7	12.4	12.7
65 & over	6.0	7.2	9.0	9.3	10.0
Median Age (years)	29.8	34.0	37.4	38.0	38.4

Table 1 Age Distribution of Resident Population, Source: SingStat (2012)

During the last two decades the population has aged dramatically, with the proportion of elderly members (over 65 years) increasing from 6% in 1990 to 10% in 2012, despite the arrival of young immigrants into the country. The age distribution also reflects the reduction in fertility rates, from 1.83 in 1990 to 1.5 in 2012.

Those demographic figures, associated with socio-economic behavioural changes, represented a massive challenge to the Singaporean authorities, which responded by pioneering solutions to deal with longevity risks, and to enhance the healthcare system.

2.2 The Healthcare System

According to Schreyögg and Kim (2004), Singapore - in 1984 - was the first country in introducing Medical Savings Accounts (MSA) as a method of funding healthcare schemes. The increase in healthcare provision is resulted by an improvement in health for the Singaporean population. Singapore Statistics (2012) reports that life expectancy at 2011 was 79.6 for males and 84.3 for females, an overall improvement of more than 9% when compared to the life expectancy in 1990.

The MSA funding method is a key factor in the implementation of the LTC scheme in Singapore.

2.2.1 The Three Pillars of Financing Healthcare

As defined by Schreyögg and Kim (2004), the Singapore health system consists of three pillars; each of which fulfils a different financing mechanism. The main pillar is comprised of a system-component called Medisave.

Schreyögg and Kim (2004) also affirm that the model is based on the concept that standard insurance systems lead to inefficient utilisation of resources, since policyholders might consume unnecessary health services according to a medical perspective. Thus, the MSA model does not work as a traditional risk pooling method. Instead, each citizen covered by the plan receives a fixed amount to cover treatment costs. In effect, each individual puts aside savings to cover healthcare costs.

As demonstrated in Figure 2 below, MSAs are part of a well-structured savings system, known as Central Provident Fund (CPF), which is the central component of the Singaporean Social Security System (Singaporean Ministry of Health, 2012). Every employed citizen is required by the State to join the scheme, with 20% of gross income paid into the CPF, and the another 20% paid by the employer. From these contributions, 6% to 8% – depending on the participant's age – are allocated to Medisave Accounts, which is the basis for the ElderShield System.

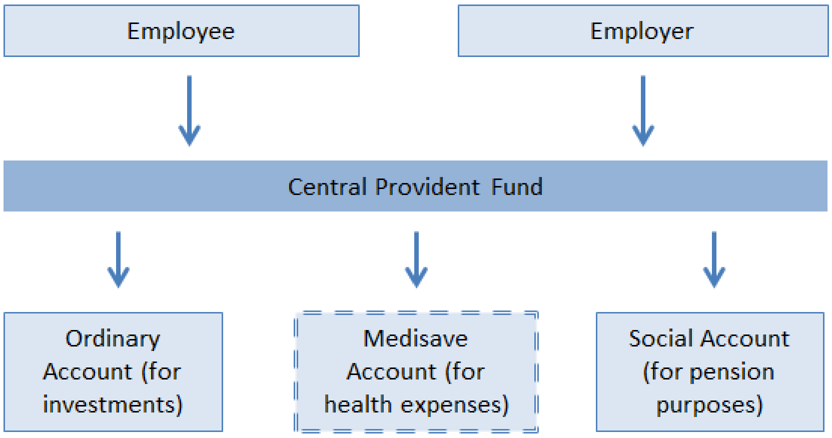

Figure 2 The Central Provident Fund as the Core of Singapore's Social Security System.

2.2.2 ElderShield Product and Scheme Design

ElderShield is the name given to the Long Term Care insurance product introduced in the Singaporean market in 2002. In essence, the product provides a monthly cash pay-out to assist elderly-disabled people (mental or physically dependent) with care expenses. Singapore citizens as well as Permanent Residents with Medisave accounts are automatically covered under ElderShield scheme at the age of 40. Participants may choose to opt-out, although the decision to return to the program is subject to a rigorous underwriting process.

As mentioned by Courbage (2012), the penetration of LTC insurance within a population is challenging due to few people being aware of the availability of the product or even LTC risk itself. Also, if the risk perception occurs at older ages, the product might be too expensive. The Singaporean case is successful due to the enrolment of the entire population at age 40. Early enough to allow time to generate a fund in case of dependency needs.

In line with Hoffman (2009), the premiums are paid until the participant reaches age 65. Then, the benefit coverage period is for the whole of life, and the insured can claim for benefit by failing three out of six ADL – Activities of Daily Life.

Still in accordance with Hoffman (2009), at plan launch in 2002, the value of the benefit was $300 SGD (£ 158) [3] per month for 5 years. In 2007, a modification to the plan provided a benefit which pays $400 SGD (£ 210) monthly for 6 years. For comparison purposes, depending on functional status and quality of accommodation (for example, number of beds in the same

[3] The exchange rate used is £1 = SGD 1.90 as at 17 July 2013

room), average nursing home costs are between \$1,000 SGD (£ 525) to \$3,500 SGD (£ 1,839) per month (Tan Ling, 2007).

In order to remove age discrimination, the Singaporean government has financed a part of the premium for those aged between 55 to 69 years old. For those aged over 69 years old or already disabled, the public benefit is received depending on their income, as mentioned by de Castries, (2009).

There are also subsidies for citizens with reduced earnings: *"For Singaporean households earning less than \$1,439 SGD per month, 75% of LTC costs are subsidized by the government. For those households earning between \$1,440 and \$3,800 SGD per month, 50% of LTC costs are subsidized, and for those earning between \$3,801 and \$5,600 SGD, 25% of LTC costs are subsidized."* Ansah et al. (2012).

Although the scheme concept was developed by the Singaporean Government, the pricing and sales strategy was derived by the private life insurance industry. A significant educational campaign was also established by the Singaporean authorities to raise population awareness regarding dependency risks and LTC insurance concept and benefits. The response was positive, as mentioned by Courbage (2012), with scheme opt-out rate reducing from 38% in 2002 to 14% in 2006. These numbers highlight that, with an effective informational movement, populations react positively to LTC insurance.

Apparently, due to the short period of benefits payments and the limited benefit amount, the product effectiveness to mitigate dependency cost could raise population concern. However, ElderShield is complemented by other funds, which subsidizes elderly care services and nursing houses, managed by voluntary organisations. Also, as discussed in succeeding topics, the lifespan of an individual in dependant states is reduced, which agrees to the reduced period established in the initial stage of the Singaporean LTC scheme implementation.

Noteworthy that ElderShield is still a recent solution, and additional measures need to be debated in parallel.

2.2.3 ElderShield: Public – Private Case

Singaporean citizens, except for those already unable to perform three out of six ADL, are automatically registered with the ElderShield scheme at age 40 and randomly allocated to a life insurance company – Aviva, Great Eastern and NTUC Income – which were selected via a competitive bidding process. After the automatic inclusion, participants are free to switch their insurer. In order to assist the decision, detailed information is provided on the Singaporean Ministry of Health website.

Although the experience is recent, the scheme involving both public and private interaction has demonstrated clear positive effects. The government's social responsibility, associated with its potential penetration, has allowed the creation of a program in which every citizen is fully engaged. According to de Castries (2009), pricing, product development and claims management are the responsibilities of private insurers. Thus, the ElderShield scheme is highly beneficial for both public and private initiatives, with clear established functions.

Taking into consideration the supply side, the health/life insurance sector is boosted by contributing its expertise. It creates a number of participants large enough to reduce volatilities, produce a fair pricing process and generate a reasonable profit margin. It is noteworthy that, since more than one insurer sells the product, the premiums are competitive and affordable, preserving the initial idea and guaranteeing the public interest.

3. Brazil: An Overview

This chapter gives an overview of the Brazilian socio-economic situation over the recent years, as well as highlighting the life and healthcare insurance industry figures.

3.1 Economic Prosperity and Social Problems

Brazil is known as one of the most noticeable emerging economies in the world. As evidence of this growth the country will host two of the majors sports events during this decade: the World Cup (2014) and the Olympic Games (2016).

During the period of 2002 to 2010 the country's real GDP experienced a growth of over 36%, according to OECD (2011) figures. The development of its primary sector of the economy in parallel with the significant numbers of its internal market offers to the country the opportunity to figure as one the worldwide central economies.

Nevertheless, Brazil struggles to improve its social development ratios; its 84th position in the Human Development Index – ranking, according to UNDP (2011) statistics, is inconsistent with its economic relevance. Key topics such as education and healthcare need to be more focused in order to drive Brazil to better social welfare.

Despite its substantial progress in many areas, a recent publication conducted by the OECD (2012), highlighted the main areas of improvement the country should focus on. The report concluded that, although Brazil spends a high share of its GDP on government-financed programmes, compared to its emerging market peers, the outcome indicators are frequently poor. To conclude, the publication also mentioned that any new programme developed in the country needs incentives to enhance its efficiency, especially related to government operations.

In terms of demographic changes, as previously mentioned, the Brazilian population is ageing. Its ageing population is predicted to increase both in percentage and absolute terms.

3.2 Insurance Industry Overview

3.2.1 SUS and Healthcare Costs

The *Sistema Único de Saúde* - SUS (Unified National Health System) was created during constitutional reform in 1988, with the majority of the system funded through federal and local taxes. Although 75% of the Brazilian population depends on SUS, only 47% of healthcare costs come from government expenditure. In OECD countries the ratio is over 70%, according to the Economist Intelligence Unit (2012).

The Brazilian ratios show enough margins to increase public contribution to healthcare costs, and might also drive private expenditure into effective healthcare schemes. Figure 3 below shows the percentage amount of government and private healthcare expenditure in terms of the total real GDP.

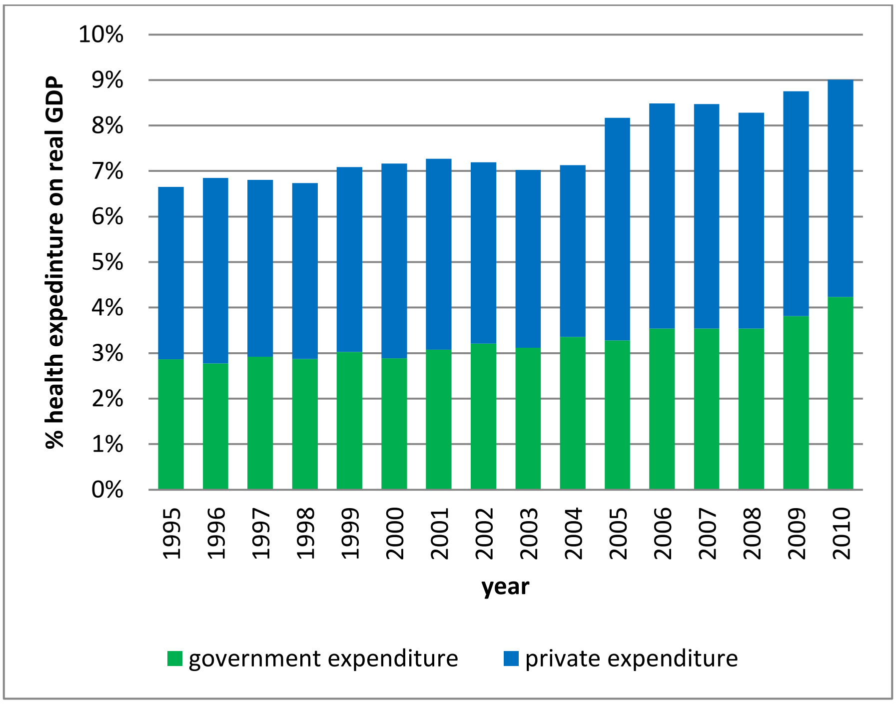

Figure 3 Government and Private Healthcare Expenditure in Terms of GDP, Source: WHO (2012).

During recent years there has been a visible increase in healthcare expenditure in Brazil, with private expenditure representing the major share of the total costs during the analysed period. Data from the WHO (2012) reveals only 41% of private expenditure are originated from private insurance and healthcare plans in 2010. The figures demonstrate that there is still margin for the development of initiatives that could reach the spending optimization on both sides: private expenditure and public budget.

3.2.2 The Health and Life Insurance Market

In common with most parts of the Brazilian economy, the life and health insurance market continues to grow on a yearly basis. Reforms such as the new legislation, in 2007, which opened the reinsurance market to foreign companies, boosted the investments in this field. Previously, the monopoly was controlled by the public company IRB – *Instituto Brasileiro de Resseguros* (Brazilian Reinsurance Institute).

The health insurance market is regulated by ANS – *Agência Nacional de Saúde Suplementar* (National Regulatory Agency for Private Health Insurance and Plans) and, according to Santos (2009), the number of medical assistance insurance contracts increased by 22% from 2000 to 2008, with the number of insured lives increased by 43% during the period.

In parallel with healthcare industry growth, a large increase in life insurance over the past years was also observed. According to SUSEP [4] statistics (2012), direct premiums increased more than 7 times from 2001 to 2012. However, despite this enormous growth, life insurance still shows a lower percentage penetration on the GDP when compared to the other nations. The average penetration of life insurance premium on the GDP is 4% worldwide, whereas in Brazil it is only 1.5%, according to Swiss Re Sigma Survey (2010).

The figures confirm that although the Brazilian economy is developing there is still room for investment in the life and health insurance market. The creation of alternative products could benefit the industry as a whole, and provide the population with a new alternative to fund dependency costs. It is clear that discussion of solutions that combine public funding, private initiative and population awareness in a new, fair and effective system should be made in Brazil.

4. Data Analysis and Model

This chapter describes the statistics that might be considered when pricing LTC insurance, as well as observations regarding the method used to obtain LTC insurance risk rates and data.

4.1 ADL Data

The figures obtained from PNAD 2008 represent the most up-to-date information available to develop dependency rates for Brazil, and hence develop a multiple state model.

The data analysed for this research are those related to *Mobilidade física e fatores de risco e proteção à saúde* - Physical activities, risk factors and health protection table, defined in the survey as restrictions related to self-care and mobility. These core activity restrictions are summarised in Table 2, IBGE – PNAD (2008).

Related Activity	Description
Self Care	Eating; Showering/bathing or using the toilet without assistance.
Mobility	Run, raise heavy objects, sports or other heavy activities * Move a table or carry out minor housing repairs * Climb slopes or stairs * Stooping, kneeling or bending * Walk more than 100 meters *

Table 2 Physical Activities, Risk Factors and Health Protection Table.

* Only evaluated for people who failed or had great difficulty in eating, bathing or going to the toilet without assistance.

Activity restrictions are therefore associated according to the four levels outlined below, as suggested by Leung (2004):

i. Could not perform the activity – Profound;

[4] SUSEP - *Super Intendência de Seguros Privados*: The Superintendence of Private Insurance is the insurance commissioner, responsible for the supervision and control of the insurance, open private pension funds and capitalization markets in Brazil.

ii. Could perform the activity, with great effort – Severe;

iii. Could perform the activity, with moderate effort – Moderate;

iv. Had no difficult to perform the activity – No care.

The number of females and males in each age band in Brazil, with and without activity restrictions based on the self-care criteria – eating, showering/bathing or using the toilet without assistance – are described in Tables 3 and 4 respectively, presented as rates per thousand of the Brazilian sample population.

Age Band	Profound	Severe	Moderate	No Restriction
14 to 24	2.7	3.8	6.0	987.6
25 to 34	3.0	4.4	8.7	984.0
35 to 44	3.4	7.6	14.5	974.6
45 to 54	4.7	11.7	25.3	958.2
55 to 59	6.9	16.3	32.2	944.6
60 to 64	6.7	21.3	45.0	927.0
65 to 69	10.0	34.9	50.9	904.2
70 to 74	14.9	39.5	71.1	874.5
75 to 79	35.8	54.9	91.6	817.7
80 to 84	48.9	88.1	117.5	745.5
85 and over	75.6	136.3	166.1	622.0

Table 3 Male Dependency Prevalence Rates (per 1000).

Age Band	Profound	Severe	Moderate	No Restriction
14 to 24	2.1	4.5	9.7	983.7
25 to 34	1.7	5.7	12.6	980.0
35 to 44	2.4	8.7	20.2	968.7
45 to 54	4.0	15.1	32.4	948.5
55 to 59	4.8	20.0	42.7	932.6
60 to 64	5.0	26.1	61.9	907.0
65 to 69	9.8	30.1	74.1	886.1
70 to 74	14.9	44.7	102.6	837.8
75 to 79	32.7	66.3	129.0	772.0
80 to 84	66.0	103.2	146.0	684.7
85 and over	126.3	171.5	189.7	512.5

Table 4 Female Dependency Prevalence Rates (per 1000).

The collected data, divided by age band, presents characteristics that were expected. For both genders, in general, the dependency rates increase with age. In the case of older ages (more than 65 years), the increase in dependency rates appears to increase rapidly compared to younger ages, which endorses the necessity of instruments to fund dependency costs.

For instance, there is a noticeable increase for profound care, from ages 70 - 74 to 75 – 79, both for males and females, with respective increases of 141% and 119%. Profound and Severe prevalence rates are higher, in general, for females. In particular, this is true for older ages.

These results are in line with the findings of Leung (2004), in which the rates were developed according to the Australian population statistics.

On the other hand, the data is quite limited since it does not include a “mild” category between moderate and no restriction states, which could assist in producing a more accurate multiple state model representation. Further limitations of the model and data will be discussed in chapter 8.

4.2 Multiple State Model

A multiple state model will be used to estimate the number of people that will require LTC in the future. The choice to use this approach is based on Leung (2004), who in turn followed the modelling and formulae for obtaining transition probabilities as proposed by Rickayzen and Walsh (2002). Nevertheless, for the sake of simplicity and based on the Brazilian data, several formulae and parameters will be adjusted. The defined states and the possible transition states are described in Figure 4 below:

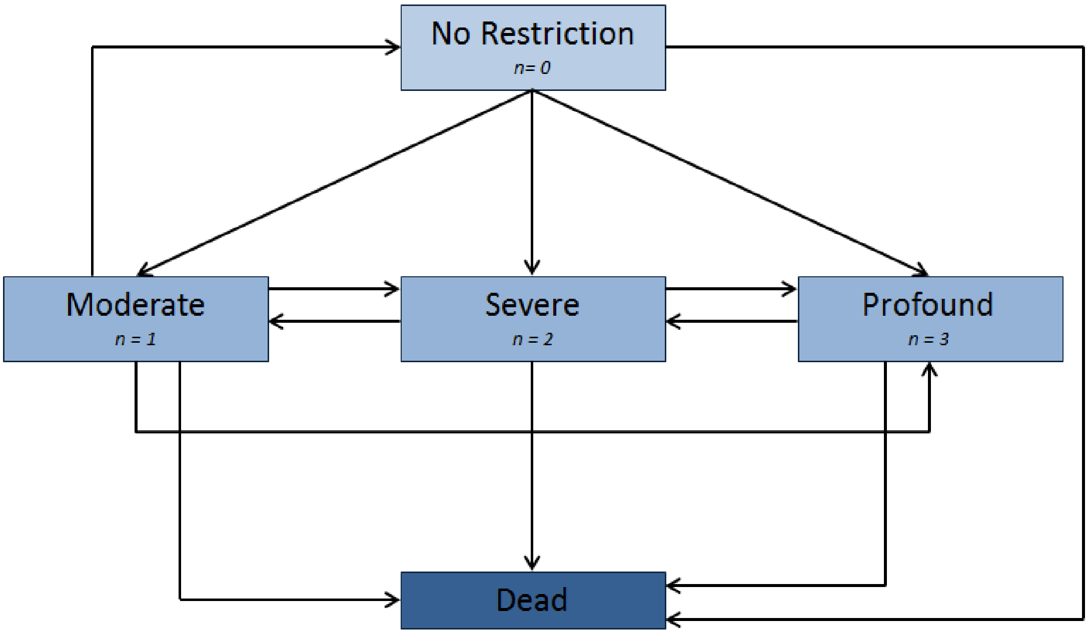

Figure 4 Transitions in the Multiple State Model, based on Leung (2004).

4.2.1 Obtaining Morbidity Rates

The state space of the model contains 5 states: No restriction, 3 levels of dependency (as stated above), and dead (which behave as an absorbing state). In order to simplify the model, the author will denote each state by {n: n = 0 to 3}, in line with Leung (2004), where 0 corresponds to no restriction and 1 – moderate, 2 – severe, 3 – profound.

In order to follow the essential approach of a discrete time Markov Chain the model will adopt stationary population characteristics to derive transition probabilities, as done by Rickayzen and Walsh (2002). Furthermore, as the purpose of obtaining the transition probabilities, the formulae and fitting methods will be described in the following sections.

4.3 Mortality Assumption

The mortality assumption will follow the BR-EMS 2010 table, contained in appendix 1, based on insured lives population – which exhibits a higher mortality than for annuitants table - and hence a closer estimate of the overall population. Separate tables for males and females will then be applied for each state (except death). The mortality study was carried out for 3 years, and finished in 2006. On the other hand, the disability survey from PNAD was carried out in 2008. Therefore, a gap of only 2 years exists between the mortality and morbidity tables. Hence, for simplicity, no adjustments or projections between mortality and disability rates will be conducted over this minor period of time.

It is reasonable to argue that there is a relationship between mortality and morbidity rates, with the mortality rates being higher for people in critical dependency conditions. For completeness, additional mortality was established for participants in either severe or profound categories, based on the Leung (2004) approach.

In Brazil, there are limited studies regarding the association between mortality and morbidity rates. The formula used to obtain the extra mortality for lives aged *x* in dependency care category *n* is given by the Rickayzen and Walsh (2002) formula:

$$Additional\ Mortality\ (x,n) = \frac{0.15}{1+1.1^{50-x}}.\frac{Max(n-1,0)}{4} \qquad (1)$$

According to Rickayzen and Walsh (2002), the following considerations were used to obtain this formula:

- Independent of gender the formula is the same;
- The maximum extra annual mortality is 0.15;
- Extra mortality is reduced for younger ages;
- 1.1 was selected as the steepness factor and the age of 50 as pivotal age

Some adjustments were required in order to replicate the formula. For instance, there is no extra mortality for lives in “no restriction” or “moderate” conditions and only 4 live states were defined for the Brazilian model. Hence, an adjustment was needed in the formula to weight the extra mortality. Figure 5 below reproduces a comparison with the mortality rates defined for males with no restriction, severe and profound categories, considering the additional mortality assumption.

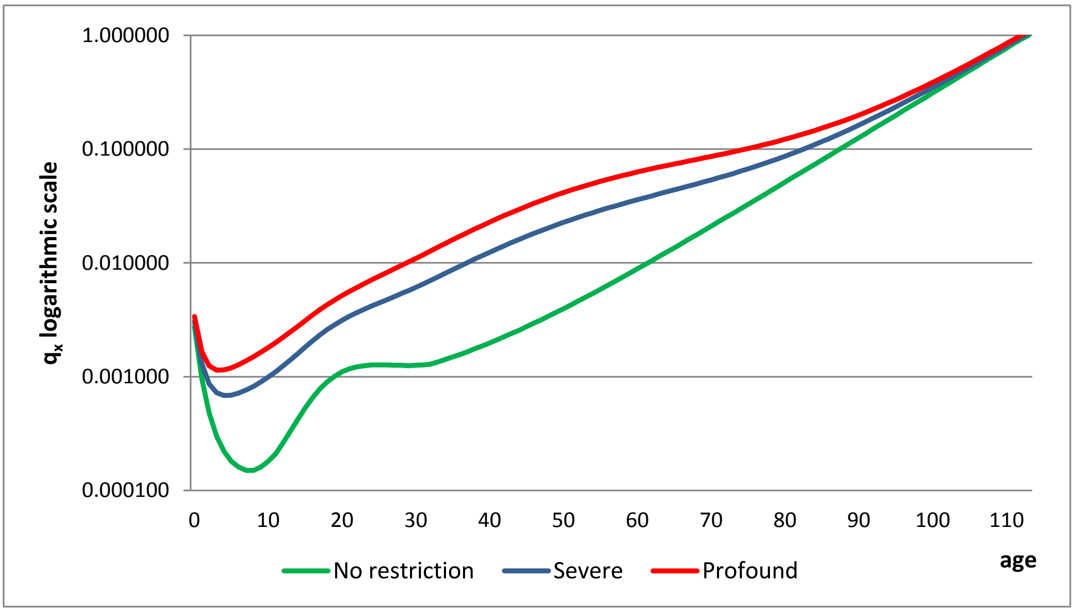

Figure 5 Additional Mortality Comparison over BR-EMS 2010 Male.

4.4 The Transition to Dependent States

Rickayzen and Walsh (2002) used a logistic formula to derive the probability of an individual becoming disabled at a certain age. As mentioned by the authors, the probability of becoming disabled is initially constrained by the proportion of people who are in the able state. The original formula contains 5 parameters for males, and 4 for females, however this project will use the male approach for both genders. The formula is defined below:

$$NewDependents(x) = \left(A + \frac{D - A}{1 + B^{C-x}}\right) \cdot \left(1 - \frac{1}{3} \, . exp\left[-\left(\frac{x - E}{4}\right)^2\right]\right) \qquad (2)$$

The 5 parameters are A, B, C, D and E. The parameter values were obtained according to the fitting method, using the optimization procedure of the Solver action in Excel to minimize the squared difference. The values inputted to Solver method were based on Leung's (2004) findings. The results are presented below for males and females:

	Parameters				
	A	B	C	D	E
Males	0.024401	1.188008	75.06879	0.389808	77.44573
Females	0.032083	1.203767	75.38363	0.50054	78.48037

Table 5 Estimated Parameters for New Dependents.

Figure 6 below shows, on a logarithmic scale, a comparison between the probabilities of males and females acquiring any disability from an able state, over one year period (the morbidity rates split by age and gender can be seen in Appendix 1).

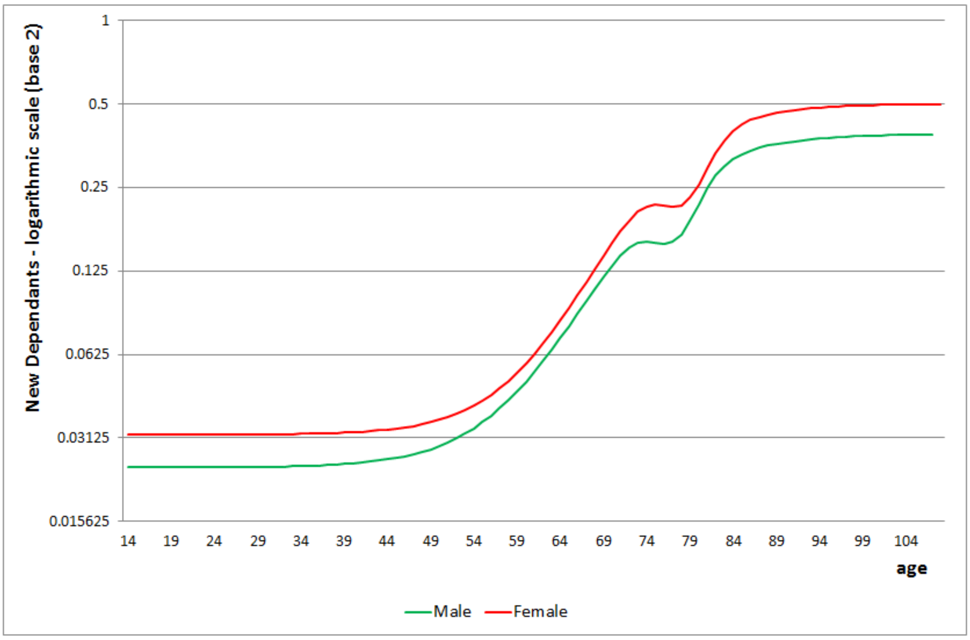

Figure 6 Probabilities of Moving to a Disabled State – Male and Female.

The rates reveal the same shape for both genders. It is worth mentioning that the probability of becoming disabled for females is higher than males for every age. In addition, up to age 70 there is a significant increasing trend in the morbidity probabilities.

Also, worth mentioning a kink on the morbidity slope for both genders at age 75, which is also observed on Leung's (2004) risk rates for the Australian population.

4.5 Obtaining the Severity of Disabilities

Participants that migrate from a healthy condition may enter any of the three established disability categories (n = 1, 2 and 3), therefore it is necessary to estimate into which of the states the participant will enter.

According to the Leung's (2004) approach, based on Rickayzen and Walsh (2002), the proposed formula that a member at age *x* will be in a certain category *n*, given that the member acquired a disabled condition, is described by:

$$Severity(x,n) = \frac{W(n).f(x)^{n-1}}{Scale(x)} \tag{3}$$

$$f(x) = P + \frac{1-P}{1+Q^{R-x}} \tag{4}$$

$$Scale(x) = \sum_{n=1}^{3} W(n).f(x)^{n-1} \tag{5}$$

W(n) represents the category widths that are considered to allow some disabled categories to have more participants than others. The scaling parameter – *Scale (x)* – guarantees that the sum of probabilities will add up to 1. The three parameters, defined by the letters *P*, *Q* and *R* are related to dependency age of disability. The estimated parameter values for severity are presented in Table 6 below and were derived using the same approach used to obtain the parameters in formula (2):

Parameter	Males	Females
P	1.076763	0.966733
Q	440.6531	38.51525
R	74.49946	74.63346
W(3)	0.941361	1.294866
W(2)	1.78345	2.671765
W(1)	2.829556	4.857762

Table 6 Estimated Parameters for Severity.

4.6 Improvements and Deteriorations

Participants in a certain disability category can get better or worse. In other words, people can migrate from one condition to a more critical or healthier state. For the improvements assumption, a simplistic approach was taken. In line with Rickayzen and Walsh (2002), individuals may only improve during a certain year if and only if, they survive the year and no deterioration was observed during the period. The author decided to use 10% as the improvement rate for the period of a year.

In order to define deterioration probabilities, Rickayzen and Walsh (2002) associated this transition with the probabilities of transferring from a healthy state to becoming disabled. The probability of an individual in a certain category *m* migrating to a more severe category *n* is F^m times the probability of a healthy individual migrating to category *n*. The formulae are detailed below:

$$Deteriorate(x, m, n) = Deteriorate(x, 0, n)\ .\ F^m \qquad (6)$$

With: $$Deteriorate(x, 0, n) = NewDependents(x)\ .Severity(x, n) \qquad (7)$$

The deterioration factor, *F*, applied was 1.1561 for males and 1.1830 for females, in accordance with Rickayzen and Walsh (2002).

5. The Pricing Model

This chapter defines the model, projections and calculations used to obtain the estimated number of individuals in Brazil that will be in disabled states. Also, the methods described allow obtaining the risk premium for the Brazilian LTC insurance in light of the Singapore scheme presented in chapter 2.

5.1 Brazilian Population Projection

The Brazilian population will be projected in order to determine the number of inhabitants that will be populating each of the states of the model showed in chapter 4. The projection will be run for the next 50 years (starting from 2010). In this section, some assumptions will be established for obtaining the future Brazilian population.

5.2 Fertility and Migration

In order to determine the fertility assumption over the period, the study followed the average provided by United Nations Statistics (2010). During the period from 2010 to 2065, the estimated average fertility rate was 1.68 births per women with age from 18 to 40 years old. Furthermore, due to data restrictions for people under 14 years in PNAD survey, it was assumed that births are linearly distributed to the able state over the projected years.

The paper assumes net overseas migration of -180,000 per annum, which means that the number of people emigrating from Brazil is higher than the number of people immigrating into Brazil. The figure is based on an average assumption according to United Nations Statistics (2010) projection for the period of 2010 to 2065. In addition, the proportion of migrants is linear distributed from ages 18 to 40 in the able state.

5.3 Mortality Improvement

Since the projection concerns a period of 50 years, an assumption regarding mortality improvement is applied to the BR-EMS 2010 table. Based on the United Nations Statistics (2010), the life expectancy at birth for males and females in 2060 is estimated as 81.33 and 86.45 years, respectively. Hence, following a simple linear approach, there is an improvement in life expectancy of 0.22 years for males and 0.18 years for females, per annum. The projection uses a similar approach to that followed by Leung (2004), in light of findings from the Investigation Reports (CMIR) (1999) of the Institute and Faculty of Actuaries, to obtain the improvements as a function of age. The formulae are described as follow:

$$q_{x,t} = q_{x,0} \, . RF(x,t) \qquad (8)$$

Where *RF (x, t)* is the reduction factor for age x at a given time t, which can be represented by the relationship:

$$RF(x,t) = \frac{q_{x,t}}{q_{x,0}} \qquad (9)$$

The reduction factor, which causes a decrease in mortality, is given as:

$$RF(x,t) = \left\{\alpha(x) + [1 - \alpha(x)] \, . [1 - f(x)]^{\frac{1}{20}}\right\}^{t} \qquad (10)$$

Where:

$$\alpha(x) = \begin{cases} c & x < 60 \\ 1 + (1 - c) . \frac{(x-110)}{50} & 60 \le x \le 110 \\ 1 & x > 110 \end{cases} \qquad (11)$$

And:

$$f(x) = \begin{cases} h & x < 60 \\ \frac{(110-x).h + (x-60).k}{50} & 60 \le x \le 110 \\ k & x > 110 \end{cases} \qquad (12)$$

The parameters *c*, *h* and *k* were defined such that a life expectancy of 81.33 years for males and 86.45 for females was obtained for the year of 2060. The formula used to obtain the expectation of life at age *x* is defined as:

$$e_x^0 = \frac{1}{l_x} \cdot \left\{ \left(\sum_{y \geq x} l_y \right) - \frac{l_x}{2} \right\} \qquad (13)$$

The parameter values are shown in Table 7 below:

	Parameters		
	c	*h*	*k*
Males	0.142	0.164	0.245
Females	0.150	0.124	0.213

Table 7 Mortality Improvements Parameters.

5.4 Projection Method

The projection approach will follow an adaptation of the methodology described by Rickayzen and Walsh (2002). The components follow the same application for both males and females. The formulae described by the authors are as follows:

Define *Lives(x, t, n)* to be the number of lives aged *x* in a given year *t* in a certain state model *n*. Then:

$$Lives\,(x,t,n) = \left[Lives\,(x-1,t-1,n) + \frac{Migrants\,(x-1,t-1,n)}{2} \right] \text{x}$$
$$[1 - Mortality(x-1,t-1,n)]\ \text{x}$$
$$[1 - Deteriorate\_From(x-1,t-1,n)\ ]\ \text{x}$$
$$[1 - Improve\_From(x-1,t-1,n)] +$$
$$Deteriorate\_To(x,t,n) + Improve\_To(x,t,n) +$$
$$\frac{Migrants(x,t-1,n)}{2} \qquad (14)$$

According to the above formulae, it is assumed that half of the migrations occur at the beginning of the year and the other half at the end of the year. Since the migration flow observed in the projections of the Brazilian population presents a deficit, the migrants leaving Brazil at the start of the year are not exposed to the decrement rates that the rest of the population is exposed.

Mortality (x, t, n) is the probability that an individual aged *x* at a given time *t* and in the state *n* dies in the following year. Hence:

$$Mortality\,(x,t,n) = \ q_{x,t} + Additional\_Mortality(x,t,n) \qquad (15)$$

The additional mortality due to disability is given by the formula (1) – section 4.3, and the mortality rate *($q_{x,t}$)* comes from the BR-EMS 2010 table. The *Deteriorate_From* function - formula (4) - represents a probability, which is related to the expressions described in chapter 4 in the following way:

$$Deteriorate\_From(x,t,0) = NewDependents(x,t) \qquad (16)$$

And

$$Deteriorate\_From\ (x,t,m) = \sum_{n=m+1}^{3} Deteriorate\ (x,t,m,n) \quad (17)$$

Furthermore, the *Improve_From (x, t, n)* function is the probability that an individual who does not suffered any decrement in the year, improves and moves to a healthier category. Thus:

$$Improve\_From\ (x,t,n) = 0.1\ for\ n = 1,2,3 \quad (18)$$

Deteriorate_To (x, t, n) is the total number of persons aged *x* at a given time *t* who make a transition to disabled states *n* from a healthier disabled condition. Hence:

$$Deteriorate\_To\ (x,t,n) = \sum_{m=0}^{n-1} \{Exposed\_To\_Detriment\ (x-1,t-1,m) \text{ x } Deteriorate\ (x-1,t-1,m,n)\} \quad (19)$$

Where:

$$Exposed\_To\_Detriment = \left[Lives\ (x,t,n) + \frac{Migrants\ (x,t,n)}{2}\right] \text{ x } [1 - Mortality\ (x,t,n)] \quad (20)$$

Improve_To (x, t, n) is the number of individuals aged *x* at a certain time *t* who make a transition to a dependent state *n* from a dependent state *n + 1*. Hence:

$$Improve\_To\ (x,t,n) = Exposed\_To\_Improvements\ (x-1,t-1,n+1) \text{ x } 0.1 \quad (21)$$

Where:

$$Exposed\_To\_Improvements\ (x,t,n) = \left[Lives\ (x,t,n) + \frac{Migrants(x,t,n)}{2}\right] \text{ x } [1 - Mortality\ (x,t,n)] \text{ x } [1 - Deteriorate\_From\ (x,t,n)] \quad (22)$$

5.5 Changes in Disability Rates

In parallel with changes in mortality rates over the coming years, it is also reasonable to conclude that changes will occur in disabled conditions over the projected period. This assumption is realistic based on improvements over social conditions – particularly in Brazil – especially in medical and educational fields. Hence, the next sections propose solutions to allow improvements in the disabled model.

5.5.1 Improvement in the Incidence of Disabled States

The improvement factor for incidence of disabled states will follow the same approach proposed for mortality factor, in line with Leung (2004). The formulae are described as follows:

$$NewDependents\ (x,t) = NewDependents(x,0)\ .RF(x,t) \quad (23)$$

Where *RF (x, t)* is the reduction factor for age *x* at a given time *t*, given as:

$$RF(x,t) = \left\{\alpha(x) + [1 - \alpha(x)] \,.\, [1 - f(x)]^{\frac{1}{20}}\right\}^{t} \qquad (24)$$

Where:

$$\alpha(x) = \begin{cases} c & x < 60 \\ 1 + (1-c).\frac{(x-110)}{50} & 60 \leq x \leq 110 \\ 1 & x > 110 \end{cases} \qquad (25)$$

And:

$$f(x) = \begin{cases} h & x < 60 \\ \frac{(110-x).h+(x-60).k}{50} & 60 \leq x \leq 110 \\ k & x > 110 \end{cases} \qquad (26)$$

The magnitude of improvements in incidence of disabled states will be 10%. I.e. the probability of transition to a disabled state at a certain age is reduced, over the term of the analysis, until the transition probability at the year of 2063 is equal to 90% of the probability in 2013. The estimated parameters are settled in Table 8 below:

	Parameters		
	c	***h***	***k***
Males	0.990	0.995	1.003
Females	0.990	0.994	1.003

Table 8 Disability Improvements Parameters.

As also mentioned by Leung (2004), due to exponential behaviour, it is not possible to obtain the same reduction factor at all ages. The 10% reduction is not uniform for all ages, with a higher percentage reduction for individuals younger than 65 years, and lower for persons older than 65 years.

5.5.2 Severity and Deterioration Improvements

Another form of disability improvement is based on the reduction of the estimated probability of transitions to higher disabled states from an initial able state, as follows:

$$f(x,t) = f(x,0)\,.\,\beta^{t} \qquad (27)$$

Where, *f(x,t)* is as per equation (20), but now is also a function of time *(t)*. Also, for simulation purposes, β will be estimated as 0.998.

Furthermore, improvements are considered for deterioration from one disabled state to a more severely disabled state. It is reasonable to consider this type of improvement since medical advances are expected to reduce the severity of the conditions of patients who already suffer from a disable state. The approach of improvement is based on Rickayzen and Walsh (2002), as follows:

$$F(t) = 1 + [F(0) - 1]\,.\,\alpha^{t} \qquad (28)$$

For initial sensitivity test α is set as 0.98.

5.6 Lapse Probabilities

It is also reasonable to consider that participants will lapse their policies during the projected period. For instance, as mentioned in section 2.2.2, the Singaporean opt-out ratio was 38% during the initial part of the programme (later reduced to 14%). A lapse probability allows the model to reflect a more realistic scenario, in which it is expected that a percentage of members will drop out of the scheme due to cancellation, resulting in a lower risk premium being obtained.

According to LIMRA International and the Society of Actuaries (2004), the lapse rates for Long Term Care products vary according to age, product type (individual and group), and policy duration. The study also highlighted that persistency of LTC insurance products continues to increase. The values used to reproduce the lapse rates are contained in Table 9 below:

Policy Year	Lapse Rate
1	14%
2	10%
3	8%
4	6%
5	6%
6	6%
7	6%
8	4%
9	4%
10	4%
11+	2%

Table 9 Lapse Rates Probabilities, LIMRA (2004).

The rates used for this study are based on LIMRA International and the Society of Actuaries (2004) data for voluntary lapse rates by policy year for group Long Term Care insurance. Since the Singaporean scheme adopts an opt-out alternative at the first years and also due to the product long-term characteristic, the lapse rate at the early years tends to be higher.

5.7 Setting a Monthly Benefit

Estimating a fair benefit amount to be paid out monthly on the LTC policy is quite challenging. Due to the lack of experience, a reduced amount should initially be set following what was implemented for the Singaporean model. Later, with further experience analysis, additional products can be offered as alternatives to the population. For simulation purposes, the value of 2 monthly minimum wages - R$ 1,356.00 (£ 400) [5] - is set as the monthly benefit paid during 5 years.

6. Calculating the LTC Insurance Premium

Before simulating the number of individuals in disabled conditions for the next fifty years, this report will estimate the premiums to be paid for LTC insurance in Brazil based on the Singaporean scheme procedures. In this chapter, the risk premium is computed based on the rates and formulae discussed in the previous chapters. The model is described at each step of its projection.

[5] The exchange rate used is £1 = R$ 3.38 as at 17 July 2013

6.1 Risk Premium

The risk premium was estimated based on the mortality and morbidity rates described in the previous chapter. For comparison and evaluation purposes, the LTC risk premium was established according to the initial assumptions of the Singaporean Model (participants joining at age 40 with 25 years of monthly premium payment and, in case of disability, 60 months of benefit). The formula used to obtain the monthly risk premium is described below:

$$Monthly\ Premium = Annual\ Benefit\ .\frac{\sum_{n=0}^{\infty} \ddot{a}*^{(12)}_{x+n:\bar{5}|}.i_{x+n}.v^{n}}{12\ .\ \ddot{a}^{(12)}_{x:\,\overline{25}|}} \qquad (29)$$

Where:

The annuity for the premium ($\ddot{a}^{(12)}_{x:\,\overline{25}|}$) was estimated considering 3 decrements (lapse, morbidity and mortality) ;

The sum ($\sum_{n=0}^{\infty} \ddot{a}*^{(12)}_{x+n:\bar{5}|}.i_{x+n}.v^{n}$), was estimated considering only the mortality risk, which is higher for disabled lives as described in section 4.3 - formula (1), and i_{x+n} reflects formula (2) of section 4.4.

According to SUSEP life insurance resolution CNSP n.117 (2004), a maximum interest rate of 6% per annum is allowed for life insurance products, which is the established rate to obtain the risk premiums.

6.1.1 Risk Premium Estimates

The risk premium was estimated separately by gender for the next 50 years. It is worth mentioning that the calculation is for a level premium due to starting on the scheme at a given inception age.

At each year (t) the mortality and morbidity rates vary according to the improvements described in formulae (8) and (23). The findings for the age of 40 are plotted below in the Figure 7:

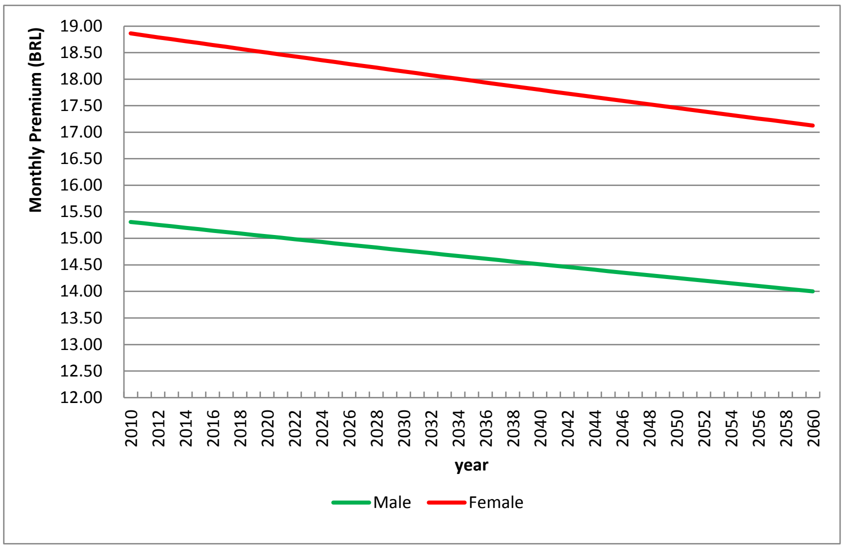

Figure 7 Monthly LTC Premium over the Next 50 years – Male and Female.

As expected, the premium is higher for females than males, since the morbidity risks are greater for females. We can also notice a linear decrease in premiums over the years, as the morbidity and mortality rates improve. At the initial year (t = 2010) the value for males and females are 15 BRL and 19 BRL, respectively. At the final year (t = 2060) the values for males and females are reduced to 14 BRL and 17 BRL, respectively, a reduction of approximately 9%.

6.1.2 Risk Premium by Different Ages

In order to compare the risk premiums according to different ages, a simulation was performed by varying the inception age, starting from age 25 up to 65 years old, with all other parameters kept the same. The results are plotted in Figure 8 below.

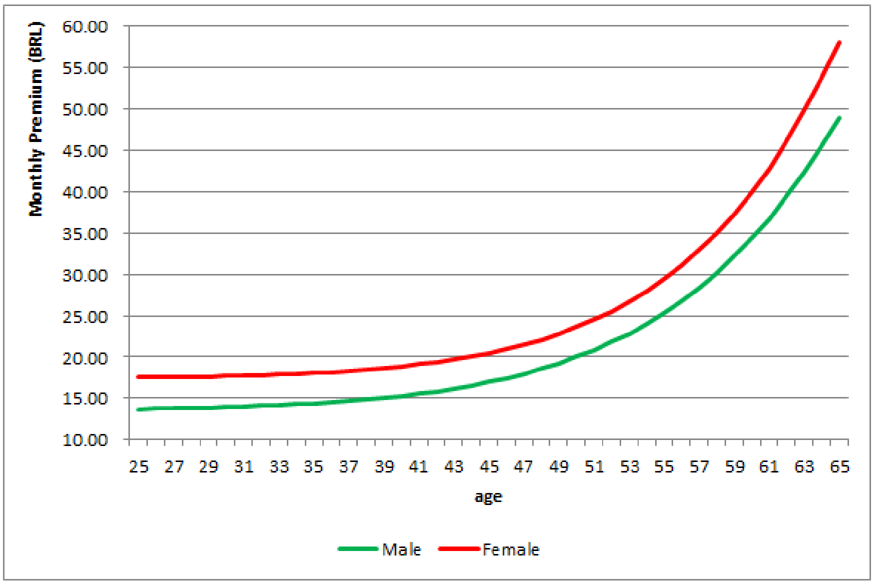

Figure 8 Monthly Premium from Ages 25 to 65 years– Male and Female.

The monthly premium for both genders demonstrates an exponential increase for older ages. From age 25 to 45, the premium development slope is less prominent than at older ages, which demonstrates that funding future costs at earlier ages is more affordable than at older ages.

The next topic describes the computation method used to derive an office premium for the LTC insurance product.

6.2 Office Premium Estimation

The formula method was applied, in accordance with Richardson (2011), based on the methods outlined by The Actuarial Education Company (2010), and it follows the basic principle that the present value of the estimated office premium needs to match or be higher than the present value of losses and expenses less the present value of income from investment. The equation is described as follows:

$$PV(Claims) + PV(Comm) + PV(Exp) - PV(Inv) = PV(OP) - PV(Pro) \quad (30)$$

Where:

PV (Claims) is the present value of expected claims;

PV (Comm) is the present value of the commission;

PV (Exp) is the present value of the expected expenses;

PV (Inv) is the present value of the expected investment income;

PV (OP) is the present value of the annual office premium;

PV (Pro) is the present value of the expected profit.

The profit to the insurer will be set in arbitrary terms as 10% of the risks premiums collected. Since the product has a social function, both expenses and commission will be set with reduced amounts in order to reduce the office premium payable. Both figures, will also be expressed as a percentage of the calculated amount, rather than fixed values.

Equation (30) will be solved in order to find the annual premium required to cover all outflows generated through the process. For simplicity purposes, reserves, taxes and capital requirements are not considered when calculating the present values. Expenses are set as 10% charge of the annual premiums and commissions will be 8.33%, which corresponds to an amount equal to one monthly premium. Although the State subsidizes the insurers in the Singaporean scheme, no assumptions were considered to obtain the estimated office premium.

Since the product scheme does not envisage agents or brokers in the early stages of the implementation, the amounts designated as commission could be kept and accumulated for future commercial decisions related to the model. For instance, incentives for complementary products or extended guarantees payment periods could be considered. Furthermore, the expected investment yield will be set as 5% per annum.

The results in Table 10 outline the amounts calculated for the monthly office premium, for each gender at 5-year intervals for the inception age (premiums will be paid from inception up to 25 years period) associated with the average monthly wage of the Brazilian population, in accordance with IBGE (2010).

Gender and Age	Average monthly wages (BRL)	Monthly LTC office premiums (BRL)	% impact of LTC premium
Male			
25	1 022.76	18.14	1.77%
30	1 321.53	18.46	1.40%
35	1 507.12	19.10	1.27%
40	1 608.79	20.29	1.26%
45	1 803.32	22.51	1.25%
50	1 905.24	23.87	1.25%
55	1 979.18	33.57	1.70%
60	1 917.17	45.58	2.38%
Female			
25	660.69	23.25	3.52%
30	800.31	23.46	2.93%
35	860.90	23.95	2.78%
40	886.44	25.00	2.82%
45	952.13	27.14	2.85%
50	989.67	31.27	3.16%
55	1 029.21	38.98	3.79%
60	1 010.95	52.96	5.24%

Table 10 Percentage Impact of LTC Office Premium.

As can be seen, the monthly office premiums across different ages present the same growth as the original risk, since the parameters included followed percentage loading. Due to wages discrepancy between genders, and also reduced morbidity risks for males, LTC insurance is more affordable to males than to females. Worth mentioning the percentage of housewives corroborates for the reduced female average earning in Brazil.

Furthermore, the percentage impact of LTC monthly premium is reduced for both genders between the ages range of 35 to 45. This indicates that the LTC product premium has lower comparative costs on ages between these age ranges. This factor is noticed due to the wage increase and the balanced premium obtained during these ages. Therefore, the LTC insurance proved to be affordable based on the Brazilian economic reality, with reduced impact in the population budget.

6.3 Reviewing the Experience and Re-pricing

The long-term nature and small numbers of studies into LTC insurance means that it is crucial for the scheme to be constantly monitored. This avoids the situation where premiums received are insufficient to cover upcoming losses and expenses. This part of the process is fundamental for the scheme's success and requires an effective data and business analysis structure.

In parallel with the monitoring process, a conservative approach to implementation needs to be taken. The Singaporean model is a good example of gradual changes being made during the process execution. Initially, the scheme was developed with a 5 years benefit period and reduced sum insured. Years later, following a positive response to the features of the scheme from the population, complementary alternatives were launched.

The insurance industry has a clear role to assist the State in such a task. The implications of monitoring results and experience analysis impact directly on the financial sustainability of LTC and indicate whether further funding could be required to guarantee the payment of the benefits. Reinsurance agreements can also contribute to ensuring stability in results, as well as monitoring the portfolio.

7. Projected Results and Sensitivity Analysis

In this chapter, key parameters used to simulate the expected number of lives that will require LTC insurance over the next decades will be identified in order to measure the impact of different estimates for future results. The selected parameters are: additional mortality, severity and deterioration improvements. Based on Leung (2004), the results will be presented in different blocks, to enable comparisons between the different approaches.

7.1 Initial Projection

In order to ensure general accuracy of the population methodology, a simulation was set to evaluate the projected population development and the corresponding UN estimate (2010). For initial comparison purposes only live (no restriction, n = 0) and dead states are considered.

The data used for the Brazilian population in 2010 was extracted from IBGE (2010), as described in Appendix 2. The project estimate and UN figures are plotted in Figure 9 below.

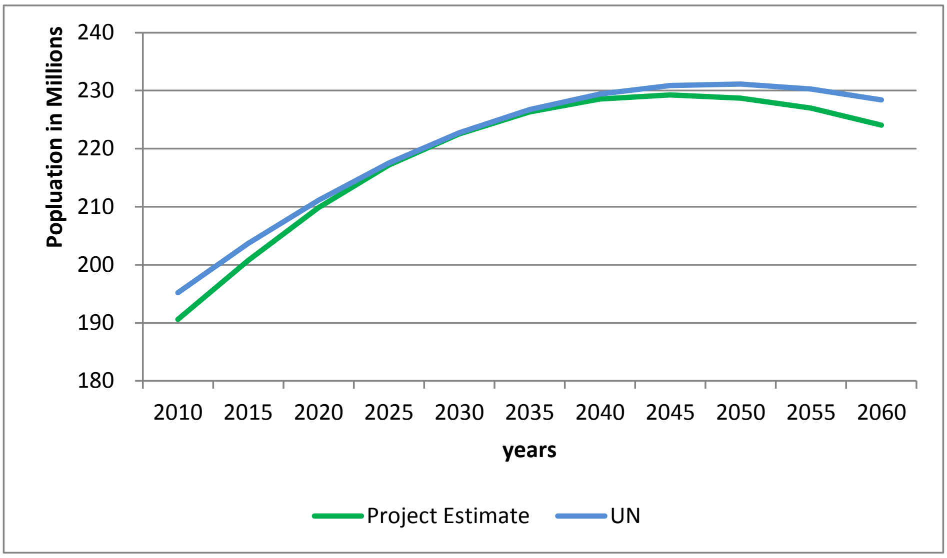

Figure 9 Comparison of UN and Project Population Projection Estimates.

As Figure 9 shows, the estimates for the projected Brazilian population over the next 50 years follow a similar pattern to UN projections. It can be seen that the model estimates are slightly lower than the total figures of the UN, with a difference of 1.9% in the 50th year of projection. The differences are explainable since the migration figure was held constant during the investigation period and the applied mortality rates, which even combined with the improvements, generate a higher mortality than the United Nations have forecast.

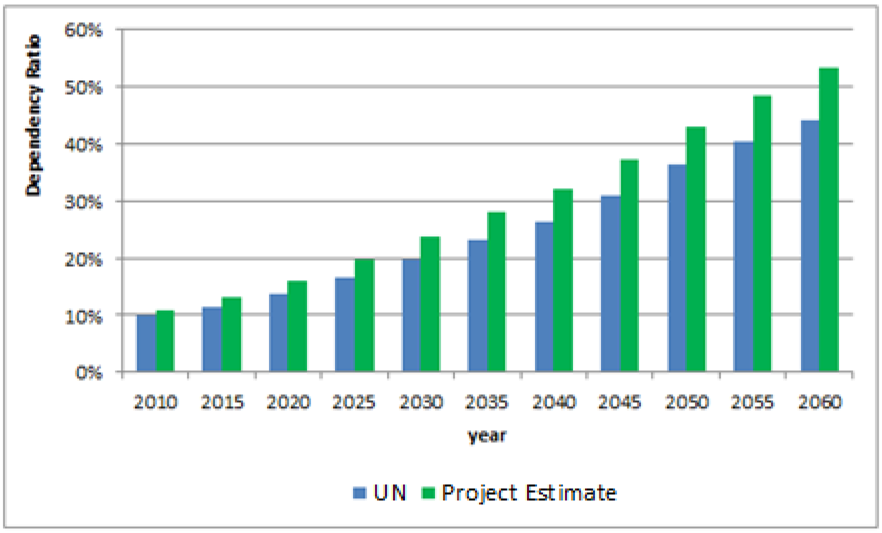

Figure 10 Comparison of UN and Project Dependency Ratio Estimates.

Furthermore, Figure 10 confirms that the model also follows the dependency ratio predicted by the UN, an important feature for LTC insurance implementation. The dependency ratio is higher for the proposed model which is also explained by the differing mortality rates used in the model. Overall, the population model is acceptable when compared to the United Nations projections.

7.2 Disabled States Projection

After estimating the population for the next decades, we now consider the numbers of people in each state (profound, severe, moderate and able). The results are outlined in Tables 11 and 12.

	male				Total
	able	moderate	severe	profound	
2010	90,591,333	1,434,378	851,575	423,747	93,301,032
2015	85,437,886	5,945,720	3,883,229	1,918,946	97,185,782
2020	83,097,990	8,759,817	5,882,005	2,854,479	100,594,292
2025	81,762,293	10,723,009	7,293,023	3,495,241	103,273,566
2030	80,618,345	12,155,396	8,360,388	3,994,624	105,128,753
2035	79,480,464	13,223,357	9,220,035	4,430,442	106,354,299
2040	78,240,991	14,006,724	9,926,811	4,825,545	107,000,071
2045	76,877,814	14,555,322	10,502,348	5,179,914	107,115,398
2050	75,455,321	14,915,411	10,964,968	5,491,537	106,827,237
2055	73,999,973	15,117,707	11,324,318	5,755,252	106,197,249
2060	72,447,672	15,173,456	11,575,454	5,964,126	105,160,708

Table 11 Number of Males in each Defined State.

	female				Total
	able	moderate	severe	profound	
2010	93,204,552	2,402,418	1,321,328	640,379	97,568,676
2015	85,414,693	9,049,274	5,947,373	3,014,512	103,425,852
2020	82,197,694	12,895,210	8,971,280	4,572,845	108,637,030
2025	80,636,398	15,535,706	11,144,916	5,678,847	112,995,866
2030	79,547,053	17,482,957	12,842,350	6,564,304	116,436,664
2035	78,585,101	18,973,503	14,255,965	7,349,253	119,163,822
2040	77,576,298	20,102,278	15,452,645	8,066,854	121,198,075
2045	76,468,662	20,921,791	16,444,306	8,705,123	122,539,882
2050	75,292,601	21,481,870	17,248,823	9,256,589	123,279,883
2055	74,057,097	21,812,865	17,875,434	9,712,584	123,457,980
2060	72,710,831	21,928,456	18,305,937	10,050,783	122,996,008

Table 12 Number of Females in each Defined State.

Unfortunately, no similar LTC studies were developed for the Brazilian population for the same period. Hence, there is a crucial problem with evaluating the rationality of the outputs featured above. Although reasonable with global trends and in line with the characteristics of an ageing population, the best approach to validate the model would be to compare with others projections, in particular to those with more critical states. In chapter 8 further analysis and limitations will be discussed.

7.2.1 Different Scenarios

In the first and conservative scenario (A), a more severe additional mortality is assumed, based on Rickayzen and Walsh (2002), in which the maximum extra annual mortality is 0.20. In addition, for severity and deterioration improvements, the values for β and α are 0.999 and 0.99, respectively. This represents smaller improvements than those in the standard scenario B.

Second scenario (B) is a middle term, and uses the parameter values primarily documented in this paper. Finally, the last scenario (C) is estimated with more optimistic values, with the annual additional mortality reduced to the maximum of 0.05. For severity and deterioration improvements, the values for β and α are 0.997 and 0.97, respectively, which are lower than those from scenario B. The three scenarios considered (A, B and C) are summarised in Table 13 as follows:

Scenarios	Maximum extra annual mortality	Severity improvement (beta)	Deterioration improvement (alpha)
A - high	0.20	0.999	0.99
B - medium	0.15	0.998	0.98
C - low	0.05	0.997	0.97

Table 13 Projections Scenarios.

7.3 Comparisons of Results

The comparisons will focus on the profound and severe disability categories. In line with Leung (2004), these categories are the most relevant when analysing future consequences of dependency costs. Figure 11 provides the comparison of the estimated percentage of inhabitants in profound and severe states, for the three scenarios.

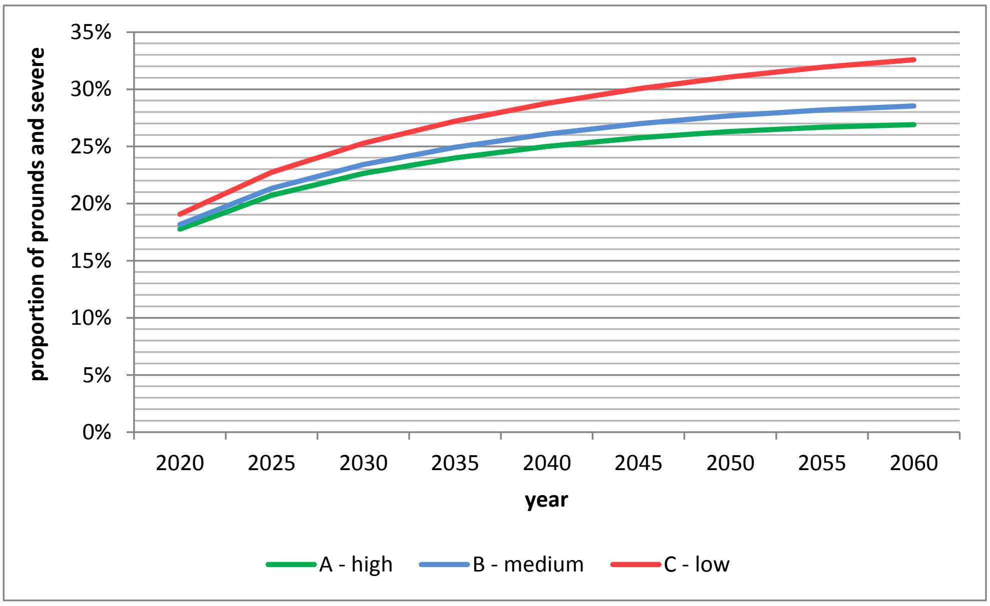

Figure 11 Percentage Evolution of Inhabitants with Severe and Profound States.

The results are in line with changes in the age distribution in Brazil, caused by a reduced fertility ratio and an improved mortality ratio. The three scenarios develop the same slope for the early years of study. However, due to the time dependent nature of the stressed parameters the figures diverge during the later years.

In particular, the additional mortality factor described in formula (1) is a critical parameter to the projected model. As Scenario C demonstrates, a reduction in the additional mortality rates for dependents is directly associated with a higher percentage of inhabitants in disabled states. The sensitivity of the results to this variable generates particular concern for LTC insurance type whose benefit is guaranteed for the whole of life.

The projected figures raise a socio-economic concern to the Brazilian government, since the scenarios suggest that a significant range of the Brazilian population in 2060 will be disabled to varying degrees. In line with the Singaporean LTC model, which the product is paid up to age 65,

Table 14 summarizes the percentage of individuals aged 65 or over who, according to the model, will be in severe or profoundly disabled state.

scenarios (% 65+)	2020	2030	2040	2050	2060
A - low	37.3%	39.8%	41.2%	41.6%	42.4%
B - medium	38.2%	41.0%	42.5%	42.9%	43.6%
C - high	40.2%	43.8%	45.6%	46.3%	47.1%

Table 14 Percentage of Disabled Individuals over Age 65.

Table 14, as also observed in Figure 11, highlights that the percentage of individuals in profound and severe states are significantly high for the projected years. As can be seen, scenarios A and B projected similar proportions over the decades, independent of mortality and morbidity transitions improvements. Furthermore, the percentage of dependents over 65 years old increased. This aspect is due to the ageing population structure, associated with the model assumption that transitions between healthier disabled states are only possible once a year, limiting higher improvements flows. Hence, the proportion trend over the period is much in line with the method applied and population structure.

The analysis will now compare the results obtained by Leung (2004) for Australian inhabitants with the figures obtained for the Brazilian population. Although the morbidity definitions and populations have different structures, the methodology applied was the same for both models, and the same pattern is expected for both results. Due to the data restriction observed in the Brazilian model, where no mild state information was available, the comparison will focus on the severe and profound states. The results can be found in Figure 12 below.

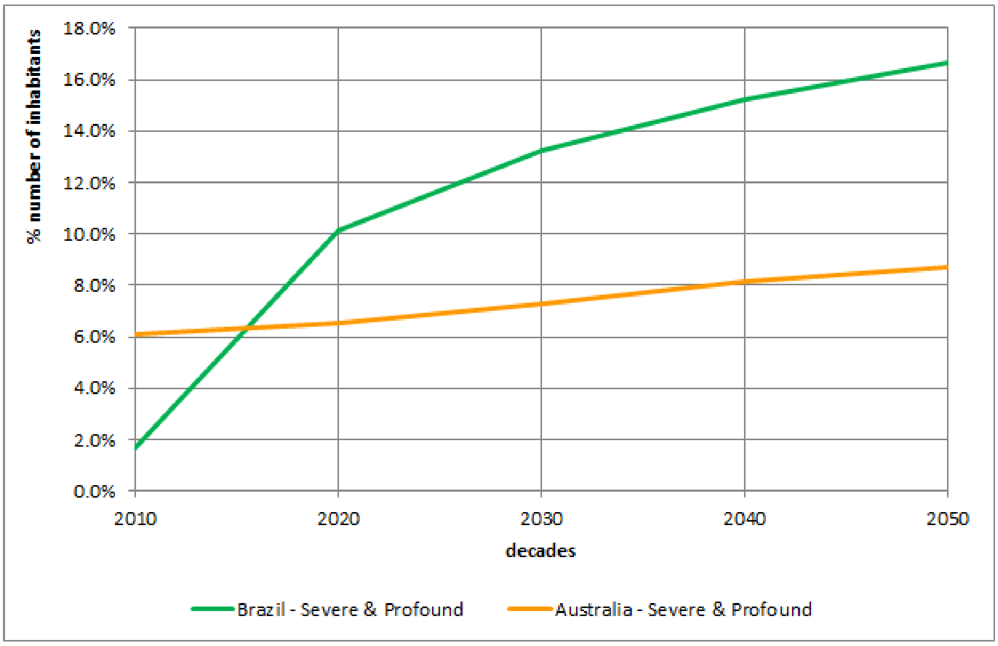

Figure 12 Brazilian and Australian Statistics for Disabled Inhabitants.

As expected, the ratios follow an increasing trend over for the next four decades. Since the Brazilian population will be older than the Australian one in the coming years, the ratio of individuals on severe and profound states in Brazil is higher than for Australia. One point of concern is the smoothness observed in the Australian progression in comparison to the Brazilian rates, which possibly indicates that the states defined according to PNAD survey might present an unbalanced classification. In the next section, further considerations are highlighted.

8. Data and Model Limitations

When considering the results obtained in this dissertation, we should highlight the limitations involved in the work.

8.1 Data Restrictions

A number of restrictions are associated with the data used in the pricing and projections performed. The essential data used as the basis of this investigation is the PNAD survey conducted in 2008. This survey categorized individuals according to a self-declared activity restriction, which means that no further investigation or uniform conclusion was developed to properly rank the interviewed inhabitants. Hence, inconsistencies and errors in the obtained figures are inevitable.

Moreover, one single self-care question embraced eating, bathing and toileting. The citizen's response to this investigation could be influenced by only one or two activities, which would clearly bias the observed results. Thus, the data was limited for deriving more detailed rates associated with ADL definitions.

In addition, the disabled states used in this paper were derived using the qualitative answers provided by each inhabitant. The subjectivity of the response, associated with the reduced number of multiple state models, could bias the model rates and conclusions. Also, no survey was performed for persons aged less than 14 years old. As a consequence, no disability was incorporated for infants through the period, which could impact the model in later years.

8.2 Model Problems

The multiple state model applied also presented limitations to reproducing the LTC scheme scenario. As previously mentioned a critical part of the projection was to fit the multiple states according to the qualitative responses of the PNAD survey, and then derive the prevalence rates. As a result, the definitions and values obtained presented a certain inaccuracy and, as a consequence, this imprecision was carried forward through the whole projected period.

In addition, due to the lack of literature in the country, no comparison was possible with other disabled conditions in Brazil. Further research on the topic should include different methodologies to obtain prevalence rates and also altered projection procedures.

Although a Markov Chain multiple state model is simple to implement, the model does not allow us to consider the duration period of an individual into that state to estimate improvements and/or detriments, as well as additional mortality. As mentioned by Leung (2004), without knowing how long the individual has been in a certain state, it is not possible to apply these different loadings.

9. Conclusion

An ageing population is definitely a topic of concern for the Brazilian government. As the insurance industry and governments become more involved in the potential of LTC insurance, different methods and approaches will arise to develop a suitable model for Brazil.

The challenges of obtaining LTC pricing and dependent population projections for Brazil are extremely relevant, and certainly impact society as a whole. This paper seeks to contribute pricing methods for Brazil, as well as raise awareness regarding dependency costs and stimulate future discussions around the problem.

The multiple state model permitted different investigations over the projected period and underlined relevant variables that should be taken into account when estimating the impacts of a dependent population. Also, the Singaporean example demonstrated the benefits of promoting a national scheme with gradual implementation and complete support of the private insurance industry. Such public-private initiative can combine with Brazilian current economic reality and help boost the development of life insurance in Brazil.

Also, the estimated office premium obtained demonstrated to be affordable for the Brazilian population, and further economic surveys could indicate the real potential for LTC penetration in the Brazilian market.

Future studies into this topic could investigate alternative methodologies and product structures to price LTC insurance in Brazil, as well as estimate the implications of the projected results on the future costs of Long Term Care insurance in the country.

Finally, the overall conclusion of the paper is that successful overseas LTC schemes can contribute to the construction of an encouraging scheme in Brazil. Reliable pricing techniques in conjunction with a public initiative can ensure the creation of a prosperous solution for Brazil.

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Appendix 1 – Initial Mortality and Morbidity Table Rates

Table 15 BR–EMSmt 2010: Males and Females.

	BR-EMSmt-v.2010										
age	Male	Female	age	Male	Female	age	Male	Female	age	Male	Female
	q_x	q_x		q_x	q_x		q_x	q_x		q_x	q_x
0	0.00274	0.00128	29	0.00125	0.00041	58	0.00749	0.00384	87	0.09609	0.06170
1	0.00095	0.00046	30	0.00126	0.00044	59	0.00814	0.00420	88	0.10517	0.07040
2	0.00048	0.00025	31	0.00127	0.00047	60	0.00886	0.00459	89	0.11511	0.08096
3	0.00030	0.00016	32	0.00129	0.00050	61	0.00964	0.00501	90	0.12600	0.09310
4	0.00022	0.00012	33	0.00135	0.00054	62	0.01049	0.00548	91	0.13792	0.10647
5	0.00018	0.00010	34	0.00142	0.00057	63	0.01143	0.00599	92	0.15098	0.12110
6	0.00016	0.00009	35	0.00149	0.00062	64	0.01246	0.00654	93	0.16528	0.13857
7	0.00015	0.00009	36	0.00157	0.00066	65	0.01358	0.00714	94	0.18093	0.15795
8	0.00015	0.00009	37	0.00166	0.00071	66	0.01481	0.00778	95	0.19808	0.17998
9	0.00016	0.00011	38	0.00176	0.00076	67	0.01616	0.00850	96	0.21686	0.20594
10	0.00018	0.00014	39	0.00186	0.00082	68	0.01763	0.00927	97	0.23742	0.23015
11	0.00021	0.00018	40	0.00198	0.00088	69	0.01925	0.01009	98	0.25994	0.25194
12	0.00026	0.00022	41	0.00211	0.00095	70	0.02102	0.01100	99	0.28460	0.27912
13	0.00033	0.00026	42	0.00225	0.00103	71	0.02295	0.01202	100	0.31161	0.31072
14	0.00042	0.00030	43	0.00240	0.00111	72	0.02508	0.01312	101	0.34118	0.34118
15	0.00053	0.00033	44	0.00256	0.00120	73	0.02740	0.01430	102	0.37357	0.37357
16	0.00065	0.00035	45	0.00275	0.00130	74	0.02994	0.01558	103	0.40904	0.40904
17	0.00078	0.00037	46	0.00295	0.00140	75	0.03273	0.01699	104	0.44788	0.44788
18	0.00090	0.00037	47	0.00317	0.00152	76	0.03578	0.01856	105	0.49042	0.49042
19	0.00101	0.00037	48	0.00341	0.00164	77	0.03912	0.02030	106	0.53700	0.53700
20	0.00110	0.00037	49	0.00367	0.00178	78	0.04278	0.02221	107	0.58801	0.58801
21	0.00117	0.00036	50	0.00396	0.00193	79	0.04679	0.02431	108	0.64387	0.64387
22	0.00122	0.00036	51	0.00427	0.00209	80	0.05118	0.02674	109	0.70505	0.70505
23	0.00125	0.00035	52	0.00462	0.00228	81	0.05598	0.02962	110	0.77204	0.77204
24	0.00127	0.00035	53	0.00499	0.00248	82	0.06125	0.03307	111	0.84540	0.84540
25	0.00127	0.00035	54	0.00541	0.00270	83	0.06701	0.03711	112	0.92575	0.92575
26	0.00127	0.00036	55	0.00586	0.00294	84	0.07332	0.04185	113	1.00000	1.00000
27	0.00126	0.00037	56	0.00635	0.00321	85	0.08024	0.04749			
28	0.00126	0.00039	57	0.00690	0.00351	86	0.08781	0.05413			

Table 16 Morbidity Rates, based on PNAD survey 2008 and formula (2) approach.

age	Morbidity Male i_x	Morbidity Female i_x	age	Morbidity Male i_x	Morbidity Female i_x	age	Morbidity Male i_x	Morbidity Female i_x
14	0.024411	0.032088	46	0.026828	0.034088	78	0.169786	0.216236
15	0.024413	0.032089	47	0.027280	0.034494	79	0.190267	0.229935
16	0.024415	0.032090	48	0.027817	0.034983	80	0.218199	0.256747
17	0.024418	0.032092	49	0.028452	0.035569	81	0.248735	0.293536
18	0.024421	0.032094	50	0.029203	0.036274	82	0.277046	0.333737
19	0.024425	0.032096	51	0.030092	0.037118	83	0.300259	0.370785
20	0.024429	0.032099	52	0.031142	0.038131	84	0.317832	0.400776
21	0.024434	0.032102	53	0.032382	0.039345	85	0.330741	0.423004
22	0.024440	0.032106	54	0.033843	0.040797	86	0.340391	0.438838
23	0.024448	0.032111	55	0.035564	0.042533	87	0.347948	0.450241
24	0.024457	0.032117	56	0.037587	0.044605	88	0.354147	0.458840
25	0.024467	0.032124	57	0.039961	0.047075	89	0.359389	0.465670
26	0.024479	0.032132	58	0.042739	0.050013	90	0.363879	0.471295
27	0.024494	0.032142	59	0.045983	0.053500	91	0.367739	0.476010
28	0.024511	0.032154	60	0.049759	0.057626	92	0.371053	0.479986
29	0.024532	0.032169	61	0.054138	0.062493	93	0.373892	0.483339
30	0.024556	0.032186	62	0.059197	0.068212	94	0.376318	0.486162
31	0.024586	0.032207	63	0.065011	0.074901	95	0.378386	0.488533
32	0.024620	0.032233	64	0.071659	0.082684	96	0.380146	0.490522
33	0.024661	0.032263	65	0.079209	0.091683	97	0.381641	0.492188
34	0.024710	0.032300	66	0.087722	0.102013	98	0.382909	0.493581
35	0.024768	0.032344	67	0.097227	0.113769	99	0.383983	0.494744
36	0.024837	0.032398	68	0.107697	0.127007	100	0.384892	0.495715
37	0.024919	0.032462	69	0.118978	0.141696	101	0.385662	0.496525
38	0.025016	0.032539	70	0.130667	0.157626	102	0.386311	0.497200
39	0.025131	0.032632	71	0.141954	0.174243	103	0.386860	0.497762
40	0.025268	0.032744	72	0.151551	0.190427	104	0.387324	0.498230
41	0.025431	0.032878	73	0.157937	0.204381	105	0.387714	0.498620
42	0.025624	0.033040	74	0.160124	0.213948	106	0.388044	0.498944
43	0.025852	0.033234	75	0.158769	0.217648	107	0.388322	0.499213
44	0.026124	0.033468	76	0.156870	0.216216			
45	0.026446	0.033750	77	0.159123	0.213621			

Appendix 2 – Brazilian Population

Table 17 Brazilian Population on 2010, divided by age and gender. Source: IBGE Census (2010)

age	Males	Females	age	Males	Females
0	1,378,532	1,334,712	51	948,591	1,043,550
1	1,369,425	1,325,484	52	985,045	1,072,188
2	1,387,143	1,339,814	53	905,975	1,003,881
3	1,419,295	1,371,487	54	883,350	1,000,256
4	1,462,592	1,407,674	55	877,013	981,986
5	1,493,253	1,438,735	56	826,882	923,370
6	1,472,635	1,421,784	57	751,293	846,389
7	1,506,828	1,452,364	58	742,051	831,864
8	1,528,003	1,467,609	59	705,105	790,268
9	1,623,425	1,564,739	60	737,957	828,340
10	1,793,146	1,712,070	61	602,476	685,880
11	1,709,291	1,643,553	62	613,839	696,871
12	1,727,220	1,675,022	63	562,959	647,505
13	1,728,588	1,684,160	64	523,804	609,489
14	1,767,168	1,726,543	65	529,674	612,257
15	1,802,172	1,772,757	66	468,666	554,433
16	1,719,415	1,691,289	67	440,243	517,554
17	1,701,889	1,670,352	68	408,863	481,535
18	1,699,061	1,668,111	69	376,619	450,966
19	1,636,331	1,629,495	70	419,302	508,323
20	1,698,081	1,691,648	71	335,925	407,322
21	1,713,268	1,708,468	72	323,844	399,311
22	1,760,477	1,750,020	73	294,410	375,966
23	1,709,675	1,710,579	74	293,891	383,342
24	1,748,728	1,754,248	75	265,369	347,796
25	1,725,173	1,729,872	76	225,782	300,854
26	1,631,055	1,667,163	77	211,817	288,022
27	1,710,763	1,756,309	78	206,262	279,883
28	1,737,767	1,777,879	79	181,287	256,375
29	1,656,237	1,712,196	80	183,850	267,401
30	1,763,562	1,785,240	81	139,772	203,290
31	1,523,891	1,604,353	82	129,748	193,899
32	1,548,975	1,616,671	83	114,919	176,495
33	1,458,789	1,523,907	84	100,334	157,264
34	1,422,441	1,496,683	85	87,856	138,790
35	1,468,144	1,522,780	86	72,953	117,267
36	1,344,132	1,419,081	87	60,074	100,588
37	1,326,646	1,413,539	88	49,839	81,920
38	1,325,659	1,386,788	89	40,037	70,159
39	1,302,083	1,379,727	90	37,970	67,510
40	1,422,254	1,458,121	91	26,745	46,409
41	1,235,034	1,316,498	92	21,371	39,539
42	1,281,124	1,342,824	93	16,052	32,021
43	1,177,147	1,273,411	94	12,826	26,115
44	1,205,009	1,297,942	95	10,317	21,515
45	1,263,401	1,326,973	96	7,905	16,184
46	1,173,710	1,277,761	97	5,743	12,265
47	1,129,200	1,231,074	98	4,314	9,395
48	1,079,370	1,164,125	99	3,250	7,447
49	1,046,333	1,141,405	100+	7,247	16,989
50	1,112,034	1,185,532			