How to determine fair value for life insurance policies in a secondary market

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Acknowledgements

Abstract

In this study a methodological approach is presented on how transactions in the secondary market for life insurance policies can be fairly priced for both policyholders and life settlement companies. Monte Carlo simulation of mortality on a pool constructed based on actual data of 85 life settlement transactions shows that a realistic assumption for the range of offered prices is limited to 15% and 20% of the face amount of the policy, given a required return of 7%. The power of the proffered pricing approach is ensured by assessing and managing mortality risk along with the other pertinent risks using stress testing, where mortality risk appears to be analogous to some extent with systematic risk on other markets of assets.

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1. Introduction

1.1. Outline of the study

Since the recent emergence of a secondary market for life insurance policies research has largely focused on pricing issues, in order to develop methods for determining the price of the transactions that occur in that market. These methods incorporate a number of factors affecting pricing. Nonetheless, the research undertaken to date and the understanding that it provides on pricing in the life settlement market remains limited. A more thorough understanding of the mechanics of pricing would result in an enhanced knowledge about the market's dynamics which, in turn, would assist the parties involved to assess the value of the traded asset, the fairness of that value and the pertinent risks associated with the asset.

The need for a better understanding on pricing in the life settlement market has become imperative since the transactions that take place have significantly increased in recent years. The market has expanded rapidly. However, a number of limitations associated with research in this market render any endeavor to further it difficult. These difficulties have contributed to the, to date, limited research in the area. The limitations mostly pertain to the lack of relevant actual data about the transactions that do occur as well as the relative size of the organized market for life settlements compared to other secondary markets for more often traded assets. This creates difficulties when trying to implement existing methods of pricing, as any attempt at empirical research in the field is rather difficult. The existing literature approaches the pricing issue from the perspective of determining the value of a life settlement given a required rate of return through discounting models. Thus, these pricing methods are not concerned with determining an appropriate return given the asset's risk as the traditional asset pricing models do, e.g. CAPM.

It is for this reason that, while a number of theoretical perspectives about pricing could be applied, the research undertaken herein relies on pricing techniques that give a direct value for the asset given a targeted return. However, as this study is intended to provide a more extensive analysis on pricing life settlements, I assess the pertinent risks of life settlement investments which it turn might assist investors to determine an appropriate rate of return. Finally, if a range of required returns were to be employed in pricing life settlements an analysis is presented on how they affect the value of a life settlement. These issues are extensively discussed in the Methodology and Theory chapters (3 and 4 respectively).

This study has been conducted to fill a gap in the empirical research in the field by implementing a method of examining pricing transactions in the secondary market for life insurance policies based on a sample of *actual* data. The approach selected from among a number of other existing pricing methods has been extensively discussed in the Theory Chapter (4). The employed method, is known in the existing literature as the stochastic method as it is based on stochastic simulation for determining the value of transactions such as those occurring in life settlements.

The purpose behind the decision to conduct this research is not limited to implementing a pricing method but determine the fairness of the pricing in this market. I rely on a) the available mortality data and b) the costs of maintaining the policy in force, to assess

how transactions in the secondary market for life insurance policies can be fairly priced. Fairness is based on the balance between the return that investors in life settlements demand and the risks pertinent to their investment. The question about how transactions in the life settlement market can be fairly priced for both policyholders and life settlement companies is the research question to be addressed in this study.

Further explanation on how this research question was derived is provided in the Literature Review Chapter (2). Methodological considerations in order to ensure that the criteria of reliability, validity, and generalizability are met are discussed in the Methodology Chapter (3). The pertinent risks and how their interaction with the required return from the investors' side can be used in determining fair value for life settlements are discussed in the Theory Chapter (4). The unique sample of data that was deployed to address the research question is presented in the Data Chapter (5). The empirical analysis and its results are presented in Chapter 6. Conclusions and suggestions for further research are summarized in Chapter 7.

In conclusion, I claim two contributions for this study. The first is the enhancement of the understanding of how a method for pricing life settlement transactions can be implemented using real life data. This contribution is on the life settlement industry level as it will assist the parties involved in life settlement transactions to enhance their understanding of how the secondary market for life insurance policies functions as a whole and whether the observed prices on these transactions are fair. The second contribution is on the research level as I provide empirical research in a rather limited field. The rigorous methodological approach that is developed to determine the fairness of the transactions can be employed for further researching the market's dynamics, e.g. to what extent is it competitive, its economics effects to the parties involved, etcetera. It also provides the grounds for a more advanced analysis that can be conducted by legislators and regulators as they are interested in a sound basis for setting pricing regulations.

Before proceeding with further analysis in this study an overview of the secondary market for life insurance policies is presented. That is, I provide some discussion of the industry's emergence and the parties involved in it.

1.2. The emergence of the life settlement market

A competitive market for life insurance policies is rather recent. In the 1980's the increasing level of AIDS cases augmented the number of individuals who were faced with the need for money to cover health related expenses (Cornelius, 2010, p. 2). Their shortened life expectancy meant that the actuarial values of their policies exceeded the surrender values[1]. These policies could yield opportunities for financial gain for investors and, thus, viatical firms emerged to facilitate the development of a secondary market for life insurance policies.

However, the extended life expectancy of those who suffered from AIDS due to better drugs in the 1990's made the purchase of these policies less profitable for viatical firms,

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[1] As Doherty, Singer (2003, p. 67) describe, this increase in the actuarial value of a life insurance policy occurs due to the increase in the present value of the death benefit because its payment will occur sooner than initially projected, and due to the decrease in the present value of premium payments because they will not be in force for as long as initially projected.

which in response gave rise to life settlement firms. Life settlement firms shifted the old interest in the policies of the terminally ill to individuals over the age of 65 with impaired[2] health. According to Doherty, Singer (2003, p. 69) viatical and life settlements are the latest innovations in the life insurance industry. Unlike the traditional life insurance industry, life settlement firms are concerned with individuals with greater than average health risks. These individuals usually have particular characteristics with respect to wealth, age, and health, in order to render their policy suitable for settlement[3].

More specifically, Doherty, Singer (2002) in explaining how the life settlement market emerged, examined the economic effects of an active secondary market for life insurance policies on both policyholders and incumbent life insurance companies. Their analysis began with a description of the options available to an insured person without the introduction of a secondary market in life policies. Two options existed before the advent of the life settlement market 1) to let the policy lapse or 2) to sell the policy to the life insurance company at its surrender value. Thus surrender value could be deemed the secondary price that the life insurance firm offered for the repurchase of life insurance policies. Surrender values and the conditions under which a policy can be surrendered are specified in the insurance contract, hence, are determined in the primary market for life insurance. According to Doherty and Singer (2002, p. 16) this market is relatively competitive. However, although the life insurance market may have many players the role of insurance regulators curtails active competition. This curtailment may have led to abuses that ultimately cost the consumer, as indicated by Doherty and Singer below when they state that surrender values are relatively uniform across the industry.

However, the existence of a surrender value for a policy does not obligate the insured individual who wants to resell her policy to resell to the life insurance company that issued it. Life insurance policies are typically assignable, that is, a policyholder is free to transfer her ownership of the policy to another person. This means that there has been a potential for a secondary market for life insurance policies as long as there has been this policyholder's right to transfer the policy to someone else other than the life insurance company. Yet, for the majority of the policyholders the life insurance company was the only potential buyer since there simply were no other interested purchasers nor organized market to tempt them.

The lack of an alternative purchaser for existing policies resulted in the life insurance companies' having monopsony power over the repurchase of their own policies. Subsequently, life insurance companies have offered uniform surrender values which

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[2] The term "impaired" and "normal" are used to refer to an individual's state of health and the corresponding state of that individual's life insurance policy. "Normal" health refers to the state of an individual's health relative to that individual's health at issuance of the policy, accordingly the term "impaired" health refers to a state of health that is impaired relative to the state of health at issuance (Doherty, Singer, 2002, p. 3). Alternatively, according to Kohli (2006, p. 113) a policy is considered to be impaired when an individual's life expectancy has decreased to a greater degree than expected at the issuance of the policy.

[3] Best (2010) states that providers do not have access to an unlimited supply of life settlements, and given that purchasing many small policies is inefficient, they want to have policies with large face amounts, therefore, wealthy insured individuals. Additionally those insured individuals should be elderly and have slightly impaired health, i.e. to be a little sick, but not too sick because then they might have an incentive to keep paying their premiums in order to pass the death benefits to their beneficiaries.

were independent of the policyholder's health. Thus the repurchased policies of those with impaired health was at a price significantly less than competitive market value. Thus, life insurance firms accumulated significant economic rents as a result of those repurchases. (Doherty, Singer, 2002, p. 3)

This imbalance between the surrender value and the market value for repurchased life insurance policies gave rise to an investment opportunity for investors. Those who were willing to purchase policies for more than the surrender value became the beneficiaries of the policies as they were responsible for maintaining the policies in force. Hence, the emergence of viatical and life settlement firms created a secondary market for impaired life insurance policies as a result of policy holder demand for an alternative option (Doherty, Singer, 2002, p. 3).

1.3. The parties involved in a life settlement transaction

As the parties involved in a life settlement are constantly mentioned throughout the study it is worth briefly introducing them before proceeding with any further analysis. The purpose of introducing them is also to help the reader to understand what role each of the following parties plays in the life settlement transaction.

1. Policyholder. In a life settlement transaction, the policyholder or the seller is the owner of the life insurance policy before the transaction. However, the policyholder does not have to be the person who is insured in the policy as it may be any natural person or entity, and once the policy has been settled the policyholder does not have any further interest in the policy.

2. Life settlement provider. The provider's role in a life settlement transaction is to act as the buyer of the policy. The provider is an entity formed for the purpose of actively procuring life insurance policies in life settlement transactions and throughout this study will be referred as the life settlement company. Also the provider has two main roles in a life settlement transaction. The provider may bring an investor and a seller together and the policy exchanges hands directly between the seller and the investor or alternatively and more commonly, the provider temporarily purchases the life insurance policy with the aim of reselling the policy to investors.

3. Broker. The life settlement broker's role is to guide the policyholder through the life settlement process and to represent her interests in dealing with the provider. Hence, the broker is responsible for being the liaison between the seller and the buyer in the life settlement transaction.

4. Investor. In the secondary market for life insurance, life settlement providers in order to finance the purchase of life insurance policies find investors who ultimately become the owners of the policies. The investors have to cover the costs of maintaining the policy in force and when the seller of the policy dies they, as beneficiaries, receive the death benefit. Those investors may be natural persons, but commonly are investment banks, institutional investors or an established special purpose entity.

5. Other indirect participants. The insured individual is a natural person whose life is insured under the policy. The life insurance company is the company that issued the life insurance policy. The life insurance company's role, in regard to life settlements, is

simply to register the change of ownership. A medical underwriter is responsible for examining the medical records of the insured individual in order to provide investors with an estimated life expectancy. Usually more than one estimate is required for each insured individual seeking a settlement. Thus the role of the medical underwriter is very important as the medical condition reflected in life expectancy is one of the most crucial factors in pricing a life settlement. The health of the insured ultimately reflects the risk that investors face when investing in life settlements. Finally, attorneys are also involved in life settlement transactions to ensure compliance with regulations and other legal issues.

2. Literature Review

Although the secondary market in life insurance policies has grown significantly in the last two decades, and despite its relevance to other derivative securities the scholarly research conducted to date remains rather limited (Cornelius, 2010, p. 4). The economic effects of this market to consumers, life insurance companies, life settlement companies and to investors are among the issues that have been examined. Regulatory and legislative matters along with securitization and pricing issues remain among the dominant topics that have drawn researchers to the field.

The economic effects of a given market are usually considered among the fundamental issues to be researched for that market. They give an understanding about how that market emerged, what the market's dynamics are, and provide a starting point for a further analysis. Thus, as a starting point on the research for a secondary market based on life insurance policies a large part of the analysis has been focused on the potential economic effects, i.e. welfare benefits and losses, for the market's participants. Doherty, Singer (2002, 2003) are two researchers who have had some impact on the field as they have been primarily concerned with an analysis of the emergence of the life settlement industry[4], commencing a rather rigorous approach on research into the topic. Among the positive economic effects are the welfare benefits to policyholders due to a competitive secondary market for their policies (Doherty, Singer, 2002, 2003; Kohli, 2006; Singer, Stallard, 2005; Mason, Singer, 2008; Zhu, 2009). The importance of a competitive market is reinforced by Bhattacharya, Goldman, Sood (2004)[5], who show that the effects of price regulation on it would affect market competition resulting in welfare losses to consumers, and Gupta (2008) who argues that a competitive life settlement market offers liquidity to policyholders.

Positive economic effects accrue to investors in this market as well. Due to its unique characteristics the risk associated with a life settlement asset is considered to be uncorrelated with the economic environment as are other traditional asset classes. Thus investors have an opportunity to diversify away the common risks associated with most of their investments through investing in life settlements (Kohli, 2006; Smith, Washington, 2006; Schwartz, Wood, 2008; Gupta, 2008). Based on these economic effects Doherty, Singer (2002, 2003), Kohli (2006), Smith, Washington (2006) anticipated a significant potential growth in the secondary market for life insurance policies. Bhattacharya, Goldman, Sood (2004, p. 645) added that as the population ages, the secondary life insurance markets will become increasingly popular, which shows the likelihood that the life settlement market will remain active into the future.

By contrast, some researchers[6] have concluded that a secondary market in life insurance policies might have negative economic effects. Deloitte Consulting LLP and the

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[4] The emergence of a secondary market of life insurance policies is due to the emergence initially of viatical and later of life settlement firms. Currently, this market consists only of life settlement firms (see "Theory" for more details). Within this paper, the terms life settlement industry or life settlement market and secondary market of life insurance policies will be used interchangeably.

[5] This study is basically concerned with viatical settlement firms. However, its results can be generalized for the secondary market of life insurance policies as a whole.

[6] It is very interesting that among those who have extensively been concerned with the negative aspects are life insurance industry's apologists and consultants, whose reports are basically "industry publications" with no significant academic rigor and, given the probability of bias, have not been discussed in the "Literature review".

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Researchers at the University of Connecticut (2005)[7] found this secondary market inefficient because of the costs involved in life settlements transactions. Fung and Kung (2008) suggested that the presence of the life settlement market led to worse consumer welfare in the primary market for life insurance policies due to the unfavorable contract terms offered by life insurance companies in response to the threat of the life settlement market. However, Daily, Hendel, Lizzeri (2008) were less adamant demonstrating that the economic effects reported by varying researchers are dependent upon different conditions. They conclude that a life settlement market either might be welfare enhancing or might lead to negative welfare effects. Gatzert, Hoermann, Schmeiser (2009) go further, suggesting that although a decline in profits, i.e. a welfare loss, for life insurance companies might initially appear due to secondary market activity, in the long run, both consumers and life insurance firms will benefit from a competitive secondary market.

After the emergence of the life settlement market, as expected, a number of legislative and regulatory issues arose in the industry. Subsequently, many of those issues are mentioned briefly in the majority of articles which have been concerned with the secondary market for life insurance policies. More in depth studies of these same regulatory issues have been conducted by Doherty, Singer (2002, 2003), Kohli (2006), Cowley, Cummins (2005). As the market continues to evolve and the legal issues remain complex (particularly in an industry in which the insurable interests are on human lives – an area of ethical concern for many) it is expected that the research in this area will become more focused.

One of the evolution developments in this market has been the securitization of life settlements. As the life settlement market was expanding and the demand from the investors' side for better management of their investments and for further investment opportunities became stronger securities started to be issued which were backed by pools of life insurance policies. According to Cowley, Cummins (2005)[8] these securitizations actually reflected the attempt to generate a secondary life insurance market. Securitization issues since then have been researched extensively. Among the researchers concerned with securitization Cowley, Cummins (2005) describe the process of securitization and Stone, Zissu (2006, 2007, 2008, 2009), Stone, Zissu, Ortiz (2008), Mott (2007), Gupta (2006) are concerned with securitizing pools comprised of life settlements while managing pertinent risks. Although the research conducted in this area of the life settlement industry is quite broad, the lack of actual data puts a caveat on the researchers' findings. Despite this, the area is highlighted as one of the most important issues to be tackled by researchers interested in the secondary market for life insurance policies.

Pricing in this secondary market has also caught the interest of a number of researchers. Stochastic simulation has been used by some (Gupta (2006), Czernicki, Harewood, Taht (2003), Zollars, Grossfeld, Day (2003), Best, (2009) to price life settlements based on modeling the mortality of the insured. Aspinwall, Chaplin, Venn (2009) describe a more advanced technique for pricing securities backed with life settlements by implementing

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[7] Although this study was published in an "industry publication" and not an academic journal, it had some impact on the research that followed and has been mentioned in other more rigorous studies.
[8] Cowley, Cummins (2005) also suggest that generally in the life insurance sector, a number of advantages accrue from the securitization of life insurance products.

methodologies used for pricing credit default swap (CDS) contracts[9]. Despite the plethora of interest in pricing issues, this research, as the research in securitization, has been hampered by a lack of actual data from life settlements[10]. I have come across only one study which used actual data (Braun, Gatzert, Schmeiser, 2010) based on actual return distributions from life settlement funds. The authors assessed general performance and compared life settlements to other asset classes. They found that returns related to life settlements appear to be stable, with low volatility and uncorrelated with other asset classes. This is consistent with the projected positive economic effects expected to accrue to investors although there are significant latent risks such as liquidity, longevity and valuation risks.

Given the lack of studies using real life data in order to examine the actual economic effects of life settlements, and to acquire a better understanding of the pricing of these transactions this area remains open for further investigation. The secondary market for life insurance policies is now more relevant than ever, particularly after the recent turmoil in financial markets. Doug Head (2010), executive director of LISA[11] has stated the following:

> *Market forces are slowly but inexorably forcing a better understanding of pricing in the Life Settlement market, which some early investors thought were sure things, not estimates. Some regulators went so far as to set pricing based on an imaginary fixed Life Expectancy.*
>
> *In the open market, the insured policy seller wants a maximum price but has a poor understanding of what to expect beyond a surrender value from the Life Company. The middleman regulated brokers have fixed costs which are only now being fully understood. The investor wants a reasonable balance between risk and return.*
>
> *Ultimately the price which an investor will pay depends on his confidence in three factors a) the accuracy of available mortality data, b) the costs of maintaining the policy in force and c) the soundness of the insurer and of possible liquid markets for the policy. Industry stability would be well served by the development of models which could aid in understanding of the interaction of all these factors. All of these are affected by regulation to some degree, but the numbers will tell the tale.*

It would seem, from this statement, that even industry insiders are still searching for a better understanding of pricing in the life settlement market. Once such an understanding is held, transactions will be more efficiently priced and the actual economic effects of the secondary market in these policies made clearer. Regulators will be able to legislate on a more accurate basis.

Therefore, I am conducting this study out of a desire to contribute to a better understanding of pricing in the life settlement industry. More specifically, this study will be used to address the research question how transactions in the secondary market

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[9] In "Theory" a more detailed description is provided.
[10] The data is considered proprietary by life settlement funds who use their experience in the industry to provide them with a competitive edge.
[11] Life Insurance Settlement Association (LISA)

for life insurance policies can be fairly priced for both policyholders and life settlement companies. This will be based on two of the three factors highlighted by Head (2010) a) the accuracy of available mortality data, and b) the costs of maintaining the policy in force. This study is enhanced by access to a limited sample of real life data. The actual methodology for extending this sample is discussed in "Theory".

3. Methodology

3.1. Pre-conceptions

The idea of undertaking research into pricing in life settlements was suggested to me by one of my thesis supervisors. I had no knowledge, prior to beginning this work, about life settlements. As a consequence any "preconceptions" I may have had were purely in the innate sense I may have had that trading in policies based on people's lives had consequences beyond the simple mechanics of determining factors to be valued. I have tried, therefore, to be guided by a strict adherence to the academic dictates of my field and to avoid emotional or ethical sides in what is still a controversial area for investors. Also as a researcher who had no prior experience in the field of life settlements and its related fields, e.g. actuarial science, I had also to recognize that conducting research within that field is a sensitive and morally fraught topic due to its relation with human lives. I found the best way to do this was to stick to a quantitative study reducing potential bias and ethical dilemmas for the researcher. Thus, the delimitation to conducting a quantitative study was also a driver for the decisions made regarding the relationship between theory and research, and the epistemological and ontological orientations of this study. Further explanation for these decisions is given below.

Given the still limited number of research papers in the area, the research to be undertaken herein could be categorized as exploratory. That is, while empirical, it is extending the knowledge of researchers in untested directions using some of the first (limited) real data made available to any researchers. My starting point is clearly embedded in the research of others (deductive) and I have been dependent on a number of secondary sources while finding an approach that can be applied to fair pricing in the secondary life market.

3.2. Relationship between theory and research

Whatever theories are used to guide research in a particular field may affect the outcome of the study. It is the theoretical perspective that provides the basis for deriving and addressing research questions. Previously conducted research in a given field gives researchers who follow with grounds for developing new hypotheses. That is, research conducted using a deductive approach to knowledge is based upon groundwork undertaken by previous researchers. An alternative inductive approach demands a level of knowledge or immersion in the subject that allows the researcher to generalize from the particular. That is not usually considered applicable in financial research and has not been considered here. The deductive approach is dominant in the (limited) existing literature on the secondary market for life insurance policies. Here, hypotheses about different issues pertinent to the function of that market are addressed by building up our general knowledge and asking questions that are derived deductively from the information that is provided by previous researchers. Among the issues pertinent to the market's function, one that has been addressed by previous researchers, is about how pricing of life insurance policies in a secondary market (called life settlements) could be undertaken.

Given the decision to focus on pricing, the theoretical issue for this researcher became one of determining an appropriate methodology and drew from not only the field of finance but from actuarial sciences and statistics. In studying pricing, the approaches

used are examined for the ability of each to provide an adequate understanding of which factors affect the pricing of transactions in general and, in this case, in the secondary market for life settlements.

In economics a key concept on the pricing of goods and services is that of equilibrium. In that context supply and demand theory is employed to determine a price. A number of theories based on market's equilibrium have been developed to explain the dynamics of pricing. One such theory is the general competitive equilibrium theory which makes an assumption about the market's competition among others. When these equilibrium theories are employed into financial economics for asset pricing, the expected return and the risk of a given asset are central to the analysis. Thus, the price of any asset in a given market will be dependent on the balance between return and risk. The market's equilibrium is then determined through assessing that balance. Some of the theories that have been developed on asset pricing are based on general equilibrium and others on partial equilibrium. One example of a model based on general equilibrium is that of Arrow and Debreu. Alternatively, the CAPM is based on a partial equilibrium since its focus is only on a particular asset's market dynamics and not the dynamics of the whole economy.

Other models of asset pricing, subsequent to the preceding models mentioned above, employ arbitrage theory for determining an asset's price. that the problem with using such an asset pricing model herein is that they are employed to infer an appropriate required rate of return given the factors that affect the asset's risks and not to infer directly a price for that asset. A fair value of the asset is calculated using the required rate of return on discount models. Finally, a recent trend in asset pricing has been the employment of options pricing models. Options pricing models have a wide range of use in modern finance as they are deployed to price options but can be modified to price other assets[12] as well. Options pricing models are based on a number of factors, among them is a variable that measures the underlying asset's risk. They give a value for a derivative asset.

Central to any analysis used in determining an asset's price is whether a market is considered complete and perfect. The latter is related to the market's competition. Thus, additional to the asset pricing theories another issue that has to be examined simultaneously in order to provide an understanding of a market's dynamics is that of competition since it can affect the market's equilibrium. Usually, in asset pricing, competition in markets is an assumption for building a model. However, for markets where the level of competition is rather a debatable issue, the pricing methods of the traded asset have to be examined more carefully.

With respect to this analysis that is pertinent to the pricing of life settlements, the pricing methods that exist in the literature and that are discussed in the study, are not concerned with determining the right balance between the expected return and the risk of a life settlement transaction. I am, instead, concerned with employing discount methods for determining a life settlement's fair value given its future cash flows and the balance between the required return from the investor's side and the pertinent risks. Thus, in this study the focus is on presenting a methodology for accurately projecting a life settlement's cash flows which are subject to discounting with a given return in order

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[12] See Mason, Singer (2008) as an example of how options pricing theory can be employed on life settlement transactions.

to determine its fair value and not to determine the right required return. However, in addition to presenting one pricing method, an analysis is presented on how the pertinent risks can be assessed which in turn allows the investors to more accurately determine their required return. Thereafter, I present how that required return can affect the fair value of a life settlement. Through this analysis I aim to address the research question.

Three main approaches on pricing life settlement transaction have been discussed in the existing literature and are presented in the theory chapter (4) of that study. The understanding of the factors that affect the pricing of that asset, i.e. a life settlement, is the key concept for understanding the mechanics of pricing in this environment. As highlighted in the "Literature review" two main factors will be considered while presenting these pricing approaches a) the accuracy of available mortality data, b) the costs of maintaining the policy in force. These two factors are incorporated into each pricing method used.

The basic difference between those three methods is the approach to modeling mortality which is related to the first factor mentioned above, i.e. the accuracy of available mortality data. Thus, in the "Theory" (chapter 4) I discussed how each method uses the available mortality data to model mortality and project based on the costs of maintaining the policy in force, which is the common factor among the three methods, a price for a life settlement or the value of a pool that consists of life settlements. The first pricing method is the deterministic method which means that mortality, i.e. the time that death occurs for the insured individual, is modeled as a deterministic event. The second method is the probabilistic method, which models mortality as a random event based on probability distributions of death occurring. That method is enhanced if stochastic simulation is deployed in projecting the timing of death of the insured individual. This last method will be used in this study.

Having reviewed this material and given this understanding of the factors that affect pricing, the more particular question about the "fairness" of the pricing strategies used in life settlements came to the fore. A determination of whether the price is fair, for the insured, for the life settlement provider, for the investor, will provide an insight into the extent that the market is competitive as well as a broader perspective on the functioning of the market as a whole.

3.3. Research strategy

The problem to be studied and the research questions posed are the drivers determining the research strategy to be followed in a study of this sort. Two standard approaches to conducting research, the quantitative and the qualitative are usually discussed by those interested in methodology (Bryman, Bell, 2007). The qualitative approach emphasizes descriptions rather than numerical data (Bryman, Bell, 2007, p. 28). On the other hand, the quantitative approach emphasizes the rigor of a scientific method in the collection and the analysis of data in order to address research questions. The use of each strategy entails different ontological and epistemological perspectives.

A quantitative approach is followed for the purpose of this study, which is consistent with the assumptions made previously with respect to the relationship between theory and research. For addressing the research question of our study, a stochastic method of pricing life settlements is employed. For empirically implementing this method a

collection of data regarding a number of life settlements is used. The reasons for selecting the stochastic method and its method of use in analyzing this data is presented in the Theory chapter (4) while the data collection is presented in the Data chapter (5).

3.4. Epistemology

Two questions are generally posed in the conduct of a research study such as this. First what should be regarded as acceptable knowledge in the field to which the research study pertains. The second and perhaps more controversial question when conducting a study using the methods of the natural sciences, is to what extent the social world can be reduced to the same principles as the natural sciences. These questions are addressed by the epistemological perspective of the study. According to Bryman and Bell (2007), there are two main positions which ought to be considered from an epistemological perspective; these are interpretivism and positivism. Interpetivism states that the social environment in which people live and operate when making decisions cannot be examined objectively as it is fundamentally different from that of natural sciences (Bryman, Bell, 2007, p. 16). Alternatively, positivism applies the practices and methods followed by the natural sciences to the study of social realities, thus assuming that an objective examination of the social environment can be achieved.

Given the traditions of the finance discipline and economics in general, in the empirical study undertaken here we have employed stochastic modeling of the timing of death in order to project the cash flows from a pool of life settlement policies. Subsequently we determine the pool's fair value given the balance between the pertinent risks and the required rate of return from an investors' perspective. This method is referred to in the literature review as the most rigorous and reliable method available for pricing life settlements. As this method is driven by the natural sciences we claim that it provides for an objective examination of the research question. A positivistic epistemological perspective is deemed to be appropriate for this study, which is consistent with the quantitative and deductive approach as discussed earlier.

3.5. Ontology

Whether the secondary market of life insurance policies and its function, which is the subject of this study, can be viewed as a social construction or an objective entity is a question that is addressed when the researcher considers ontology. Ontology is the study of existence and is concerned with the nature of being. While the life settlement market could be classified as a social construction wherein life insurance policies are settled, the market, deals in life insurance policies which are traded physical assets. As the market deals in these tangible objects with an objective reality it has, itself, a tangible reality. Thus, if the market itself and the assets traded into this market have objective reality, so does the asset's price. An asset's price can be measured and can be examined as any tangible entity. Hence, since by definition the life settlement market and the pricing of life settlements as a function of this market have an objective reality, objectivism is deemed to be an appropriate ontological perspective.

3.6. Secondary Sources

The reliability of the secondary sources of a study is an important factor for insuring that the criteria of reliability, validity, and generalizability are met. This reliability is even more important for a quantitative, positivistic study which is based on deductive reasoning,

as these sources determine the theoretical background for developing the model which is subject to empirical analysis. In order to insure this reliability, although the existing literature in the field of life settlement market is rather limited where many "industry publications" exist, non-refereed and non-academic sources have been limited to minimum. Additionally, wherever possible seminal work in the field has been included. The fact that this study is based on actual policies held by life settlement funds adds to the reliability of the result over and above the work that has preceded it. The methods employed have been frequently used among statisticians and other quantitative analysts and are considered reliable in actuarial practice. Thus, in the author's opinion the criteria mentioned above have been totally met.

4. Theory

4.1. Pricing of life settlements

Much of the focus of research conducted to date on the secondary market for life insurance policies is on the pricing of life settlement transactions. Since the life settlement market emerged a number of techniques on pricing life settlements have been presumed to be employed in the industry and accordingly have been researched by academics and discussed by practitioners. In this part of the study three techniques will be discussed in order to provide the reader with an understanding on how life settlements have been priced by researchers. Before that, however, life insurance contracts are compared with credit default swap (CDS) contracts, and pools comprised of life settlement contracts are compared with a collateralized debt obligation (CDO) structure. This comparison is done given the similarities of the assets that are traded on the secondary market of life insurance policies with these other assets. Moreover, CDSs and CDOs have been employed in the life insurance industry for pricing other mortality products, i.e. products based on life insurance policies. Thus, according to Aspinwall, Chaplin, Venn (2009) as life settlements are such mortality products, these concepts should help those involved in life settlement transactions.

The three pricing methods are extensively described. Each method is explained both on the basis of pricing a single life settlement contract and pricing a pool of life settlements. The latter is ultimately of concern to investors and provides an insight into how the secondary market for life insurance policies functions as a whole[13]. The third method discussed, the stochastic method, will be used within this thesis in order to address the research question.

4.1.1. CDS contracts and life insurance contracts

A CDS contract has many similarities with a life insurance contract (Gourieroux, Monfort, 2008; Aspinwall, Chaplin, Venn, 2009). Both are mortality products, a CDS contract is concerned with corporate "mortality" (the likelihood of a default) and a life insurance contract is concerned with human mortality. A CDS contract has a reference entity whose default triggers the payment on the contract, a maturity date, and an agreed premium payable over the life of the contract. Two parties are involved in a CDS contract: a writer of protection; and a buyer of protection. Usually the buyer and the writer of a CDS contract are unrelated to the reference entity. The buyer pays the regular agreed premium and the writer pays the face value of the underlying security when a credit event occurs during the life of the contract.

Hence, the reference entity in a life insurance contract is the insured individual, the buyer is the life settlement company which pays the premia and the writer is the life insurance company which pays the death benefit to the beneficiaries when the insured individual dies - which is the credit event.

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[13] This is discussed on part 4.3 where the theoretical framework on pricing life settlements is connected with the research question.

4.1.2. CDO contracts and life insurance contracts

A CDO is a financial structure where a portfolio of risky assets defines a reference pool whose cash flows, in particular related to credit events, are used to define the cash flows on "tranches of risk" (Aspinwall, Chaplin, Venn, 2009, p. 27). The underlying asset may be CDS contracts, bonds, loans, mortgages, or any other risky investment instrument physically backed by such assets or synthetically related to such assets, for example, through indices. A life settlement company can create such portfolios where the underlying assets are the settled life insurance policies, i.e. the life settlement contracts.

4.1.3. Approaches on pricing life settlements

First method: Deterministic approach

According to Stone, Zissu (2008) the value of a life settlement contract is based on the life expectancy of the insured individual, which is a function of age and health. The valuation of a life settlement is given by discounting the premia, p, paid over the insured individual's life expectancy (negative cash flow) and the death benefit, B, to be received at the time the insured dies (positive cash flow). The following formula describes the valuation of a life settlement, in present terms, based on the life expectancy, t, of the settler, also a constant discount rate, r, is assumed:

$$V = -p\left[\frac{1}{(1+r)^1} + \frac{1}{(1+r)^2} + ... + \frac{1}{(1+r)^t}\right] + \frac{B}{(1+r)^t}$$

or

$$V = \sum_{j=1}^{t} -\frac{p}{(1+r)^j} + \frac{B}{(1+r)^t}$$

Hence, for a pool of life settlements the value of the pool at any given time will be the sum of the premia of the policies which are still in the pool (negative cash flow) and the sum of the death benefits received for the deaths that occurred at that given time (positive cash flow). A value of a pool with n life settlements will be given, in present terms, by the following formula:

$$V = \sum_{i=1}^{n} \sum_{j=1}^{t_i} -\frac{p_i}{(1+r)^j} + \frac{B_i}{(1+r)^{t_i}}$$

By using this method to value a pool of life settlements we fail to reflect the longevity risk of the portfolio, that is the risk that individuals live longer than had been projected initially, since the cash flows for each life settlement in the pool are already determined by the life expectancy of each individual. For this reason we can use different scenarios for reducing or extending the life expectancies of the settlers in the pool in order to show the effect of the stochastic factor on the value of the portfolio.

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Second method: Probabilistic approach

The failure of the deterministic approach is the assumption that the insured individual dies at a specific point of time in the future. Although the scenario analysis of life expectancy shows how the price of the contract or the value of a portfolio of life settlements is affected if the insured dies at different points of time, it does not fully reflect the death of any person as a random event. That means that a death can occur at different points of time with given probabilities. This notion is incorporated into a probabilistic approach to pricing a life settlement contract.

Gupta (2008, p. 1) describes the probabilistic approach to pricing a portfolio of life settlements as follows: first, life expectancy is translated to an expected mortality, this is usually done in terms of a mortality multiple based on an underlying table. Then the expected mortality is deployed to project an expected cash flow. A similar description is provided by Zollars, Grossfeld, Day (2003, p. 36). Neither of these studies give any example of the application of this proffered method.

A methodology for calculating the price of a life insurance policy which pays a death benefit, B, upon the insured individual's death and the insured pays a yearly premium, p, is provided by Bhattacharya, Goldman, Sood (2004, p. 647). This methodology, although is not mentioned by Bhattacharya, Goldman, Sood (2004) as being the probabilistic approach, appears to be consistent with the description of the probabilistic approach. It is provided here in order to enhance the reader's understanding of this approach to valuing a life settlement. Under an assumption that the secondary life insurance market is competitive and the life settlement firms make zero profit the price of the life settlement will be:

$$V(a) = \sum_{t=1}^{\infty} (Ba_t - pS_t)b^t$$

In this formula $a = (a_1, a_2, a_3, ..., a_t, ...)$ represents the probability of the death of the insured individual for each time period t. $S_t = \sum_{\tau=t}^{\infty} a_\tau$ is the probability that the insured individual survives to the beginning of period t, where $S_1 = 1$, and $b = \dfrac{1}{1+r}$ where r is the cost of capital for life settlement firms. Finally, $V(a)$ is the price that the life settlement firm is willing to pay for the life insurance policy to the settler with mortality risk a, which also reflects the actuarially fair price for the policy. In practice the probability of death $a = (a_1, a_2, a_3, ..., a_t, ...)$ for each time period t is taken from mortality tables. In that case $V(a)$ will be calculated in a finite period.

In order to reflect the insured individual's mortality risk the probabilities are multiplied by a mortality multiple which reflects to what extent the health of that insured is impaired relative to a healthy person (see the stochastic approach for more details on mortality multiples).

Third method: Stochastic approach

In the probabilistic method the time of death is taken as a random event and a probability distribution is employed. The method could be enhanced if it were used in combination with simulation giving more realistic estimates of times of death. This notion is consistent with Zollars, Grossfeld, Day (2003) who suggest that the combination of both is the most powerful tool for the valuation of life settlement contracts, although it is recommended that the probabilistic approach is more suitable for pricing individual life settlements and the stochastic approach is more suitable for pricing pools of life settlements. A consensus appears to be developing on accepting the stochastic approach as the best among the three for pricing life settlements (Zollars, Grossfeld, Day, 2003, p. 37; Gupta, 2008, p. 2). The power of this method accrues from the fact that 1) death is a random event determined by a probability distribution of mortality risk which is adjusted to each individual's health profile, and 2) the subsequent stochastic simulation of the point of time that each person dies. This allows us to model death as a stochastic event and fully reflect the stochastic factor in the valuation of life settlements.

Both Gupta (2003) and Zollars, Grossfeld, Day (2003) suggest that the most commonly used method is the probabilistic method. However, both project an increase in the use of the stochastic method, although it may have some disadvantages in its implementation. Two disadvantages are the complexity of the method, and the fact that the method is more suitable for large pools of life settlement transactions rather individual ones. Another disadvantage appears to be the computing power demanded for running a sufficient number of simulations in a reasonable amount of time. The author's opinion is that currently the computing power demanded should not be rendered as a disadvantage as its recent development is tremendous and allows for adequate number of simulations per unit of time.

Moreover, although the stochastic approach appears to have some complexity, an experienced person with a basic knowledge of computer programming and sufficient quantitative background should not have any problem in implementing it. Finally, as it will be discussed in the data section of this thesis (chapter 5) the second disadvantage, appears to be rather weak as the accuracy of the method is not significantly affected by the number of life settlements on the pool. None-the-less, the method is more likely to be employed by academic researchers than by practitioners in the field.

Stochastic simulation of mortality

With a stochastic method, each life settlement contract's time remaining in the portfolio is simulated separately based on the life expectancy of the insured. This stochastic simulation of mortality for an insured individual is done with Monte Carlo simulation. The same approach is used in Gupta (2006), Czernicki, Harewood, Taht (2003), Skucaite (2006).

Life settlement providers value life settlement contracts by using mortality tables that have been modified to account for various manifestations of impaired health (Stone, Zissu, 2008). One mortality table that is commonly used as a baseline assumption, i.e. a standard mortality table for modifying mortality tables is the 2008 Valuation Basic Table (VBT). Modifications can be made by calculating a mortality multiple which

reflects the extra mortality risk for each individual. For example if for an individual the mortality multiple is 150% that means that the individual's probability of dying is 1.5 times more than the basic mortality rate provided by the VBT for given age, gender, and smoking status. Alternatively, as Schwartz, Wood (2008) describe, this mortality multiple may be based on a scoring technique using debits and credits which are assigned to the specific risk factors of the insured. The total of these debits and credits is then converted into a mortality multiple. When the mortality multiple has been determined, the VBT is modified and the life expectancy is calculated. Hence, the life expectancy is a derivative calculation.

When the modified mortality table has been determined with respect to each insured, a simulation takes place to draw random probabilities about whether the insured is likely to die or not at any given point of time on a span of a number of years (usually more than twenty). Subsequently if the process indicates the insured is likely to survive, the life settlement firm has to pay the premium to the life insurance company; otherwise the life settlement firm becomes the beneficiary and receives the death benefit. With this methodology the present value of the cash flows for a portfolio of life settlements can be estimated. A detailed step-by-step explanation of the stochastic approach is presented below.

First step: Life expectancy and mortality multiple

The first step in the stochastic method is the modification of the mortality table for each individual in order to reflect that individual's mortality risk. Each policy in the pool has to be connected with a standard mortality table (see for example Table 1), with the risk associated with each individual corresponding to one row of the standard mortality table for his or her age at the time of settlement and with the probabilities of death after that age. Their life expectancy is then used to calculate a mortality multiple which will be used to adjust these probabilities for individual mortality risk. In the end one table which contains the adjusted probabilities of death for each individual is formed (see for example Table 2). This will be the table whose elements will be used in the simulation process.

Since the information that is usually revealed about a policy is the individual's life expectancy the mortality multiple has to be calculated in order to use it for modifying the standard mortality table. One method consistent with this notion is reverse engineering (Schwartz, Wood, 2008, p. 73; Gupta, 2008, p. 3). That means that if a standard mortality table and the life expectancy of a policy are known, the mortality multiple can be calculated or as mentioned by Schwartz, Wood (2008), and Gupta (2008) to be reverse engineered by using the solver tool of MS excel based on the definition of life expectancy and linear interpolation. Before providing an example on how to calculate a mortality multiple it is worth defining life expectancy.

One common definition of life expectancy in the industry is the time period T such that the probability of surviving to T is 50% (Aspinwall, Chaplin, Venn, 2009, p. 39). This can be expressed with the following notion.

If $S_t = \sum_{\tau=t}^{\infty} a_\tau$ is the probability that the insured individual survives to the beginning of period t where a_t represents the probability of the death of the insured individual for each time period t, then if $t=T$, where T is the life expectancy, the probability of surviving to T is S_T, and $S_T = 0.5$. T is then implicitly given by the following formula:

$$0.5 = \sum_{\tau=T}^{\infty} a_\tau$$

Given that $S_1 = 1$ it is shown that the above formula is equivalent with the formula[14]:

$$0.5 = \sum_{\tau=1}^{T-1} a_\tau$$

However, in the mortality table that is used in this study the probabilities of death refer to the end of each period t. Thus, the term T-1 that is given implicitly from the above formula is the beginning of the time period T which corresponds to the life expectancy.

It has to be mentioned that this definition of life expectancy is called "median life" and should not be confused with "expected life". Other definitions can also be found among actuarial researchers[15] where life expectancy is expressed by using a survival function. In that case if there is a survival function $S(t)$, then life expectancy LE is the area under

the survival function which is given by the integral $LE = \int_{0}^{\infty} S(t)dt$.

Another interpretation of the notion of the median life is this: if 1000 people were alive at a given age then half of them will be alive at their life full expectancy. As the VBT basically shows, the mortality rate for a given age is dependent upon the individuals who die per 1000 individuals at any year after that given age. Thus, the table can be modified to show the probability of dying at any year after the given age. Table 1 that follows shows a portion of the 2008 VBT[16] for a non-smoking male.

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[14] $S_1 = \sum_{\tau=1}^{\infty} a_\tau = \sum_{\tau=1}^{T-1} a_\tau + \sum_{\tau=T}^{\infty} a_\tau$ and $S_1 = 1$, thus, $\sum_{\tau=1}^{T-1} a_\tau = 1 - \sum_{\tau=T}^{\infty} a_\tau$, also $\sum_{\tau=T}^{\infty} a_\tau = 0.5$, hence,

$\sum_{\tau=1}^{T-1} a_\tau = 0.5$

[15] For more details see Aspinwall, Chaplin, Venn (2009, p. 32), or Bhattacharya, Goldman, Sood (2004, p. 652).
[16] See the report that accompanies the 2008 VBT for more details on how it was developed (available at: http://www.soa.org/files/pdf/research-2008-vbt-report.pdf). However, it is worth mentioning that the underlying data used in developing the 2008 VBT was the Society of Actuaries (SOA) Individual Life Experience Committee's (ILEC) 2002-2004 Intercompany Study.

Table 1
2008 VBT M NS ALB (Mortality per 1000 individuals)

Age	Duration				
	1	2	3	4	5
65	2.25	3.51	4.80	6.14	7.58
66	2.49	3.90	5.35	6.87	8.51
67	2.77	4.35	5.97	7.70	9.55
68	3.09	4.86	6.69	8.63	10.73
69	3.47	5.44	7.49	9.69	12.06

This table shows for example that for male individuals who are 65 years old (age is considered on last birthday) and who are non-smokers the mortality rate after one year is 2.25 per 1000 individuals, between year one and year two 3.51 per 1000 individuals, etc. Alternatively in order to have a similar table but with probability of death instead of mortality rates, each element of the table is divided by 1000. Thus, Table 1 is modified to Table 2 which follows and is interpreted as the previous one.

Table 2
2008 VBT M NS ALB (Probabilities of death)

Age	Duration				
	1	2	3	4	5
65	0.0023	0.0035	0.0048	0.0061	0.0076
66	0.0025	0.0039	0.0054	0.0069	0.0085
67	0.0028	0.0044	0.0060	0.0077	0.0096
68	0.0031	0.0049	0.0067	0.0086	0.0107
69	0.0035	0.0054	0.0075	0.0097	0.0121

Based on the first definition of life expectancy and the following formula: $0.5 = \sum_{\tau=1}^{T-1} a_\tau$,

in order to find the life expectancy for a male who is 65 years old for example, the probabilities for each year have to be added until the year in which the sum is 50%. Thus, for a non-smoking male, whose age is 65 years, the life expectancy is 20.2 years. Table 3 shows life expectancies for non-smoking males and females which are calculated as described above.

Table 3
Life expectancies based on 2008 VBT

Age	Male	Female
65	20.2	22.5
70	16.3	18.4
75	12.7	14.4
80	9.3	10.6
85	5.9	7.0
90	3.9	5.0

At this point it is worth mentioning that the life expectancies as calculated in this study were compared with those that were found in other studies in order to ensure the accuracy and reliability of the estimation methodology. For example on an industry publication by Mohoric, Kinney (2008) the life expectancies that are given for a non-smoking male are presented in Table 4.

Table 4
Life expectancies based on 2001 VBT

Age	Male
65	20
70	16.7
75	13.9
80	10.7
85	7.7
90	4.9

However, these life expectancies are based on the 2001 VBT. Thus, any discrepancies between Table 3 and Table 4 might be attributed to the use of a different standard mortality table.

After having an understanding on how life expectancy is calculated in practice, we proceed to an example on how to calculate (or reverse engineer) the mortality multiple. This will be based on reverse engineering. Consider the following example, a male individual is 85 years old and has life a expectancy of 4.2 years. As it can be inferred by Table 3 that this male has impaired health because relative to a healthy person he is expected to live less long. The 2008 VBT for a non-smoking male for the first six years after the age of 85 is as follows.

	1	2	3	4	5	6
85	2.07	4.23	7.93	10.24	12.65	14.72

The above table is the standard mortality table for that individual. Thus, we have to calculate a mortality multiple, which in our example will be greater than one. It is necessary to determine the figure which if multiplied by each probability on the above table would result on life expectancy 4.2 years. In order to this we use MS excel and the tool solver combined with linear interpolation. For this example the reverse engineered mortality multiple is 1.85. That means that the adjusted probabilities of death for that person are given on the adjusted mortality table that follows. If the life expectancy is calculated for this adjusted mortality table it will be 4.2 years.

	1	2	3	4	5	6
85	3.83	7.83	14.67	18.94	23.40	27.23

Second step: Monte Carlo simulation of the time of death

When each policy has been linked with the adjusted probabilities of death, i.e. the adjusted or impaired mortality table of all policies in the pool has been created; Monte Carlo simulation is employed in order to project when each individual dies. For a given year a uniformly distributed random number[17] between 0% and 100% is draw. Subsequently, this number is compared with the probability of death for a policyholder at that given year as it is given by the impaired mortality table. If the random number is less than or equal to the probability of death, the policyholder is assumed to be dead, hence, the premium payment stops and the death benefit is received. Otherwise, the policyholder is assumed to be alive, the premium payment continues for the next year,

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[17] A.M. Best does not specify the distribution of this random number. However, Jobst (2005, p. 69) simulates the probability of defaults on a pool of collateralized loan obligations as a uniformly distributed random number.

and the process is repeated. The same process is repeated for every life settlement in the pool.

Third step: Cash flows

The final step on the pricing of the value of a portfolio of life settlements is the aggregation of the projected cash flows that each policy in the pool produces. Let X_i be the probability of death for a policy in year i, Y_i the random number that is drawn from the Monte Carlo simulation, where $Y_i \sim i.i.d \ U(0,1)$, and CF_i the cash flow that accrues from this policy, which can be either the premium, p, or the death benefit, B, after paying the premium. This is shown in the expression:

$$CF_i = \begin{cases} -p, Y_i > X_i \\ -p + B, Y_i \leq X_i \end{cases}$$

When the third step of the method is finished, we end up having a row vector whose elements are the projected net cash flows, i.e. total death benefits received (cash inflows) minus total premia (cash outflows) of the portfolio for each year until the maturity of the portfolio. These net cash flows can be used in order to calculate the present value of the portfolio. This can be done by discounting the net cash flows of the portfolio for each year. Thus, the present value of the portfolio will be a function of the discount rate which ultimately reflects the investors' demanded rate of return on their investment. The analysis that follows in part 4.3 on the discount rate and the present value of a portfolio of life settlements will provide an understanding on how life settlements are priced and which factors have to be taken into account in order to postulate whether the life settlement transactions are priced on their fair value based on our knowledge about the balance between risk and return that investors demand. However, before that, on part 4.2 some considerations are provided regarding the understanding of risk that a pool of life settlement entails.

4.2. Mortality risk and stress testing

Mortality risk is the primary risk reflected in a portfolio of life settlements. Hence, its understanding remains a key factor to understanding the value of such a portfolio and to determining anticipated cash flows. Mortality risk can be perceived as the inherent risk potentially affecting all life settlement transactions and portfolios comprised of life settlements. Thus, mortality risk appears to be analogous to some extent with systematic risk on other markets of assets, i.e. the risk peculiar to the market itself. Systematic risk and mortality risk are non-diversifiable risks existing on any portfolio of assets or life settlements respectively.

Mortality risk is associated with the timing of deaths. This directly affects the value of the portfolio by affecting the timing and size of cash flows. Mortality risk, thus, can ultimately be perceived as the risk associated with the fact that the point of time at which an individual dies is, in the portfolio context, random. It is measured, as indicated, through mortality tables which present mortality rates or probabilities of death, and through life expectancies and mortality multiples. In order to understand mortality risk we separate factors affecting mortality risks that accrue from modeling mortality and the factors that accrue from the medical underwriting process.

Assessing and managing mortality risk as derived from modeling mortality, as described in part 4.1 involves a standard mortality table used as a benchmark. For the purpose of this study the standard mortality table used is the 2008 Valuation Basic Table (VBT) as it is one commonly used in the industry. It has been mentioned also as the benchmark mortality table in studies researching issues on the life insurance field and particularly on the field of life settlements. Another issue on using this particular standard mortality table is the fact that it is the only publicly available mortality table that could be found. The mortality tables that life insurance and life settlement companies use are not available to the public as they are considered proprietary and are based on their own actuarial studies.

The construction of this table is based on a number of assumptions regarding mortality rates. These include assumptions about the pattern of mortality to be expected in the populace and assumptions about mortality decreases[18] which are related to anticipated increase in life expectancy. As a result there is a high level of uncertainty that the standard mortality table used here in modeling mortality and subsequently valuing a portfolio of life settlements may have been biased and based on non-realistic assumptions about mortality risk.

One way to understand the impact of the standard mortality table on the value of a portfolio of life settlements is to stress test it. This can be done by multiplying the standard mortality table by a number lower than one in order to obtain a standard mortality table that yields to a longer life expectancy. The increase in life expectancy results from the reduced mortality risk in the new mortality table. Therefore, from stress testing the standard mortality table we show the effect of reduced mortality on the timing of deaths occurring among individuals as this affects the value of the portfolio.

Another way to understand the impact of the standard mortality table on the value of a portfolio of life settlements is to stress test the assumption that has been made on the mortality decrease. That is, the actuarial study that is conducted to estimate the mortality for each year at a given age has made an assumption about the extent of mortality rates decrease each year. The mortality decrease from the perspective of the life insurance firm can generate larger profits due to increased longevity of policyholders yielding to more premia paid. However, from the point of view of an investor in a pool of life settlements, mortality decrease can affect the profitability of the portfolio negatively. That is, an understated mortality decrease could yield unrealistic mortality rates which are higher than the actual mortality rates. As a result the erroneously projected early deaths would have produced a higher value of the portfolio in present terms.

Hence, stress testing for mortality decrease has to be done to reflect the uncertainty regarding future rates of mortality. This stress test would entail lower mortality, thus, more realistic assumptions about it. As Schwartz, Wood (2008, p. 75) state these future mortality decrease trends might be due to changes in eating habits or the development of improved techniques to manage disease, among other factors.

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[18] Although the term "mortality improvement" is the most accurate that is used in actuarial science to indicate the "improvement" or simply the decrease in mortality rates, in order to avoid confusion for the reader the term "mortality decrease" is used henceforth.

Another factor that affects mortality risk as perceived by the life settlement investor is the medical underwriting process used in assessing the mortality risk of an insured individual. This underwriting process subsequently yields a mortality multiple which reflects the assessed mortality risk. Where a mortality multiple is overstated by the medical underwriter it yields an overestimate of the contribution of that policy's cash flows to the value of the life settlement portfolio exactly as discussed in the preceding mortality table factor. By stress testing mortality multiplies, we can reflect the impact of a higher mortality risk on the value of the portfolio.

In conclusion, the standard mortality table and medical underwriting estimates affect the perception of mortality risk for the life settlement investor. Mortality risk ultimately is inherent in the market and cannot be diversified away. The value of a portfolio can be affected significantly by understating mortality risks. Once the mortality risk for each individual policy in the portfolio has been assessed investors face longevity risk. Longevity risk is the risk that individuals live longer that initially projected, Longevity risk is the flip side of mortality risk. Hence, the stress testing mentioned earlier is intended to show the impact of longevity risk on the portfolio's value or the negative (from the life settlement investor's perspective) aspect of mortality risk. As will be discussed in part 4.3., the projected portfolio value is the key driver for determining the required return for investors and for pricing a life settlement.

Other risks pertinent to particular life settlement transactions and subsequently to pools of life settlements also exist. These risks are to be considered analogous to unsystematic risk as described earlier, thus, these risks can be diversified away. One risk for a given portfolio has to do with its size and the correlation on the life expectancies among life the insured lives in the portfolio. Smith, Washington (2006) suggest that although a small portfolio is easier to evaluate on a policy-by-policy basis, a large portfolio offers greater diversity to investors. This diversity arises by reducing the life expectancy correlation those on whom the policies are held. This can be achieved by securitizing a pool of life insurance policies of insured individuals with different diseases. In the event of the development of new drugs to treat a particular disease, insured individuals with the same disease would experience an increase in life expectancies. By holding policies on individuals with a variety of diseases negative effects from a positive correlation would be minimized (Stone, Zissu, 2006, p. 67).

Finally, as discussed in the Literature review presented in Chapter 2, life settlements appear to be uncorrelated with the economic environment, consequently investors have an opportunity to diversify away the common risks associated with most of their investments through investing in life settlements. However, other risks associated with these investments may be impacted by economy wide events. For example, after the recent financial crisis it became evident that no elements of the economy's components stand alone. For instance, one risk that investors in life settlements might face is credit risk. Credit risk arises from the risk that a life insurance company might be insolvent, thus, it will not be able to pay the death benefits when a death occurs. Although credit risk can be mitigated by limiting purchases of life insurance policies to those that have been issued by life insurance companies with high credit ratings, as Stone, Zissu (2008, p. 63) suggest, the likelihood of being insolvent even for a company with a very high rating became significant in recent times. Another risk is the liquidity risk, which exists due to the fact that secondary markets for life insurance policies are rather illiquid.

Therefore, the understanding, assessing, and managing of risks is considered to be of vital importance for pricing life settlement transactions. Stress testing on the non-diversifiable mortality risk, diversification of the life expectancies on a pool of life settlements, employment of risk management techniques[19] and risk measures[20] pertinent to portfolios of life settlements, and a more comprehensive understanding of the notion of risk itself are some ways to deal with these risk issues.

4.3. How to determine fair value of life settlement transactions

Pricing in life settlement transactions is based on a determination of the risk and return from securitized portfolios of life policies. Available approaches to assessing potential cash flows assist in the pricing process. Investors will rely on the projected value of the portfolio and will be more comfortable with the investment if they have an understanding of the risks involved in life settlement transactions.

The stochastic approach described earlier appears to be the best method among the three that were described to determine, or more accurately to project the value of a portfolio of life settlements. The strongest argument in favor of this method is the way that it models death. It allows us to perceive death as a stochastic event, and based on an accurate and proper modeling of mortality risks, which incorporates the available mortality data, to model the cash flows that the portfolio produces based on the costs of maintaining the policies of the portfolio in force. Thus, a) the availability of mortality data and b) the costs of maintaining the policies in force are the basic factors used to price life settlement transactions. The availability of mortality data affects our understanding of mortality risk. As this data is not released by either insurance companies nor life settlement providers, stress testing the factors that affect mortality risk, and quantifying, assessing, and managing the other pertinent risks allows us to approach a realistic value assessment.

As in other investments, the value of life settlements is inherently a product of expected future cash flows. Getting a realistic assessment of these cash flows is the major drawback for investors. Bhattacharya, Goldman, Sood (2004, p. 647) suggest that if the market is competitive, then the life settlement companies will make zero profits and charge a price which is equal to the present value of the death benefit net of premium payments reflecting the actuarially fair value of the life insurance contract. Accepting this proposition, we have to estimate the purchase price of the life settlements given the internal rate of return (IRR) from the investors' side. This purchase price is estimated as a percent of the face value of the policies, i.e. a portion of the death benefit that the beneficiaries will receive. Thus, in a competitive market where the net present value of an investment in life settlements is zero a certain range of IRR's will yield to a range of prices as reflected by the percentages of face values. By using a methodology that provides this information we can postulate whether the transactions that occur render the life settlement market competitive.

For the purpose of this study a small sample of life settlements will comprise a pool for our purposes. We will use this in order to a) to determine the value of the pool using a stochastic approach, and b) using a range of IRR's that appear to have historically

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[19] Stone, Zissu (2006, 2007, 2008, 2009), Stone, Zissu, Ortiz (2008) are concerned with developing risk management techniques.

[20] Gupta (2008) develops a number of risk measures on quantifying and assessing risks.

existed in the industry to infer whether the offered purchase prices appear to have been in the range of the "fair" purchase prices implied by our model. Also in order to provide an understanding on the associated risks that implicitly affect the prices of life settlements we employ stress testing on the assumptions made to implement our model. This stress testing will also reveal how these ranges of IRR's and prices are sensitive to changes in those assumptions. The extent of this sensitivity will provide a better understanding on how the basic drivers affecting the pricing of life settlements are altered by a) the accuracy of available mortality data, and b) the costs of maintaining the policy in force[21].

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[21] For the purpose of this study the costs of maintaining the policies in force are only the premia to be paid. Other costs such as administrative costs also exist. However, it is unknown what portion of the total costs they are. For this study an assumption has been made in order to incorporate the effect of those costs in our analysis. I assume that investors are aware of those costs and determine the required return on their investment based on that. Thus, the range of IRR's that is used for the analysis also reflects the effect of those costs.

5. Data

To address the research question on the fair value of life settlement transactions we decided to employ the stochastic approach. In order to implement this, a pool of life insurance policies was constructed based on actual life settlement quotes. As it was highlighted in the "Literature review" the lack of actual data renders any attempt at empirical studies in the research field of life settlements rather difficult. As the data is considered proprietary by life settlement funds who use their experience in the industry to provide them with a competitive edge, it is difficult to access it. However, after much effort and promises of confidentiality[22], a sample of such life settlement transactions with their relevant data was made available in order to allow this study to go forward.

The sample consists of eighty-five life insurance policies which were settled during 2009 in different states in the US. For each of these 85 policies, the sample contained data regarding the age of the insured individual at the time of settlement, the individual's life expectancy at the time of settlement, the face amount of the policy, and the premia for maintaining the policy in force. On Table 5 a portion of the whole sample with the relevant data is presented. Moreover, other data were also available, such as the state in which transaction took place, the individual's state of residence at the time of settlement, and the rating of the life insurance companies that have underwritten the life insurance policies along with the rating company. However, these were irrelevant to conducting our study.

Table 5
Relevant data of life settlement transactions
Age and life expectancy are in years.

Policy	Age	Life expectancy	Face amount	Annual premium
1	75	8.3	300000	14187
2	86	3.8	120900	16508
3	85	4.2	100000	8648
4	74	9.2	500000	8764
5	87	7.3	1500000	12791

Although there were no missing data for any of the 85 policies that made up the pool, information regarding the gender and the mortality multiple were not available. In the theory chapter of this thesis (Chapter 4), a method of calculating the mortality multiple using the life expectancy for each individual was given. Thus assumptions had to be made regarding this figure as will be explained. Gender, given that it is one of the most crucial variables involved in determining mortality rates, was needed to proceed with our study. Thus, once again, we had to develop a method to determine a gender association with each individual policy. The assumptions made included that the pool consisted of insured individuals with impaired health, as impaired health is considered

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[22] Redacted copies of this information can be made available to serious researchers wishing to replicate these results.

to be one characteristic that an individual should have in order to render her policy suitable for life settlement. Impaired health would entail higher mortality risk, thus, would make the portfolio's value higher as insured individuals would be expected to die earlier compared to relatively healthy ones.

This impaired health is reflected in the life expectancy and the mortality multiple. If the life expectancy of a person of a given age is lower that the life expectancy of individuals who are healthier relative to that person then this person is considered to have impaired health and the mortality multiple for that person would be greater than 100%. In order to determine a benchmark for determining whether or not to postulate ill health among those holding policies in our sample we used the 2008 VBT[23] to calculate life expectancy.

Thus, first life expectancies for all ages between 68 and 90[24] for both males and females based on the 2008 VBT were calculated. Then the absolute differences of each individual's life expectancy with the life expectancies for a relatively healthy male and a relatively healthy female within the same age group were obtained. The gender of each individual was determined from the minimum value between the two absolute differences. This is expressed with the following expression:

$$G_i = \begin{cases} 1, \min\left(\left|LE_{M,i} - LE_i\right|, \left|LE_{F,i} - LE_i\right|\right) = \left|LE_{F,i} - LE_i\right| \\ 0, \min\left(\left|LE_{M,i} - LE_i\right|, \left|LE_{F,i} - LE_i\right|\right) = \left|LE_{M,i} - LE_i\right| \end{cases}$$

G_i is the gender of an individual in the pool with age i years, and $LE_{F,i}$ and $LE_{M,i}$ are the life expectancies for a female and a male of the same age respectively. If G_i is equal to one the assumed gender is female and if G_i is equal to zero the assumed gender is male. Table 6 exhibits a few examples in order to make the method more clear.

Table 6
Gender correspondence

i	LE_i	$LE_{F,i}$	$LE_{M,i}$	$\left|LE_{F,i} - LE_i\right|$	$\left|LE_{M,i} - LE_i\right|$	G_i
89	5.7	5.3	4.2	0.4	1.5	1
84	7.3	7.7	6.5	0.4	0.8	1
79	4.9	11.4	10.0	6.5	5.1	0
81	9.3	9.9	8.6	0.6	0.7	1

This methodology for determining genders corresponding to individuals in the pool who are assumed to have impaired health falsely minimizes longevity risk. It is expected that in a pool of life settlements not all individuals will have impaired health. According to Schwartz, Wood (2008, p. 76) where appropriate, policies should be assigned mortality multiples lower than 100% of the standard mortality table. That would reflect insured individuals with greater health than the relatively healthy person who is reflected in the 2008 VBT. One example is the first individual on Table 6 who has longer life

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[23] See Table 3 on "Theory" where life expectancies for different ages were calculated based on 2008 VBT
[24] This is the range of ages of the individuals on our pool.

expectancy than projected by 2008 VBT. That person's mortality multiple if it were calculated would be less than 100%. Moreover, Schwartz, Wood (2008, p. 76) state that it is not uncommon in the industry that all individuals who meet the requirements for a standard risk are assigned a 100% mortality multiple, which subsequently overstates the mortality risks for individuals with favorable health factors. For our study no individual's mortality risk was overstated since if a mortality multiple was less than 100% it was left in place.

Table 7 summarizes the statistics of the policies comprising the pool used in our study and Fig. 1 and Fig. 2 exhibit histograms for age and life expectancy respectively at the time of settlements.

Table 7
Summary statistics of policies in the pool
The pool consists of 85 policies, 44 males and 41 females. The number of policies with mortality multiple less than 100% was 27. Mortality multiples in this table are presented as numbers. Age and life expectancy are in years.

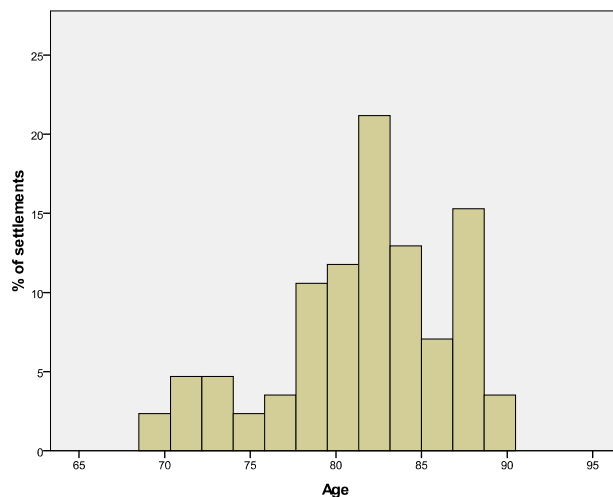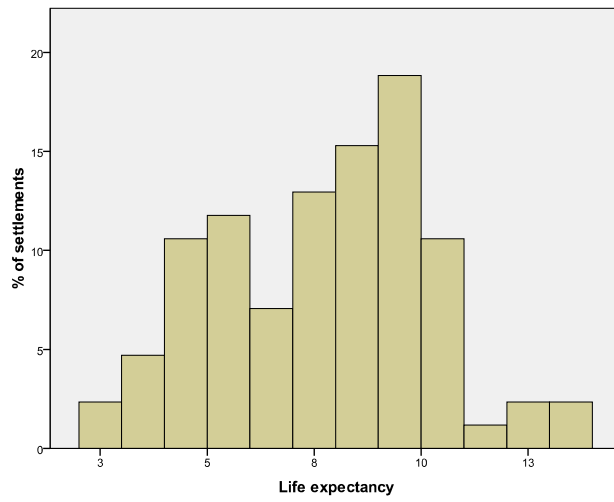|	Age	Life expectancy	Face amount	Annual premium	Mortality multiple
Mean	81.6	7.7	2651014	139211	1.62
Median	82.3	8.0	2000000	80283	1.2
Standard Dev.	5.0	2.4	3138076	164883	1.10
Min	69.3	2.6	100000	1958	0.57
Max	90.3	13.1	20000000	1077829	4.92

Figure 1. Age at time of settlement

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Figure 2. Life expectancy at time of settlement

6. Empirical Analysis and Results

6.1. Monte Carlo simulation on a pool of life settlements

After having constructed a pool of 85 life settlements and having determined the adjusted mortality table for all policies in the pool as described in the theory chapter; we employed Monte Carlo simulation in order to project the timing of deaths for individuals in the pool and, subsequently, the projected cash flows for the portfolio. The model that was developed using VBA programming, run–simulations and, thereafter, aggregating the simulated cash flows from the pool. This allowed us determine the value of the portfolio for each year until its maturity, i.e. the projected net cash flows. The maturity of such portfolios can vary depending on the investors' needs. For our study the maturity of the portfolio was set to forty years[25]. That means that cash flows were aggregated until forty years after the construction of the pool. It can be assumed that any policies left in the pool after the fortieth year either are allowed to lapse or are sold to the incumbent life insurance company at the cash surrender value. For this study and in order to avoid having an effect on the value of the portfolio in present terms we assumed that if any policies were left in pool at maturity, they lapsed. Had we assumed they were sold to the insurance company the affect on the portfolio's value in present value terms would not be significant due to the minimal likelihood of having any policies left in the pool upon its maturity and the effect of the discount factor on any cash flows after this period of time.

Regarding the number of simulations, we run 1500 simulations as also was done by Gupta (2006). This number of simulations appears to give our results a high level of accuracy in a reasonable amount of time. Figure 3 exhibits a graph of the projected net cash flows of the portfolio until the pool's maturity. The total face value of the portfolio, that is the total death benefits to be received, is $225,336,212 US dollars. The portfolio begins to produce positive net cash flows, i.e. total death benefits received minus total premiums paid, at the end of the third year. Figure 4 exhibits the projected policies left in the pool each year until its maturity.

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[25] In order to make a realistic assumption about the maturity of the pool of life settlements that we use in this study, we ought to have historical data about actual pools that have been constructed in the past. However, the availability of such data is very limited. Stone, Zissu (2006, p. 71) provide some data about three pools of life settlements that had been securitized publicly by December 2005. For one of them they indicate that it was securitized in 2004 and was to reach maturity in 2039, thus, a 35 year maturity appears to be a realistic assumption. For our study, given the characteristics of our sample, any maturity greater than 30 years does not significantly affect our analysis. For instance the difference between the expected IRR's (see part 6.3) for 30 and 40 years of maturity is 0.01% on average . As can be observed in Figure 4, the projected policies left in pool after the 25th year appear to be very close to zero, thus, only a selected maturity of less than 25 years would have a significant effect on our analysis. For example the expected IRR's for a pool with 20 years to maturity are on average 0.3% lower than a pool with maturity set at 40 years. In conclusion, a maturity of 40 years, given the characteristics of our sample and the limited available historical data on securitized pools, appears to be a realistic assumption.
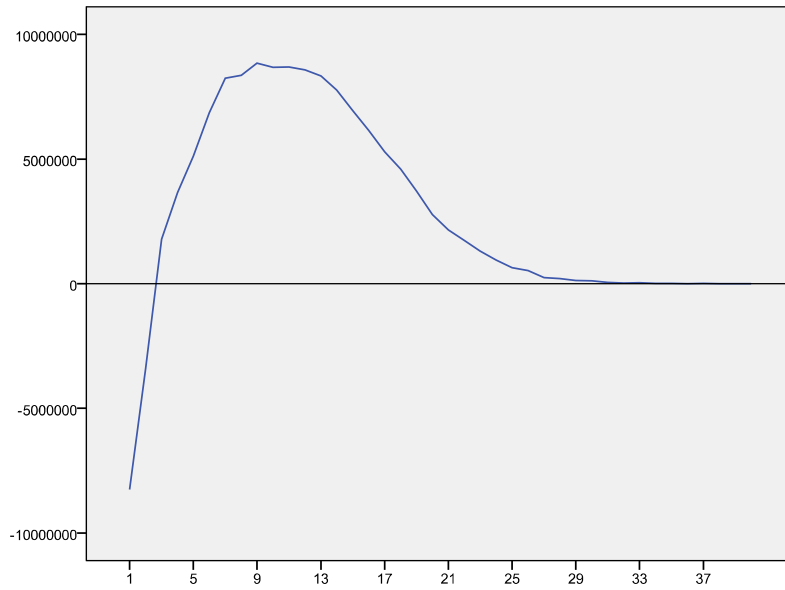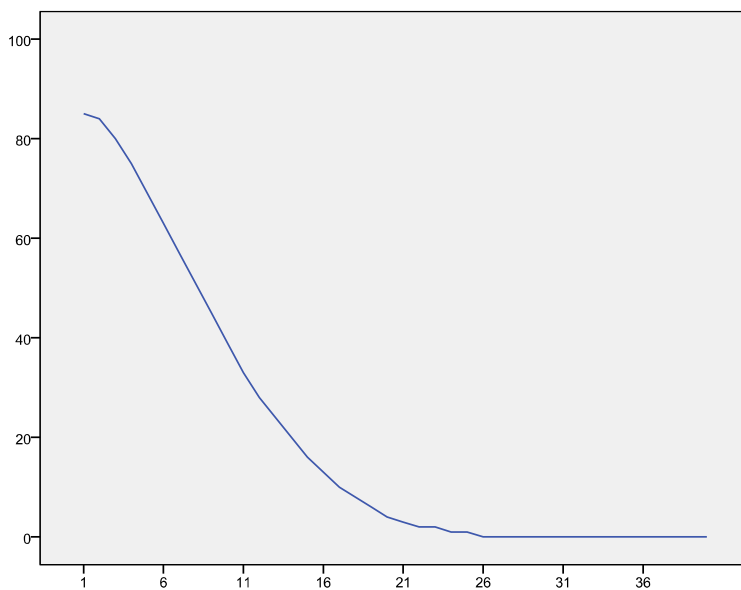
Figure 3. Projected net cash flows

Figure 4. Projected policies left in pool

The stochastic simulation of the time of death for each insured results in a projected life expectancy for each individual. This projected life expectancy for one individual in the pool is the mean value of the time of death for each of the 1500 simulations. As expected, a discrepancy between the projected life expectancy of the model and the life expectancy provided in the data, as presented in the data chapter, was observed. After calculating these discrepancies for each of the 85 policies, the mean for the all insured settlers was obtained which was 2.0 years. That is, the projected life expectancy in the pool was on average 2.0 years more than the given life expectancy on our sample of the settled life insurance policies. This discrepancy is attributed to the methodology used and the assumptions made in modeling.

One factor that affects the projected life expectancy is the use of a methodology that incorporates the gender of individuals. This gender assignment might have caused a part of this discrepancy. Should those holding the empirical data release gender information, the accuracy of the modeling of the time of death for each individual would be enhanced. Another factor that directly affects the outcome of the stochastic simulation is the use of the implied mortality multiples. As explained in the theory chapter (4) these mortality multiples were not available in the data and had to be reverse engineered based on a number of assumptions. These reverse engineered mortality multiples were expected to affect the simulated time of death, thus, the projected life expectancies and the projected portfolio's net cash flows. Once again if the mortality multiples were available this discrepancy might have been lower.

In order to show the effect of the use of different mortality multiples we re-ran the simulations. This time all the calculated mortality multiples were increased by 10% (VBT,1.1MM). This scenario resulted in a lower mean discrepancy of 1.5 years[26] between the projected life expectancy and the given life expectancy in the sample. The results of these decreased mortality rates on the projected cash flows and the projected policies left in pool are presented on Figure 5 and Figure 6 respectively, where are compared with the initial settings of the model (VBT,MM). Both portfolios produce positive net cash flows at the end of the third year.
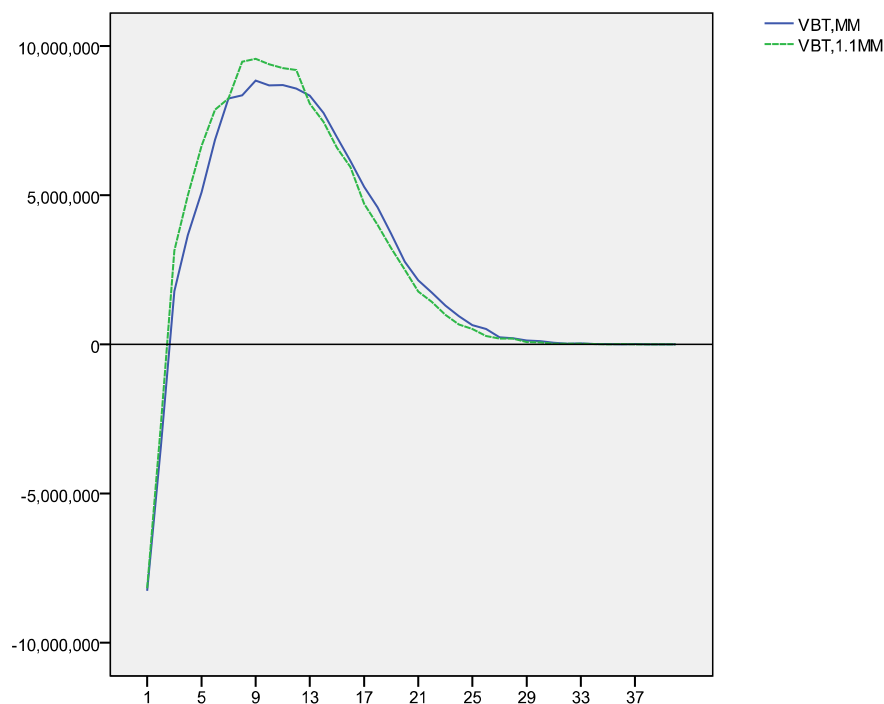

Figure 5. Projected net cash flows for (VBT, MM) and (VBT, 1.1MM)

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[26] The different scenarios that can be run are several and the model can be adjusted to produce any desirable outcome. However, the settings of the model and the different scenarios to be run should be based on realistic assumptions which ensure a reliable and accurate outcome.
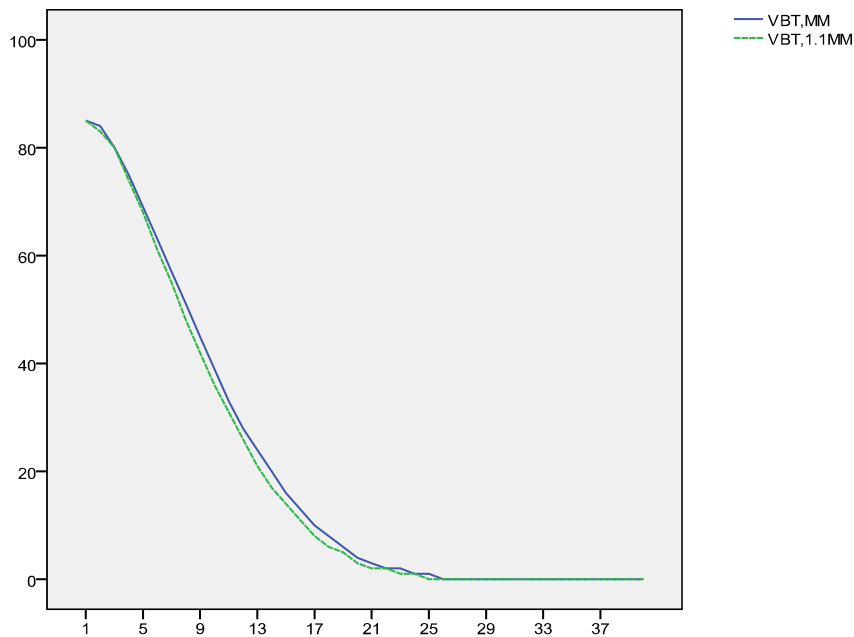
Figure 6. Projected policies left in pool for (VBT, MM) and (VBT, 1.1MM)

6.2. Stress testing

In order to understand how mortality risk is affected by changes in the assumptions that underlie it's calculation, we stress test the standard mortality table, which is the 2008 VBT, and the mortality multiples. By stress testing these two factors we can reflect the impact they might have on the projected cash flows and the projected policies left in pool. In the first scenario (0.9VBT, MM) a stress test on the 2008 VBT is deployed. This is done by decreasing all the mortality rates in the table by 10%. Thus, we use 90% of the VBT as the standard mortality table and we re-run the simulations. The outcome of this scenario will be a decreased mortality which affects negatively the projected cash flows. In the second scenario (VBT, 0.9MM) a stress test on the mortality multiples is deployed. This is done by reducing all mortality multiples by 10%, thus we re-run the simulations for 90% of the initial mortality multiples. Finally, a third scenario combines the two previous ones. These two scenarios result again on a decreased mortality which affects negatively the projected cash flows. All of these scenarios aim to show the effect of longevity risk on the projected cash flows and the projected policies left in pool.

On part 6.3. these three scenarios are deployed in order to explore the effect of the decreased mortality rates on the net present value of the portfolio and the internal rate of return. Figure 7 and Figure 8 that follow summarize the graphs of these three scenarios and the initial settings of the model (VBT, MM) for the projected net cash flows and the projected policies left in pool. Regarding the projected net cash flows, for all scenarios they are negative for the first years and they become positive for the following years until maturity where they are approaching zero. Regarding the projected policies left in pool, they are monotonically decreasing. With the initial settings of the model (VBT, MM) the projected policies left in pool are decreasing faster than in the other scenarios, which results to earlier positive cash flows as shown on Figure 7.
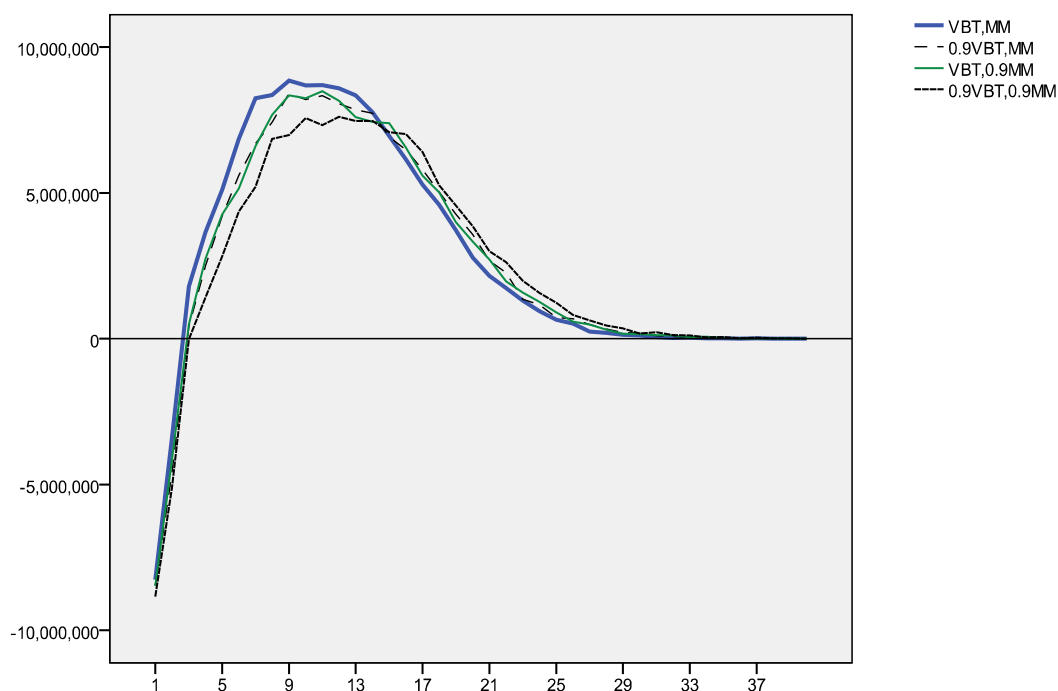
Figure 7. Projected net cash flows for (VBT, MM), (0.9VBT, MM), (VBT, 0.9MM), (0.9VBT, 0.9MM)
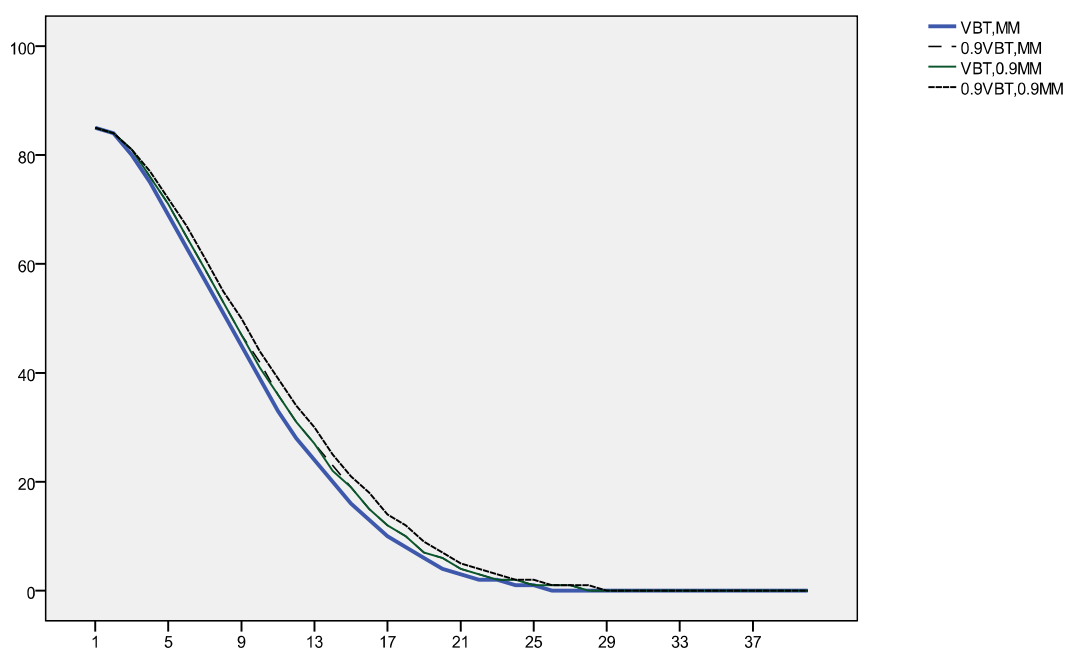

Figure 8. Projected policies left in pool for (VBT, MM), (0.9VBT, MM), (VBT, 0.9MM), (0.9VBT, 0.9MM)

6.3. Fair value of a pool of life settlements

We have extensively discussed the methodology used in determining the projected portfolio's value and, through stress tests, examined how sensitive it is to changes in the underlying assumptions. We now proceed to an empirical analysis and a discussion of

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our results regarding the final step in the pricing of life settlements. Before determining how life settlements can be fairly priced it is necessary to determine a proper discount factor to apply to the projected net cash flows that have been modeled. This discount factor is the required rate of return that investors demand given their understanding of the risks of their investment. In order to infer the fair prices of life settlements, this required return must be equal to the IRR in order to have a net present value of the portfolio equal to zero. These prices are expressed as a percentage of the face amount of each policy. For the whole portfolio the fair value will be expressed as a percentage of the face value of the portfolio.

For the different scenarios that were deployed in running the simulation and for a range of prices expressed as percentages of the face value of the pool (column 1), Table 9 shows how the net present value for the portfolio (columns 2 and 3) and the internal rate of return (column 4 and 5) change. When calculating the NPV the discount rate was set at 9%. Any other discount factor could have been used, since we wanted only to show the qualitative characteristics of the NPV of the portfolio for different purchase prices and not to conduct an analysis on the value of the portfolio in monetary terms. Moreover, 9% appears to be in the range of the historically observed rates of return in the industry, thus, its use is based on a reasonable assumption of a realistic discount rate. Columns 2 and 4 show the expected NPV and IRR respectively for the 1500 simulations, and columns 3 and 5 show NPV and IRR at the 10th percentile of the distribution of the simulated portfolio's present value. That means that the probability of having a portfolio's present value that results in an NPV or an IRR lower than the indicated level at the 10th percentile is 10%. Thus, a 90% confidence level has been assumed. Figure 9 shows the plotted histogram of the portfolio's present value discounted at 9%.

From the results presented on Table 8 it is shown that when stress testing the standard mortality table and the mortality multiples, i.e. the mortality assumptions, the IRR is reduced significantly and in both cases the results appear very similar. That means that changes either in the standard mortality table or the mortality multiple have a similar impact on the IRR reducing its range for the different offered purchase prices. The third scenario where both assumptions are stress tested at the same time results in an even smaller range of returns. Thus, in the best case scenario a required return roughly between 4% and 19% would result in a range of offered prices between 5% and 30% of the face value. Stone and Zissu (2007, p.63) however, suggest a more realistic range of returns ought to be between 7% and 11%. This has purportedly been observed historically in the industry and would result in a range of 10% to 20% for the prices offered to sellers of life policies. This offer price has also been observed in the past, however, given the lack of actual data, there is no consensus regarding it. In the worst case scenario the offered range of prices would be reduced to between 5% and 15% in order to maintain the same returns as previously. Thus, even in the worst case scenario, the life settlement industry offers at least a price equal to the cash surrender value typically offered by the insurance industry (Head, 2010).

Table 8
Price and required rate of return

| Price at % of face amount	NPV (discounted at 9%)		IRR	
	Expected NPV	10th percentile	Expected IRR	10th percentile
(1)	(2)	(3)	(4)	(5)
VBT, MM				
5%	25553797	14024953	19.25%	13.38%
10%	14286987	2758142	13.30%	9.68%
15%	3020176	-8508668	9.74%	7.17%
20%	-8246635	-19775479	7.26%	5.28%
25%	-19513445	-31042289	5.38%	3.80%
30%	-30780256	-42309100	3.88%	2.60%
0.9VBT, MM				
5%	19748993	7593577	16.41%	11.36%
10%	8482182	-3673233	11.42%	8.12%
15%	-2784629	-14940044	8.34%	5.94%
20%	-14051439	-26206854	6.16%	4.31%
25%	-25318250	-37473665	4.48%	2.99%
30%	-36585060	-48740476	3.14%	1.90%
VBT, 0.9MM				
5%	20104409	8090430	16.63%	11.42%
10%	8837598	-3176380	11.54%	8.19%
15%	-2429212	-14443191	8.42%	5.99%
20%	-13696023	-25710001	6.22%	4.35%
25%	-24962833	-36976812	4.52%	3.04%
30%	-36229644	-48243623	3.17%	1.95%
VBT, 0.9MM				
5%	14294378	1976449	14.09%	9.54%
10%	3027567	-9290362	9.83%	6.81%
15%	-8239243	-20557173	7.13%	4.90%
20%	-19506054	-31823983	5.19%	3.47%
25%	-30772864	-43090794	3.69%	2.32%
30%	-42039675	-54357604	2.48%	1.34%
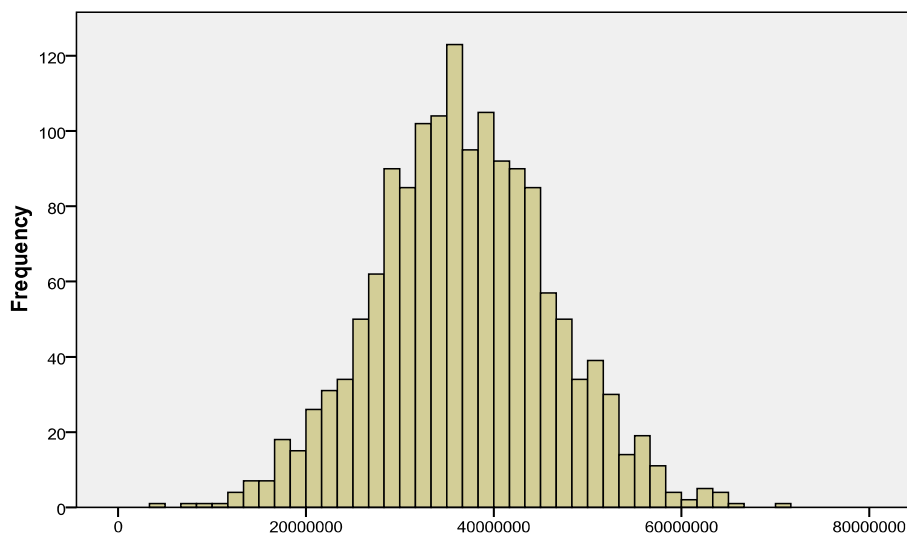
Figure 9. Histogram of the portfolio's present value discounted at 9%

It is interesting to observe that the only previous study[27] conducted using actual data, which analyzed the returns of the life settlement industry over the period 2004-2009 found a mean annual return on life settlement investments of 6.7% which is lower than the range of returns that have been reported to appear in the industry. That means that if this return is the most realistic assumption then the range of offered prices is limited to 15% and 20% of the face amount of the policy.

The estimated range of the implied fair prices presented here is also based on the approach used to project the portfolio's value. If another approach had been used, that range could have been different, thus, our perception on which range of prices should be rendered as "fair" would have been altered. Regarding the prices that each of the three methods discussed on the theory chapter (4) produce, Gupta (2008) states that the stochastic method used might produce a lower price than the alternatives. The selected method for pricing life settlements, while perhaps somewhat biased toward the lower end of the scale, suggests offering prices between 15% and 20% would be realistic. This is a fair level price range given the required return of about 7%. While this might appear low to those who have used alternative methods, it is based on the empirically tested historical data that we were able to gather.

Finally, regarding the accuracy of the estimated IRR given the size of our portfolio, Gupta (2006) shows that the variance of IRR on a pool of life settlements priced with the stochastic approach reduces at a very slow pace as the portfolio size increases. That means that the performance of a pool of life settlements is not significantly affected by its size. Thus, our results and conclusions appear to be accurate and reliable.

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[27] Braun, Gatzert, Schmeiser (2010)

7. Conclusions and Further Research

In this study a methodology for pricing life settlements is presented. The stochastic modeling of mortality that is employed and the available mortality data along with the costs of maintaining the policy in force are the key factors for determining how transactions in the secondary market for life insurance policies can be fairly priced for both policyholders and life settlement companies. The latter question is addressed to contribute to a better understanding of pricing in the life settlement industry and to provide a rigorous methodological approach on pricing life settlement transactions using real life data, filling the gap in the empirical research that has been conducted to date in the field.

In the first part of the analysis the stochastic approach on pricing life settlements is presented and is implemented on a pool of life insurance policies. The pool was constructed based on actual life settlement quotes. This part of the analysis was used for simulating the timing of deaths for the individuals in the pool and subsequently for projecting the cash flows for the portfolio.

In the second part of the analysis the notion of mortality risk is presented and considerations regarding stress testing are extensively discussed. As the fair price of an asset is determined by the appropriate balance between risk and return, considerations about risk are considered of crucial importance. Through the discussion of such considerations the understanding of the pertinent risks on investing on life settlements is enhanced. Regarding mortality risk, which is the primary risk reflected in a portfolio of life settlements, it appears to be analogous with systematic risk on other markets of assets.

In the last part of the analysis a range of required returns is deployed to infer a fair level price range. In the best case scenario a required return roughly between 4% and 19% would result in a range of offered prices between 5% and 30% of the face amount of a life insurance policy. However, a more realistic range of returns between 7% and 11%, which has purportedly been observed historically in the industry, would result in a range of 10% to 20% for the prices offered to sellers of life policies. In the worst case scenario the offered range of prices would be reduced to between 5% and 15% in order to maintain the same returns as previously. In that scenario, the life settlement industry offers at least a price equal to the cash surrender value typically offered by the insurance industry. Finally, based on the only available actual data on returns on life settlement investments the most realistic assumption for the range of offered prices is limited to 15% and 20% of the face amount of the policy, given a required return of 7%.

Nevertheless, the aim of conducting this study in not to find which is the appropriate rate of return for investors, it is rather to show how the rate of return drives the price of life settlement transactions as a part of addressing the research question. On the other hand in this study it is not eventually concluded whether the life settlement transactions are mispriced or not since the actual value of such transactions is an unknown variable and a comparison with the simulated values produced by this study cannot be made.

It is worth to be mentioned that central to this analysis is the assumption that the NPV of the portfolio comprised of life settlements is zero, which consequently implies that life settlement companies make zero profits by purchasing life insurance policies in the

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secondary markets. In reality life settlement companies do not make zero profits. If a study in the future with real data on actual prices found that the price range suggested by the model presented in this study has a discrepancy, then this might be attributed to the fact that eventually the market in not competitive and life settlement providers act in this industry because of that reason.

In conclusion, through the analysis presented in this study an attempt has been made to illustrate how a range of required returns on a pool of life settlements is reflected in the prices that investors are willing to pay. Unlike a study conducted by Stone, Zissu (2007), whose aim was also to analyze how the required return dictates the price, with this study I go one step further and attempt to infer whether that range of required returns and the subsequent range of offered prices renders life settlement transactions are fair. The research question as has focused on the fairness of the transactions that occur in the life settlement market, has driven this study to present a more rigorous and sophisticated approach to determining the pool's value than had been presented before, implementing it on a pool of actual data. Through, the extensive discussion of the considerations about assessing and managing the pertinent risks the issue of existence of fairness of the transactions is highlighted to a greater extent.

However, this field of research remains to be enhanced with further researching some of the aspects of the secondary market of life insurance policies. The issue of whether this market is competitive or not, and if not how it will become given that this market's dynamics are not similar to those of other markets, remain one of these aspects. Moreover, the development of other methodologies for pricing life settlements, or methodologies for determining the appropriate required rate of return using asset pricing models is deemed important for a better understanding on pricing issues. Finally, the methodology presented in this study and similar methodologies of other studies, remain subject to empirical analysis using actual data. Such analysis will reveal more knowledge on the market's dynamics and to what extent transactions are fair.

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