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On the Effect of the Move from Book to Market Valuation of Pension Liabilities

Importance of Credible Regulatory Enforcement: Target Zone Approach

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On the effect of the move from book to market valuation of pension liabilities.

Importance of credible regulatory enforcement: Target zone approach.

by

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Chapter 1

Introduction

Traditional defined benefit pension funds and insurance companies are the main guaranteed pension providers[1]. Excluding governments, they have long been ensuring old age income provision and security for the beneficiaries. Nevertheless, during the last years both of these institutions have gone through some major developments. Besides having outlived the financial turmoil and experiencing sharp decreases in interest rates, they are now facing changes in regulations and accounting standards that will have a major impact on their business models and the liability side of their balance sheets. This in turn has all the potential to affect the important role they play as guaranteed pension providers.

Today there is a major discussion between two primary methods concerning valuation of pension liabilities – the book valuation (BV) and the market valuation (MTM). The book value approach has been widely used in pension, insurance and corporate accounting historically. Nevertheless, a trend moving towards market valuation of the liabilities has gained a momentum in recent years and is likely to continue since harmonization among regulatory frameworks is looming and mark-to-market liabilities are becoming the default in the regulatory frameworks, such as IORP II, Solvency II and IAS 19.

Introduction of the new regulatory framework could be described as a disruptive change for the pension industry. Essentially it asks for tremendous adjustments to the way pension providers that offer guarantees operate. Not only do they have to alter the way they report and calculate their liabilities but also they have to revise their perceptions towards risk and investment strategy (see Ponds and Quix, 2003). Thus, market valuation could be seen as a shift that will affects the whole value network. In order to preserve the guarantees in pension schemes and insurance solutions, senior managers have to completely rethink their old business models from the root to tip.

A large body of academic literature has indicated that adapting managerial behaviour following a disruptive change is not always easy or convenient (see for example Utterback, 1994 and

[1] In this thesis we consider a guaranteed pension provider to be a pension fund or an insurance company that guarantees a certain amount of nominal or real benefits for their members/customers upon retirement.

Christiansen, 2003). It has been argued that in times of a change people tend to maintain 'status quo' by focusing on improving efficiency in their current business model (Zaltman and Duncan, 1977; Burmeister & Schade, 2007). If this is also the case among pension providers, introducing a new regulatory framework will not be sufficient to make a tangible change in the way how these managers run their business. Due to the complexity a move towards MTM liability approach implies guaranteed pension providers might be reluctant to reengineer their business models and put emphasis on the shorter-term tail risks. It is likely that they continue to manage the longer-term risk around the mean instead which should *in expectation* deliver higher pension payments. To address this concern in this thesis we seek to address the following question:

Does the move from BV to MTM valuation method for pension liabilities influence the behaviour of guaranteed pension providers such as pension funds and insurance companies? If so, in what way and what are the implications?

To investigate if and how the credibility of the regulator affects the behaviour of pension providers following a move from BV to MTM framework we turn to the literature on target zone. Paul Krugman showed, in his ground breaking paper from 1991, that the behavioural effect of the exchange rate movements within a target zone is influenced by the credibility of the central bank. In his paper he presents a case where the central bank imposes a new exchange rate regime and switches from a free float to a target zone. The Krugman model reveals quite interesting implications of the corresponding exchange rate behaviour. It recognizes that the behaviour of the exchange rate after the regime shift is affected only if the regulatory authority, i.e., the central bank, is considered to be credible. If the central bank lacks credibility, imposing a new regulatory regime does not change the behaviour of the exchange rate – even under a target zone regime, the dynamics of the exchange rate continues to be the same us under a free float (Krugman, 1991).

Essentially, in guaranteed pension provision, a move from BV to MTM framework is very similar to the shift from free float to a target zone. Consequently, it seems reasonable to ask the following question – is the main message of the Krugman target zone model applicable to the introduction of MTM in the guaranteed pension provision? To shed a light on the surprising and significant lessons the pension industry can grasp from the target zone literature, in this thesis we present a theoretical Solvency model based on the core principles of the Krugman model. This model will be capable of identifying whether the providers of guaranteed pensions consider the regulator credible or not in the transition towards a MTM framework.

The focus of this thesis is a theoretical qualitative discussion based on utilising diverse elements from different academic fields that will be synthesized into a model that can be used to analyze the behavioural consequences of introducing the MTM methodology.

This thesis will be structured in the following way. Firstly, in *Chapter 2*, we will give a brief overview of the vigorous debate the move towards MTM liabilities has triggered among insurance companies, pension funds, academics, and policy holders by uncovering the most relevant arguments. Also the impact a change in the regulatory framework has on pension provider's risk exposure, risk management and investment approach will be highlighted. Further, *in Chapter 3*, we will review the literature on disruptive change. Ultimately, it will allow us to gain deeper understanding of how difficult the disruptive shift from BV framework to MTM framework can be for insurance companies and pension funds. These challenges are technical but foremost of behavioural nature and therefore it makes sense to learn from other industries that also have faced disruptive change. In *Chapter 4* we will concentrate on the significant impact a strong and credible regulatory enforcement may have on the behaviour when introducing a new valuation regime. As the core component of this chapter we will present the theoretical framework and the key findings of the Krugman exchange rate target zone model that will further be the main building block for the construction of the Solvency model further in the thesis. *Chapter 5* will deal with the hypothesis and the research approach and in *Chapter 6* we will present the Solvency model. *Chapter 7* will fit the Solvency model to the empirical observations of the Netherlands, Sweden, and, depending on the results obtained, will draw conclusions about the accuracy of the hypothesis proposed in *Chapter 5*. Finally, *Chapter 8* will conclude the thesis by providing policy recommendations.

Chapter 2

Book valuation vs. Mark-to-Market

If you don't know where you're going,
any road will take you there.

~ Alice in Wonderland ~

When looking at how institutional investors value their assets today, we note that a single market based approach is the dominant valuation methodology. Before the introduction of 'efficient market hypothesis' in 1960s, it was unanimously accepted to valuate assets at book value (BV), i.e., initial cost adjusted for realized capital gains and losses (Jackson and Hamilton, 1968; Duska et al., 2011). However, this methodology led to adverse investment decisions. For example, an insurance company did not sell an asset if the market price had fallen below the book value because by doing so it would have to realize a loss that would weaken the balance sheet. In other words the peaches were sold, the lemons were kept and senior management worried about unrealized losses. Warren Buffet once said: 'You get into a lot of trouble when you start putting fictitious numbers on value[2]'. With the gradual transition towards market to market (MTM) valuation of assets, the field of financial risk management began to develop and lead to the introduction of modern financial instruments such as derivatives.

When we consider guaranteed pension liabilities, the story turns out to be somewhat different. Only recently we have begun to see the transition from the book valuation to the market valuation. Since each of these two methods is based on different underlying assumptions, they result in significantly different valuation and volatility of pension liabilities. As a consequence the solvency ratio, i.e., a ratio of pension or annuity provider's assets to its liabilities[3], obtains a different risk-return profile.

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[2] Charlie Rose Show October 1, 2008. Available at http://www.charlierose.com/view/interview/9284 (Accessed on 1.08.2012)

[3] Definition available at http://financial-dictionary.thefreedictionary.com/Funding+Ratio

Under traditional actuarial approach, which is based on book valuation principles (BV), future liabilities are discounted with an actuarially fixed discount rate while the assets are marked-to-market. The liability discount rate is chosen by rule of thumb, usually based on the future expected returns on assets or on the difference between the expected long term asset return over the wage growth. In the Netherlands, a fixed discount rate of 4% was used until 2007. This valuation methodology leads to a situation that the liabilities are more or less constant and unaffected by yield curve movements observed in the market.

Under the MTM regulatory framework, pension funds and insurance companies are required not only to mark their assets to market but also to discount their liabilities using the market yield curve. In that way both sides of the balance sheet reflect actual financial value (Ponds and Quix, 2003). This means that it is possible to determine how much assets are needed in order to back up all the obligations today which become relevant considering the termination of a pension plan or an insurance company (Donohue, 2010).

New regulations have already changed the landscape for insurance companies while pension funds are still on the road towards significant changes. Therefore discussing what impact these changes bring to pension funds is both interesting and fundamental. The pros and cons of pension funds moving towards MTM have been discussed widely and this vigorous debate has marked a thick line between defenders and opponents of the move.

Opponents claim that a constant discount approach provides a higher stability for a pension fund and enforcement of the MTM liability approach onto pension funds leads to unnecessary volatility and solvency risk. Accordingly, such enforcement results in high probability of short-term insolvency (Plantin et al. 2008). Therefore, it makes pension managers to focus strictly on short-tem financial decisions which in turn could lead to sub-optimal long term results (Day, 2003; Plantin et al., 2008). One could summarize the arguments as: The long-term expected return will be dominant and by managing the short-term tail risk, an alternative cost is introduced at the expense of future pensions.

In contrast, proponents argue that fair market valuation is the only consistent and transparent way how to assess the actual solvency of a financial institution (see Exley et al. 1997; Chapman et al., 2001; Bader and Gold, 2002; Ponds and Quix, 2003; Kocken, 2012). The advantage of the fair valuation method over the BV method is that it is more sensitive and responsive to new market information. Incorporation of new market signals into the liability valuation gives pension funds an appropriate insight into the prevailing solvency ratio. Proponents also argue that by using MTM pension funds can also manage the solvency risk by using financial instruments.

Nevertheless it has been argued that an inconsistent valuation of pension's assets and liabilities although seemed appropriate in the 1990's when the market gave returns far above the expectations, is unsustainable in the long run. Under the traditional BV approach where assets are floating and liabilities are fixed, the decreasing (increasing) interest rate does not affect the value of the liabilities while the value of the fixed income assets increases (decreases). Hence, under BV regime decreasing interest rates improve the solvency ratio which is beneficial and desirable for a pension fund. However, the fact that is terribly ignored is that the actual solvency ratio is essentially decreasing as the actual liability value is increasing substantially. Consequently, BV approach leads to inappropriate risk management behaviour and self-constructed measurement of the solvency ratio without any glimpse on the prevailing financial risk. (Ponds and Quix, 2003).

Moreover, a constant discount rate for pension liabilities allows pension plans and their sponsors to engage in systematic manipulations of the solvency ratio. When using a discount rate that is significantly higher than the market rate, a pension fund is seriously under valuating its pension obligations. It has been proven that the discount rate manipulation has been indeed used in practice. Bodie et al. (1985) have provided evidence from the United States that less profitable companies have often used higher discount rates to assess the value of their liabilities. For instance, public pension plans in US use a discount rate of 8% when the 20 year Treasury yield is at 2,30%[4]. This clearly overestimates any future investment returns, but it allows the public funds to understate their liabilities and in that way avoiding an increase in contributions during hard economic times (Gray, 2012). Also, the notorious company ENRON manipulated its balance sheet by assuming a rate of 15% for its pension liabilities (Benston and Hartgraves, 2002).

Furthermore, responding to the opposition's short-term focus argument, proponents of fair value approach argue that risk management in the short term remains as important as in the long run. According to Ponds and Quix (2003), a fund facing insolvency will not be attractive to the younger generation. They will anticipate that joining such pension fund will harm their overall lifetime income as a considerable insolvency will have to be compensated by high long-term contributions. Thus, younger generations will expect that they benefit less than the old

[4] Available at: http://www.treasury.gov (Accessed on 6.08.2012)

generations from each Euro invested which will discourage them from joining such a fund (Kocken, 2012).

The early movers to adapt a MTM framework have been the UK, the Netherlands and the Scandinavian countries. The common link between these countries is the emphasis on the market valuation of pension liabilities and risk-based regulations. Nevertheless, each of these countries has gone separate ways and encountered different developments and experiences.

Further we will analyze more deeply what a move towards fair valuation (MTM) framework implies to all providers of guaranteed pensions, pension funds and insurance companies, when it comes to risk exposure, risk management and investment approach.

2.1 Risk exposure

Providers of guaranteed pensions are mainly exposed to two types of financial risks, i.e., equity risk premium and interest rate risk. Under BV regulatory framework with an asset driven approach and fixed liability discount rate, equity risk is considered the main driving force for changes in the solvency ratio as the liabilities show no sensitivity to interest rate changes. What is more, falling interests actually improve the balance sheet as the value of fixed income assets is rising. However, according to Ross (2007), when we look at guaranteed pension providers adapting fair liability valuation (MTM), the interest rate risk is much more relevant for its solvency status. The liability value is highly dependent on the short-term fluctuations and long-term trends of the term structure.

Interest rate changes under the MTM framework become significant when we consider asset-liability duration gap. A typical guaranteed pension provider holds liabilities with an average duration of 15 years, while its assets have much shorter duration. Consequently, due to a mismatched duration under the MTM, in the environment with decreasing interest rates guaranteed pension providers will experience a significant fall in solvency ratio as the value of pension liabilities will increase more than the value of assets.

Hence, mismatch risk (MMR) becomes a central concept when measuring the solvency risk to which a guaranteed pension provider is exposed to under MTM framework. Generally the mismatch risk is defined as a standard deviation of the solvency ratio and the size of it is largely depended on the underlying asset mix chosen (Ponds et al., 2011).

It is important to note that there a trade-off always exists between higher excess returns and lower exposure to the mismatch risk (Ponds and Quix, 2003). However, due to this risk-return trade-off accepting more mismatch risk does not bring any economic value (Ponds, 2003). Although it could bring lower contributions or contribution holidays in the future, it also increases the risk of insolvency.

2.2 Risk management

Risk management under MTM framework over time is essentially the management of the mismatch risk (Ponds and Quix, 2003). A guaranteed pension provider has to manage its mismatch risk exposure in accordance with its risk taking capacity so it can make sure that insolvency will not occur even in the worst case scenario. Basically it means that a guaranteed pension provider has to ensure appropriate risk level, i.e., it can afford to bear more risk if it is in a good financial shape, i.e., its solvency ratio is high, but should avoid being exposed to a high risk level when being close to facing insolvency. Thus, higher risk taking requires a higher solvency ratio. However, this kind of systematic risk management is possible and only makes sense if a fund has enough reserves and capital to act. If a pension fund has become insolvent a few possibilities for it to increase its solvency ratio and to recover is to either increase contributions/decrease benefits, uptake more risk exposure or at least stay in a constant risk level in a hope for higher future excess returns. For an insurance company, in case of insolvency the shareholder has to inject an extra capital if it does not want to lose its licence and clients. This implies that the timing of the introduction of MTM is essential. As only fully funded pension providers are able to apply systematic risk management as it is required under MTM framework, it makes no sense to implement the new regulatory framework at the time when pension guarantors are expected to be insolvent in the new framework.

A guaranteed pension provider can reduce risk exposure by closing the duration gap between its assets and liabilities[5], i.e., creating a hedge portfolio, or by selling its risky assets. By matching assets with liabilities a pension provider can immunize the discount rate effect. All the negative (positive) changes in the assets will be offset by positive (negative) changes in the value of the liabilities. In turn, the solvency ratio will not be affected by the changes in interest rates. Oppositely, a pension provider can increase its risk exposure, hence the expected excess returns, by increasing the interest rate gap or by allocating more into the return seeking portfolio.

[5] Although in practice perfect matching might not always be possible, by using financial instruments a pension provider can always manage to obtain duration gap very close to zero (Franceries and McHugh, 2007; van Bragt, 2011).

One has to note that under MTM framework, hedging the interest rate risk is crucial from a policy perspective. However, the actual exposure to the yield curve is an investment decision that should hinge on the pension managers' interest rate expectations.

Moreover, due to changing nature of pension liabilities under MTM framework, pension managers have to pay detailed attention to tail risk management in order to insure the solvency against *black swan events*[6]. This is different from the risk management under BV framework where one only considers the mean of the asset return distribution.

2.3 Consequences to Investment strategies

As discussed before, a significant difference between BV and MTM framework is that under MTM the value of underlying liabilities is changing and essentially determines how much risk a guaranteed pension provider can afford to take. This in turn implies that there are significant differences between the optimal investment strategies under each of the frameworks.

Under the traditional BV framework pension managers are following asset-only based investment strategies. As the sensitivity of pension liabilities toward the yield curve is not considered when making an investment decision, the optimal asset allocation is derived from the traditional efficient frontier. Thus, an organization providing a pension guarantee is striving for the highest absolute return given the level of equity risk. Under the traditional asset-based approach the low risk investment is considered to be cash. Hence, if you want to reduce your investment risk exposure temporarily, you can move away from the stock or bond market and instead reallocate to government short-term debt and cash.

However, if a pension provider operates under fair valuation regulatory framework (MTM), it has to completely rethink and reappraise its investment approach. Under MTM, the low risk investment is not cash anymore but instead a liability mimicking portfolio. A liability mimicking portfolio is a perfect hedge portfolio where the exposure to the mismatch risk is eliminated[7]. Having a large duration gap essentially means that the pensions guarantor will borrow at the long end of the curve in order to invest at the short end of the curve. This is typically called a negative carry trade which only makes sense when yields are rising[8]. If the curve is falling or flat, this strategy will systematically erode the solvency. If a pension managers has a strong view

[6] The black swan theory has been developed by Nassim Nicholas Taleb. It refers to unexpected, rare, and hard to predict events of large magnitude that have a major impact in history (Taleb, 2010).
[7] Definition available at http://www.examsuccess.ca/pdf/L3ss5outline2012a.pdf (Accessed on 10.07.2012). In most cases the liability mimicking portfolio is not investable which leads to practical challenges.
[8] *Bond trading 201: How to trade the interest rate curve*. http://www.bondsquawk.com/bond-school/bond-trading-201-how-to-trade-the-interest-rate-curve/ (Accessed on 6.07.2012)

that the interest rates are going to increase in the near future, it is completely rational for them to increase the duration gap and mismatch risk exposure.

Thus, due to the significant importance of the liability side, instead of focusing only on the return level, a guaranteed pension provider has to recognize the unique relationships between assets and liabilities and further incorporate that into its investment strategies and decisions. An investment policy under which the mismatch risk can be addressed is the so-called liability-driven investment (LDI) strategy. It aims to reduce pension provider's exposure to falling interest rates by focusing on liability hedging. The LDI has been promoted actively by investment banks since it gives them opportunity to transact financial derivates.

To sum up, Table 1 demonstrates the differences between asset-only (BV) investment approach and risk based (MTM) investment approach.

Table 1:

	Asset-only: BV	Risk-based: MTM
Objective	To reach asset return target	To outperform liabilities
Risk free investment	Cash	Liability mimicking asset portfolio
Investment benchmark	Asset focussed portfolio	Liability mimicking asset portfolio

Conclusion

Essentially, a switch from BV framework to MTM framework means a very large, difficult and challenging disruptive change for the guaranteed pension industry that asks for behavioural adjustments. Nevertheless, the behavioural change when moving from asset-based approach (BV) to risk based approach (MTM) is not so straight forward nor particularly easy. Undoubtedly, under MTM hedging the interest rate risk is a policy decision. Nevertheless, shifting from the return yielding strategies to the safe liability matching strategies is not the most desired nor comfortable path of action as it asks for tremendous organizational adjustments and will have implications on the outcome of the current guaranteed pension products.

Even more, pension managers are subject to pressure from the media and public that makes the change in a regulatory framework more difficult to adapt. Under BV framework the main tool for comparing pension providers is the return that is made on the asset side while under MTM framework it is essentially the solvency ratio that should be compared. Unfortunately also under MTM the media attributes much bigger value to the asset returns made. Hence, pension funds and insurance companies that obtain slightly higher returns due to their risky investments are usually favoured and highlighted more than their industry brothers that although making lower returns are keeping their solvency stable.

In sum, a change in the regulatory regime is extremely difficult to grasp for all stakeholders; pension organization management, consultants, regulatory authorities, media etc. It is a process that involves tremendous amount of uncertainty and ambiguity thus asks for pension managers' creativity and determination. It is a process where those who will recognize the patterns of change and modify their business models will manage to survive providing guaranteed pensions under the new regulatory environment. However, evidence in the academic literature has showed that most of the time business leaders fail to reinvent their businesses. Instead they respond to a disruptive change in a way that ensures their ultimate failure. As managers of organizations providing guaranteed pensions are not expected to be significantly different they are expected to face exactly the same problems as any other organizational elite.

In the next chapter we will approach behavioural aspects of the problems and challenges that a disruptive change may bring to an organization. Ultimately, it will allow us to gain deeper understanding of how difficult a shift from BV framework to MTM framework can be for an organization providing guaranteed pensions.

Chapter 3

Disruptive change - literature review

In times of disruptive change your expected future is no longer valid. Leaders need to think and act differently in order to chart a new course for the enterprise.

~ Doug Berger ~

Inevitably whenever a disruptive change touches an industry there are winners and losers.

There will always be businesses that reinvent themselves, thus, are receptive to the change but there will always be others that continue their old routines and eventually find themselves struggling or even get engulfed by the change.

Looking backwards in time there are many examples where worthy and great companies encountered insurmountable problems when a disruptive change hit their business niche. To mention just few examples of industries, companies dominating the ice industry went out of business following an introduction of fridges, just few typewriter manufacturers overcame the rise in personal computers (Utterback, 1994) and a shift to transition radios posed problems for firms like RCA (Henderson and Clark, 1990).

A recent and fascinating illustration of how difficult it is to change old habits and implement a strategy that straddle the business model of today and one of the future is the case of KODAK. The recent Chapter 11 bankruptcy protection filed by the company in January 19 this year[9] was the end of a legend. Back in 1888, KODAK revolutionized the world of photography by putting the first simple camera into the hands of consumers. After that for more than hundred years it kept expanding the ways how photography affected people lives all around the world, 'the KODAK moment' became a slogan associated with photography. At the turn of the 21st century its glory days were disrupted by a rise of a digital age. Although the iconic company tried to

[9] http://www.kodak.com/ek/US/en/Eastman_Kodak_Company_and_Its_U.S._Subsidiaries_Commence_Voluntary_Chapter_11_Business_Reorganization.htm (Accessed on 6.08.2012)

adjust, its corporate culture was so attached to the well-known, profitable and beloved paper and film business that it could not adapt to the latest technology and failed to finds its place in the new value chain of digital photography (Socsys, 2012).

The case of KODAK represents a company that failed to reinvent itself and although had all the skills and prerequisites necessary misses its chance to adapt to the rise in the digital technology. Ultimately, it was a failure of leadership and its inability and resistance to recognize the need for a change in the direction. By holding steadfastly to their outdated business model KODAK essentially triggered its own unfortunate fate (Mendes, 2007).

Managers of organizations usually devote a lot of time and effort to fine-tune the business so that it will work and function more efficiently in order to improve the shareholder value. Inevitably they also form particular expectations (linear extrapolations) on their business development in the future, but this anticipated future ceases to exist when a disruptive change hits (Doug, 2005).

A vast majority of academic literature has indicated that a complex organizational change following a disruption in the industry is extremely difficult to implement and follow through. This has been proven by the impressive amount of companies that have not been able to transform their business models. Moreover, contradicting to what one might think, most of the times the failure has not been due to unsatisfactory technical solutions but rather due to a strong resistance among management and employees in the organization itself (Shaffer and Thomson, 1998; McKinsey & Co, 2006).

The conflict arises when new information that advocates a need for a change is brought in to the equation. This involves evidence that the current model of working is not sustainable in the long run and needs to be changed into a new system. When an organization confronts this change that requires setting new rules, new priorities and new beliefs, it frequently finds itself being unable to do so. Generally speaking reshaping an inside culture and the way of operating takes a long time. Managers are trained and rewarded for managing process in a cost efficient way but they are not trained to adjust and adapt to something new. Consequently, inexperience with the process under the new system might lead to anxieties and confusions. Nevertheless, some managers can even face difficulties to recognize the need for a restructuring since the previous business model has performed well in the past. It takes a long time for a fast moving Boeing jet to make a U-turn in the atmosphere, when it comes to a disruptive change it can take a very long time for the required change in managers' behaviour to occur (Rumsfeld, 2011).

In the academic literature a resistance to change is called a ‘status quo bias’. Burmeister & Schade (2007) have argued that people disproportionately often tend to choose the option that they have been choosing before. When an organization is going through a disruptive change there are various reasons why managers would resist changing their behaviour and doing things differently. That involves fear of unknown and insecurity, lack of competence and oversized ego, and last but not least lack of proper incentives.

When one is faced with a change he might feel fear rather than excitement. Everything that is new seems unknown and lacks certainty, and security. Accordingly one may feel the necessity to stick to the past which is more predictable and comfortable (Zaltman and Duncan, 1977; Coghlan, 1993). If prior the disruptive change the way of doing business worked well, managers do not feel comfortable to change their behaviour and cannibalize on their existing revenue streams (Reinganum, 1983). Some might feel that there is no necessity to ‘rock the boat’ and therefore refuses to adjust their familiar business model (Agócs, 1997; Reichers et.al, 1997).

Undoubtedly, in times of disruptive change, new set of skills is required in order to become successful. As a result, management fear that their organization might not be able to make the transition well and achieve as high results as in the past. Consequently, the only way for them to avoid hurting their ego and admitting their lack of competence is to resist the change and to further enrich their old position (Utterback, 1994).

Once business leaders have formed their own views on the way things should be done they tend to conserve their opinions. Shiller (1998) has shown that people tend to refuse accepting new information and evidence that is contrary to their view. When new information is released they refuse admitting and understanding that the problem exists thus fail to adjust and regenerate. This phenomenon, also known as ‘conservatism bias’, increases when one is educated and competent in the subject (Ritter, 2003). In practice, this means that organizations suffering from ‘conservatism bias’ tend to focus on ‘back to basic’ by improving the existing products and introducing cost cutting programs to increase competitiveness.

In addition, managers often lack incentives to change their behaviour. Durant (1999) has indicated that in order to reinforce a new behavioural model, incentives to do so have to present. Frequently the old behaviour is still rewarded although changes are necessary. Drawing parallels with the pension industry, media and other stakeholders are comparing asset returns in that way rewarding and highlighting pension managers who act as they were still operating under BV regulatory framework rather than MTM. This in turn may kill incentives and introduce a career risk for those managers that change their behaviour and do the right thing under MTM framework.

Conclusion

It seems that people rarely see change as something good or exciting. More likely they see it as something ambiguous, scary and uncomfortable. Consequently, they resist changing their behaviour and doing things differently. Historically this has been a reason for an enormous amount of venerable organizations failing to adapt to the new environment and as a result getting swept out of the business. Hence, a disruption in the industry, i.e., new technology, globalization, frameworks, standards, etc., is typically not sufficient to make a tangible change in the way how managers run their organization. By linking to the reforms affecting the industry providing guaranteed pensions, it would follow that a change in the regulatory regime alone will not create sufficient amount of incentives for pension managers to change their old styles of risk management and investment practices.

Therefore, if the regulator wants to see industry truly implementing the rules and the underlying requirements of MTM framework, he/she has to provide an external pressure that would forces managers to think differently.

In the next section we will concentrate on the significant impact a strong regulatory enforcement may have on people behaviour when confronted with a disruptive change.

Chapter 4
General on regulatory regimes & enforcement

Excellence is never an accident.
It is always the result of high intention,
sincere effort, and intelligent execution;
~ Aristotle ~

Consider a taxi driver for whom having a driving licence serves as a prerequisite for having a job, hence stable income. Losing this licence would lead to unemployment. Nevertheless he likes to drive fast since then he can serve more customers in shorter time. The emotions also play a role: he feels a rewarding effect when speeding by demonstrating his driving skill and getting an adrenaline thrill when breaking the rules. Yet at one point in time the road regulatory authority decides that fast driving should be prevented, at any cost, to increase safety on the roads. Thus it issues a law that speeding is forbidden. Police in one city decides that it will concentrate on giving warnings to the offending drivers but will not punish them hard as it believes that eventually due to the law drivers will change their behaviour themselves. Oppositely, in the other city, police decides to take more radical actions and equips the whole city with highly visible cameras and marked police cars. Moreover, it makes it clear that ones who will get caught will get their driving licence taken away immediately. The question rises – how will the approach by the police affect the behaviour of the taxi driver in each of the cities? Will the taxi driver change his behaviour and forgo higher income and excitement of fast driving in the city where he/she will not get punished? Or will he/she be more likely to stop speeding in the city with a hard punishment for reckless driving?

This simple example illustrates the lessons we have learned from the behavioural science literature in the previous chapter of this thesis - people are reluctant to adjust their behaviour when confronted with a change. Sense of urgency to act is repressed by various factors such as fear of unknown, insecurity or lack of proper incentives. At the end doing things in the old way is easier and less costly, thus brings higher utility. Consequently, if no punishment is targeted towards the old behaviour, it is completely rational for people to resist a change.

Undoubtedly, most of the time enforcement of prudent regulations is necessary. However, one has to note that the main objective of any regulations should be public's protection and safety achieved by deterring people from behaving in a way that might cause harm or abuse to others. Essentially it is not to concentrate on maximizing the number of breaches detected but instead on discouraging the offence as prevention is always cheaper than cure. Regulations should primary serve as deterrence for those tended to commit an abuse through making the risk of getting caught and punished salient. It has been proven that consistent offence preventing strategies can bring persistent change in one's attitude that further reinforces behavioural change (Loeber and Farrington, 1998).

A good illustration of how important a credible regulatory enforcement is in times of a disruptive change is the theory developed by Paul Krugman (Krugman, 1991). In short, he acknowledges the fact that the market will start acting differently after a change in the exchange rate regime only if the regulatory authority will be credible and consistent in enforcing the new rules. Thus, the same as in the taxi driver example, the existence of a credible enforcement by the regulatory authority will reinforce permanent change in the behaviour.

Essentially, a change in the liability valuation method from BV to MTM is identical to a change in an exchange rate regime from a free float to a target zone – it is a disruptive change that asks for a behavioural response if one wants to successfully survive under the new regime. Just as the central bank needs to ensure that the exchange rate dynamics will adjust to the target zone, the pension regulator has to make sure that the behaviour of pension managers will adjust to the MTM requirements.

Hence, there are certainly lessons to be grasped from the Krugman exchange rate target zone model when addressing the switching from book liability valuation regulatory framework to mark-to-market valuation framework. However, to fully understand these lessons one has to clearly understand the logics and the main idea behind the Krugman model. Furthermore, we the theoretical framework of the exchange rate target zone model will be addressed and explained.

4.1 Krugman exchange rate target zone model

4.1.1 Theoretical framework

Following Krugman continuous time model the log exchange rate at time t (s_t) depends linearly on an aggregate economic fundamental at time t (f_t) and the instantaneous expected exchange rate depreciation rate $\left(\frac{E_t[ds_t]}{dt}\right)$:

$$s_t = f_t + \alpha \frac{E_t[ds_t]}{dt}. \tag{1}$$

In the equation (1) α is a positive constant representing the elasticity of the exchange rate to its expected future changes.

Further, the fundamental consists of two components, namely, the log of velocity (v_t) and the log of money supply control (m_t):

$$f_t = v_t + m_t. \tag{2}$$

The first component – velocity - is assumed to be an exogenous variable, i.e., it is assumed to be a non-controllable financial shock that affect movements of the exchange rate. The second component - money supply control – is a control variable and is subject to central bank's intervention. By changing the aggregate fundamental through m_t, i.e., decreasing or increasing the money supply, the central bank is able to control the dynamics of an exchange rate as it will respond to the monetary behaviour by appreciating or depreciating.

If there is a freely floating exchange rate, i.e., there is no specific currency band, the central bank does not intervene in the money supply and thus the control variable m_t is zero. Hence, the exchange rate is influenced only by the exogenous, non-controllable variable v_t.

In the presence of a target zone, the central bank controls the money supply in order to hold the exchange rate within a specific band, for instance,$\mp$2,5:

$$s^l \leq s_t \leq s^u, \tag{3}$$

where s^l is the lower boundary value and s^u is the upper boundary value. If the exchange rate reaches the upper or the lower edge, the central bank intervenes by either decreasing or increasing the money supply.

Furthermore, the Krugman model is based on two crucial assumptions:

i. The target zone is perfectly credible, i.e., agents expect that when the exchange rate lies near one of the boundaries, the central bank will intervene and drift the exchange rate back in the band. The exchange rate is expected to stay within the boundaries forever.

ii. The central bank defends the exchange rate by “marginal” interventions only, i.e., as long as the exchange rate lies in between the band, the money supply remains unchanged.

To find an explicit solution for the Krugman model, we also need to specify the stochastic process for the exogenous component – velocity. This component is assumed to follow a continuous time random walk:

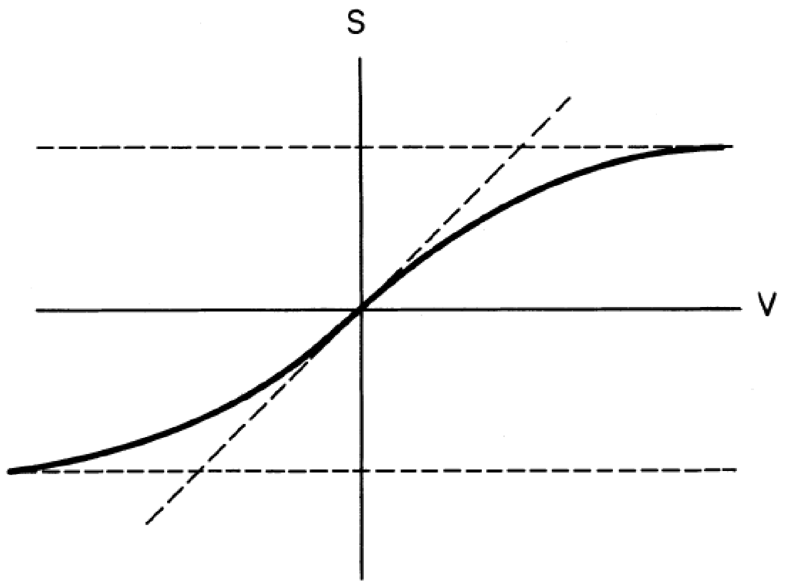
$$dv = \sigma dz \tag{4}$$

One might expect that in between the band since money supply is held constant and the velocity term follows a random walk, there would be no expected change in the exchange rate, i.e., $\frac{E_t[ds_t]}{dt} = 0$. However, due to the perfect credibility assumption, agents are anticipating the intervention of the central bank at, or near, the edges of the target zone. Consequently, already inside of the zone the expected change of the exchange rate is no longer zero but is negative (positive) as the exchange rate approaches the upper (lower) edge of the band. This anticipated intervention appreciates (depreciates) the exchange rate even before the actual central bank’s intervention takes place.

In other words, as the expectations enter equation (1), the target zone creates nonlinearity between the exchange rate and the velocity. Instead of a straight line, the relationship between s and v must be bent, creating a smooth S-curve (Figure 1). Krugman (1991) refers to it as the ‘honeymoon effect’.

Figure 1:

Relationship between the velocity and the exchange rate. The velocity is measured on the x-axis; the exchange rate is measured along the y-axis. We can observe that in a case of a free floating exchange rate, the fundamental equals the exchange rate (dashed line); however, in a case of a target zone, the relationship can be modelled as an S-shaped curve (solid line).



Source: Krugman P.R. (1991)

Another important application of Krugman model is the "smooth pasting" condition, i.e., the exchange rate will spend more time at the boundaries of the target zone than in the other areas of the zone. The intuition behind it is as follows: if the market is experiencing a series of positive (negative) shocks to v, the exchange rate will start to depreciate (appreciate). When the upper (lower) boundary of the target zone will be reached, the central bank will step in and any further increase (decrease) in v will be offset by decreasing (increasing) the money supply. The interventions will take place as long as there will be any positive (negative) shocks and will stop when a negative (positive) shock to v will take place driving the exchange rate back in the band (see Appendix A for more explicit algebraic analysis).

4.1.2 Imperfect Credibility

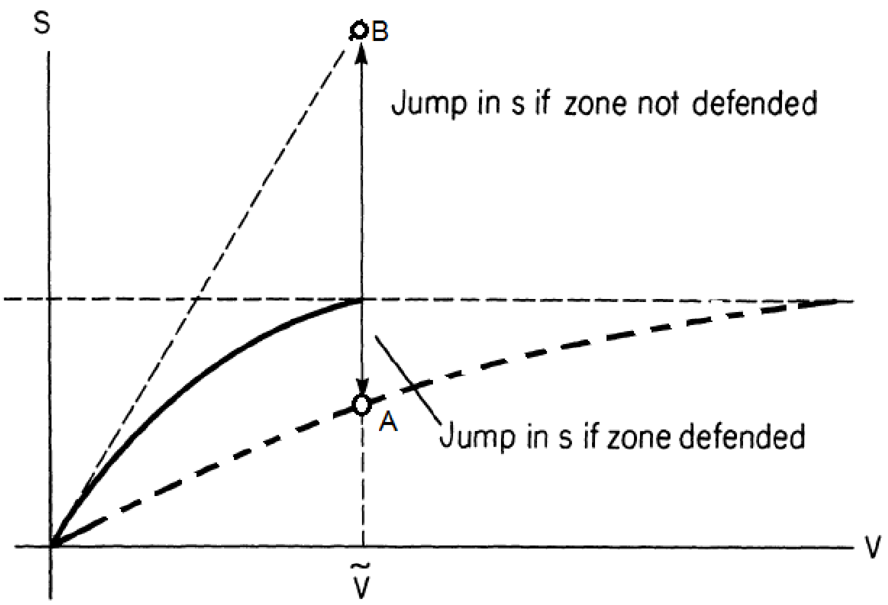
The analysis showed the dynamics of the exchange rate inside a target zone with a perfectly credible central bank's commitment to defend the zone. By relaxing this assumption and allowing for imperfect credibility the model provide some interesting implications.

Previously we assumed that agents believe that the target zone will be defended and the exchange rate will stay in the band forever. As a result, the probability of the central bank intervention at the edges was assumed to be 1. However, as we relax the credibility assumption we also have to change the perceived probabilities. Hence, a probability ϕ $(0 < \phi < 1)$ is assigned to the likelihood that the target zone will be defended and a probability $1 - \phi$ that it will be not.

In a situation where market starts experiencing series of positive (negative) shocks to v, the central bank is supposed to step in when the upper (lower) boundary value of the target zone is reached in order to prevent the exchange rate depreciating any further. If the zone turns out to be credible and the central bank defends its currency the exchange rate will jump to its full credibility value at point A. If, however, the zone turns out not to be credible, the exchange rate will start following a free float by jumping to point B (Figure 2).

Figure 2:

Imperfect credibility exchange rate behaviour at the upper edge of the target zone. Velocity is measured on the x-axis; the exchange rate is measured along the y-axis. Solid line represents the imperfect credibility exchange rate. Thin dotted line shows the free float exchange rate. The thick dotted line represents the full-credibility rate.



Source: Krugman P.R. (1991)

One can observe that the imperfect credibility exchange rate is less stabilizing than the full credibility exchange rate inside the zone. This arises from the fact that agent expectations have changed. As they no longer anticipate central bank's intervention with probability of 1 but rather with a probability ϕ (<1), the exchange rate becomes the weighted average of a perfectly credible target zone rate and a free float rate. In other words, agents' perceptions towards authority's commitment play a crucial role in determining the strengths of the exchange rate stabilizing effect ('honey moon effect') in the zone. As α approaches 1, the imperfect credibility exchange rate's behaviour will approach the full-credibility rate. Oppositely, for smaller ϕ, i.e., closer to zero, the behaviour will be better reflected by a free float rate and the curvature of the S-shaped curve will be reduced bringing it closer to the 45-degree line.

Historically imperfect credibility has been associated with speculative attacks. When George Soros sold short more than $10billion in pounds on September 16, 1992, he and other investors folloeing his position was placing a direct speculative bet against the credibility of Bank of England. As he was forward looking and anticipated that the bank will not be able to defend the announced target zone, he speculated on the depreciation of the pound and eventually forced UK to exit the European Exchange Rate Mechanism (ERM) and return to a floating currency (Lien, 2008).

We learned from history that it can take years to build up credibility but it can be lost over night as it happened with Bank of England. Nevertheless, once the credibility has been lost it is very hard and costly to try to recapture the lost innocence of a target zone (Obstfeld and Rogoff, 1995).

Conclusion

In sum, The Krugman target zone model reveals that a credible commitment by the central bank to defend the announced target zone induces a stabilizing effect on the exchange rate variation already within a band. This in turn ensures that the exchange rate stays in the target zone forever. As the commitment of the bank becomes less credible, the exchange rate loses its stabilizing property and starts reflecting the behaviour under the old free float regime.

Parallels can be draw with the pension industry offering guaranteed pensions. Just as in the target zone theory, one could expect that anticipated regulatory intervention would induce a significant behavioural change among guaranteed pension providers. It seems plausible that if the regulator is fully credible, i.e. would practice a harsh punishment in case of insolvency, a provider of guaranteed pensions would do everything to stay above the minimum solvency requirements. As a consequence, managers of guaranteed pension solutions would change their old behaviour and adjust their investment approach to the one appropriate under MTM framework. That way they would ensure that they never would become insolvent. In analogy to the target zone approach, we would expect that if the regulator is not fully credible, pension managers' behaviour would not change along with a change in the regime and even under the new MTM framework would be better described by the one appropriate under the old BV framework. In other words they would bet against the regulator not defining the MTM framework.

The lesson we can take from the Krugman exchange rate target zone model is that imposing a new regulatory regime makes sense only if the regulatory authority is able to commit and be persistent in imposing the new rules.

Chapter 5

Hypothesis and research approach

We are at the very beginning of time for the human race.
It is not unreasonable that we grapple with problems.
But there are tens of thousands of years in the future.
Our responsibility is to do what we can, learn what we can,
improve the solutions, and pass them on.

~ Richard Feynman ~

Up until now we have been trying to come closer to answering the research question proposed at the beginning of this thesis: *Does the move from BV to MTM valuation method for pension liabilities influence the behaviour of guaranteed pension providers such as pension funds and insurance companies?* In order to answer that question we have investigated the problem for two completely different perspectives – economical and behavioural.

As we discussed throughout this thesis a move from BV framework to MTM framework fundamentally changes the rules of the game and asks for a change in the behaviour of guaranteed pension providers. Nevertheless, academic literature claims that if there is no pressure this behavioural change may not be self-evident. It is rational for agents to stick to the familiar ways of doing things of the following reasons:

i) Behavioural – it is difficult to adjust the behaviour
ii) Organizational – reorganization takes time and effort
iii) Economical – cannibalizing of the existing revenue streams is uncomfortable and unpleasant

Taking into consideration these aspects that a move from BV to MTM implies, one has to comprehend that imposing a new regulatory regime is not a standalone concern for the pension regulator. A far more important concern is to what extent the regulator is able to enforce its regulations onto the organisations providing guaranteed pensions. The regulator must be aware of the important role it has in this process. Inspired by the main lore of Krugman exchange rate target zone model we expect that imposing the MTM regulatory regime will make sense and will induce a difference if and only if the regulatory authority will be able to commit and be persistent in imposing the new rules.

Consequently, the hypothesis of this thesis is:

- ⇨ 1) A new regulatory framework without a credible enforcement will not change the behaviour of the industry.

There exist two major regulatory enforcement levels implemented by pension regulators across the world. While in some countries guaranteed pension providers are subject to firm regulatory enforcement, others are exposed to somewhat softer regulatory philosophies. According to our hypothesis, it is expected that the behavioural change of pension managers, following a switch from BV to MTM, will explicitly depend on the regulator's credibility and the ability to enforce the new rules. It is expected that pension managers that are exposed to soft regulations will not change their behaviour along with a switch to the MTM regulatory framework.

In order to test our hypothesis, this thesis will firstly develop a theoretical framework for a Solvency model based on the core principles of the Krugman exchange rate target zone model. Further, the findings will be illustrated by studying regulatory approaches of the top countries according to the Mercer pension index[10] that has moved to MTM framework (Table 2).

Table 2:

Country	Liability valuation method	Enforcement by the regulator
Sweden, Denmark[11]	Mark-to-market	Firm
The Netherlands	Mark-to-market	Soft

As the Table 2 indicates these three countries illustrates separate practices. On the one side there is the Netherlands and on the other there is Sweden and Denmark. These three countries have already moved towards market based liability approach thus have the same MTM

[10] http://www.mercer.com/articles/global-pension-index#What

[11] Although Denmark has not been included in the Melbourne Mercer Global Index 2011, it will be added in 2012 report and is expected to rank among the top pension systems in the world.

regulatory framework and also similar solvency rules. However, when we look at how strictly these rules are imposed onto guaranteed pension providers, two different approaches emerge. While pension regulators in Sweden and Denmark have set up tight supervision practice and impose a hard punishment for breaking the solvency rules, the regulatory authority in the Netherlands allow for more flexible recognition of the actuarial losses if a pension provider does not meet the necessary requirements.

If our hypothesis proves to be right we will observe that after the introduction of MMT framework pension managers in Sweden and Denmark showed a different behavioural response than pension managers in the Netherlands. The main reason for that - differences in the regulatory enforcement levels.

Chapter 6
The Solvency model

Learn all you can from the mistakes of others.
You won't have time to make them all yourself.

~ Alfred Sheinwold ~

Inspired by the standard Krugman target zone model, we will construct a simple theoretical model that will be capable of predicting the relationship between the solvency risk level of an organization offering guaranteed pensions and its solvency ratio under the MTM regulatory framework. In this thesis we refer to this model as ‘the Solvency model’. As it was mentioned in Chapter 2, under MTM framework a guaranteed pension provider is required to manage its solvency risk level in line with its risk taking capacity to assure that it will not become insolvent over time. Adopting the same reasoning as under the Krugman model, it is expected that the regulators success in enforcing pension providers to act in that way will explicitly depend on his/her credibility. If guaranteed pension providers believe in regulators credibility they will adjust their investment and risk management in line with MTM requirements.

Firstly, we will lay out the basic theoretical framework of the Solvency model. This will uncover the intuition of the fundamental similarities between the Krugman model and the Solvency model. Later under model parameterization we will derive an explicit solution of how to model the theoretical relationship between the solvency risk level of a guaranteed pension provider and its solvency ratio. Finally, we will cover the limitations of this model.

6.1 Theoretical framework

Firstly, we express the solvency risk level (SRL) as an explicit function of the solvency ratio:

$$SRL = f(solvency), \tag{5}$$

where solvency is defined as the ratio between assets and liabilities and is a function of an interest rate and an investment return. The solvency ratio essentially shows to what extent an organization providing guaranteed pensions can meet its pension obligations, the so called liabilities.

Do to the difficulty to find data in the market, in the Solvency model we decided to use the required coverage ratio as a measure of the solvency risk level. The required coverage ratio is a minimum solvency ratio that a pension fund or an insurance company should have given the riskiness of its portfolio. It contains a surplus which is sufficient to absorb certain economic shocks. Hence, by having this surplus a guaranteed pension provider can avoid having its solvency ratio of less than 100 per cent after experiencing potential adverse events. The required coverage ratio is individual and depends on the specific risk exposures and the investment policy of the organization. Riskier investment policy asks for higher surplus, hence, leads to higher required coverage ratio.

The value of the required coverage ratio tells us to how much solvency risk a pension fund or an insurance company is exposed to. For example, the required coverage ratio of 125% means that, a pension fund or an insurance company has 25% chance of having its solvency ratio being less than 100% in one year time (solvency risk level is 25%). However, the required coverage ratio of 110% means that the risk exposures are such that the chance of becoming insolvent is only 10% (solvency risk level is 10%). If the required coverage ratio is 100%, it means that there is no probability of becoming insolvent (solvency risk level is 0%). As we have mentioned in Chapter 2, a guaranteed pension provider can reduce risk exposure in two ways - either by closing the duration gap between its assets and liabilities or by selling its risky assets.

In our model, the lowest possible solvency risk level is zero and the highest (carrying capacity) is normalized to one. Hence, the solvency risk level is constrained by the minimum and maximum levels (See Figure 3):

$$0 = SRL_{min} \leq SRL_t \leq SRL_{max} = SRL_{risk\ limit} = 1. \tag{6}$$

Values of the solvency risk level are, as already mentioned, in reality the probability of becoming insolvent in one year time. The maximum solvency risk level is the risk limit that a guaranteed pension provider is willing to accept. Ultimately it depends on the risk appetite of the trustees. The maximum level, should normally be reached when a guaranteed pension provider is already highly solvent. At such point in time, an increase in solvency is not needed anymore and therefore additional risk taking does not pay-off. For example, if the risk limit for an guaranteed pension provider is reached with a portfolio containing asset mix of 50% stock

and 50% bonds with 5 year duration, its maximum solvency risk level will be 27% (required coverage ratio will be 127%) (Houben, 2008).
Secondly, the evolution of a solvency ratio is constrained by minimum and maximum solvency requirements:

$$100\% = solvency_{min} \leq solvency_t \leq solvency_{max} = 200\% \tag{7}$$

Theoretically the maximum solvency ratio can be infinitely large, however, in order to keep our model simple and more realistic, we assume that above 200% solvency a guaranteed pension provider has reached its maximum solvency risk level, and therefore, it becomes irrelevant for our further analysis (See Figure 3).

In the case when the regulator is fully credible a guaranteed pension provider will manage its solvency risk level such that when being at the $solvency_{min}$ it will not be exposed to any risk (will have its required coverage ratio of 100%), while at the highest boundary of the solvency, i.e., at $solvency_{max}$, it will bear the maximum level of risk. In that way a pension fund or an insurance company will always bear appropriate risk level in line with its risk taking capacity. In other words, it will bear more solvency risk (its required coverage ratio will be higher) if it is in a good financial shape and virtually no solvency risk (its required coverage ratio will be 100%) when at the minimum allowed solvency ratio. Thus, the two following conditions must hold (See Figure 3):

$$f(solvency_{min}) = SRL_{min} \text{ and } f(solvency_{max}) = SRL_{max} \tag{8}$$

As we use the target zone approach in order to assess the relationship between the solvency risk level and the solvency ratio, we will adopt two crucial assumptions of Krugman model to our Solvency model:

i. Under MTM framework, the regulator is perfectly credible, i.e., managers of pension funds and insurance companies expect that in a challenging economic environment (low interest rates and/or low investment returns) where the solvency ratio is pushed towards the minimum 100% boundary, the regulator will be strict and consistent at all times. Thus, guaranteed pension providers with a solvency ratio below 100% will be subject to an immediate regulator’s order to take the right measures. If the minimum solvency requirements have not been met, in order to restore a decent solvency ratio, a pension fund has to increase contributions or decrease the benefits but an insurance company has to inject an extra capital. No reliefs of the solvency requirements will be allowed.

Thus, in case of insolvency the regulator will intervene in order push back the solvency ratio in the allowed boundaries. Drawing parallels with the Krugman model, the regulator will act similarly to the central bank which intervenes in the money market when the exchange rate has reached one of the target zone boundaries. By intervening, the same as the pension regulator, the central bank controls the evolution of the exchange rate and forbids it to go out of the target zone boundaries.

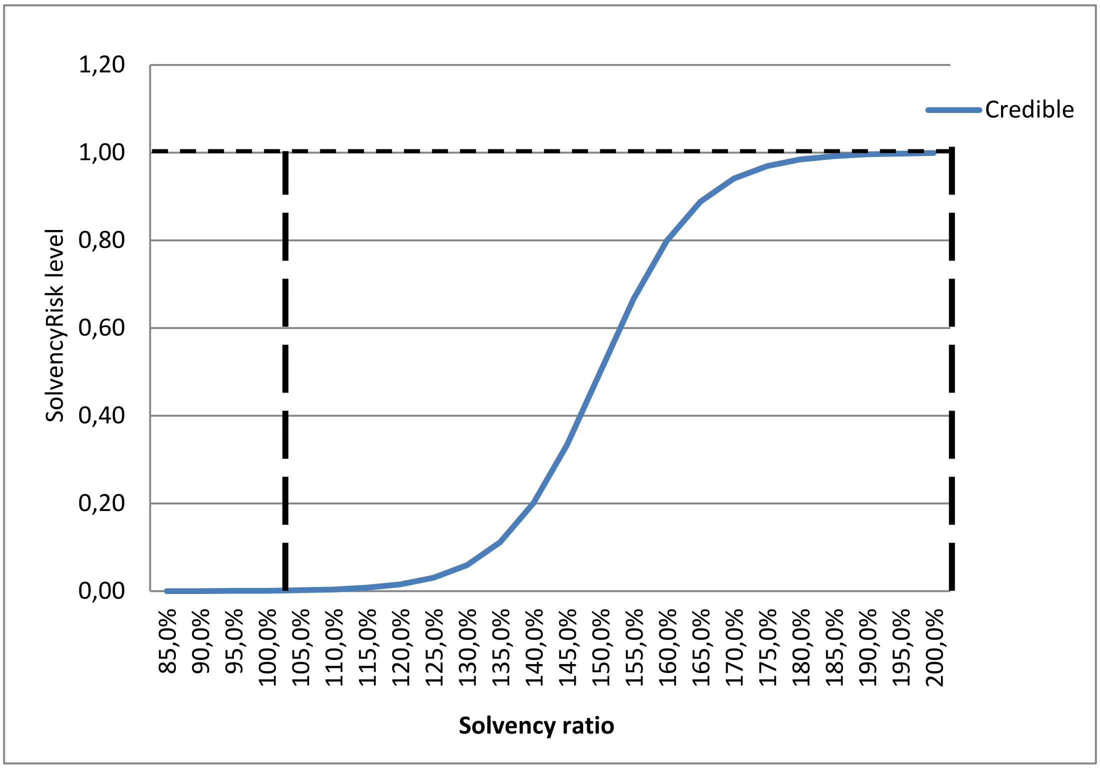
ii. The regulator imposes a penalty only at the lower margin. As long as a pension fund or insurance company is above the minimum solvency ratio no intervention by the regulator occurs. Hence, as in the Krugman model, we assume marginal intervention only.

Further we will consider how the relationship between the solvency risk level and the solvency ratio will evolve under MTM regulatory framework with a perfectly credible regulator.

As in the Krugman target zone model, pension managers' expectations about the regulators intervention play a crucial role. Previously we saw, that due to an anticipated central bank's intervention in the exchange rate market, a stabilizing exchange rate effect is reached already inside the target zone. Likewise, we would expect that an anticipated regulatory intervention in case of insolvency would change the behaviour of a pension organization offering guaranteed pensions and be reflected in its investment strategy and risk management. This means that they would optimize their investment strategy by taking into the interest sensitivity of the underlying pension liabilities into account. It also means that they would manage the tail risk carefully and make sure that when being at the lowest boundary of the solvency requirements it would not be exposed to any risk of going insolvent, i.e., its required coverage ratio would be 100% (equation 8).

Thus, we assume that under perfect credibility where positive expectations about regulator's intervention enter into the decision making process regarding the solvency risk management. This creates a smooth S-shaped like relationship between the solvency ratio and the solvency risk level (see Figure 3). This can be compared with the honeymoon effect in the Krugman model.

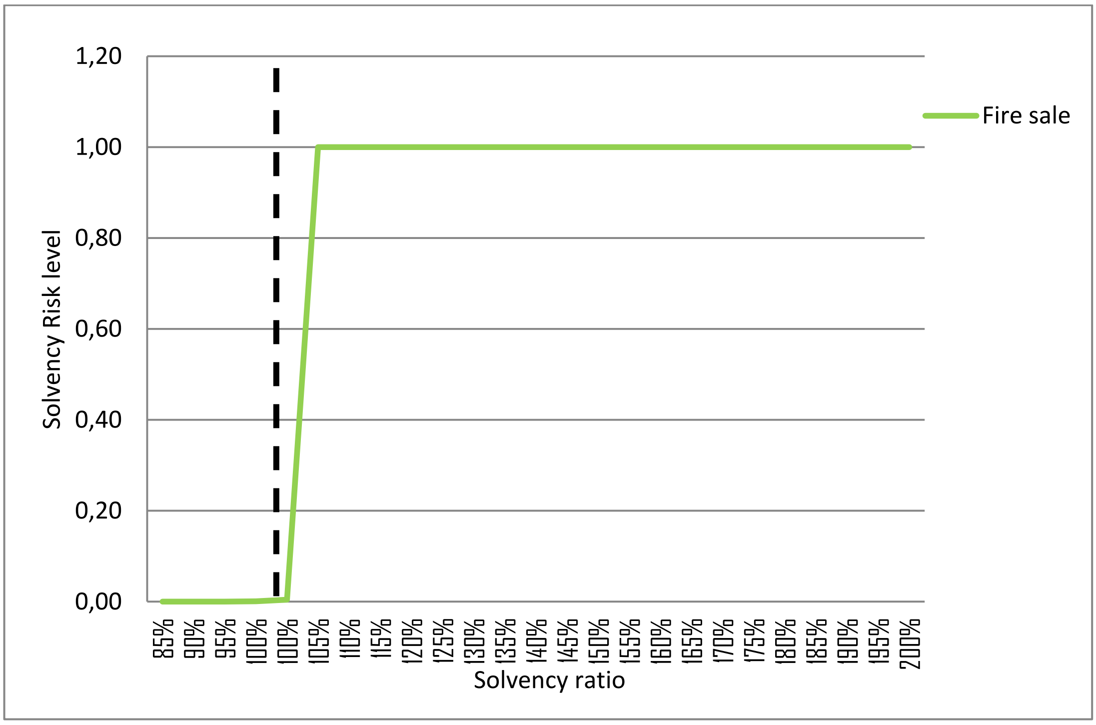
Figure 3:



To argue that this is the case, we will view what happens if a pension fund or an insurance company does not manage its solvency risk responsibly although the regulator is credible. Consider a situation where the solvency ratio of a guaranteed pension provider is decreasing due to some adverse conditions in the financial markets. However, pension managers decide to keep the solvency risk level at a very high level and not immunize liabilities. At each point there are always two possibilities of the solvency ratio to evolve in the future. Respectively, it either moves up or down. In a situation where the solvency ratio has become sufficiently low, say 105%, the credibility of the regulator plays a crucial role. If the solvency ratio goes up, a guaranteed pension provider will not experience any necessity to change its solvency risk level. However, if the solvency ratio is pushed down further, the situation will turn out to be unpleasant due to the regulators intervention.

As the regulator is credible, he/she will not allow a pension fund or an insurance company to be insolvent. A guaranteed pension provider knows that if it will go under 100% boundary it will be subject to certain sanctions. A pension fund will have to decrease benefits or increase contributions but the shareholder of an insurance company will have to inject extra capital or otherwise its licence will be taken away and its clients will be transferred to another company. None of this is desirable. The only way to eliminate the probability of going insolvent is to de-risk its portfolio by eliminating the risk exposure instantly (see Figure 4). A fire sale in a bad economic environment will turn out to be extremely costly and disadvantageous. Undoubtedly, pension managers will always try to avoid such a scenario. When pension managers anticipate that they will not be allowed to become insolvent, under any circumstances, they will plan ahead and de-risk their portfolio gradually as the solvency ratio decreases. Following such strategy will help pension managers to avoid a fire sale.

Figure 4:



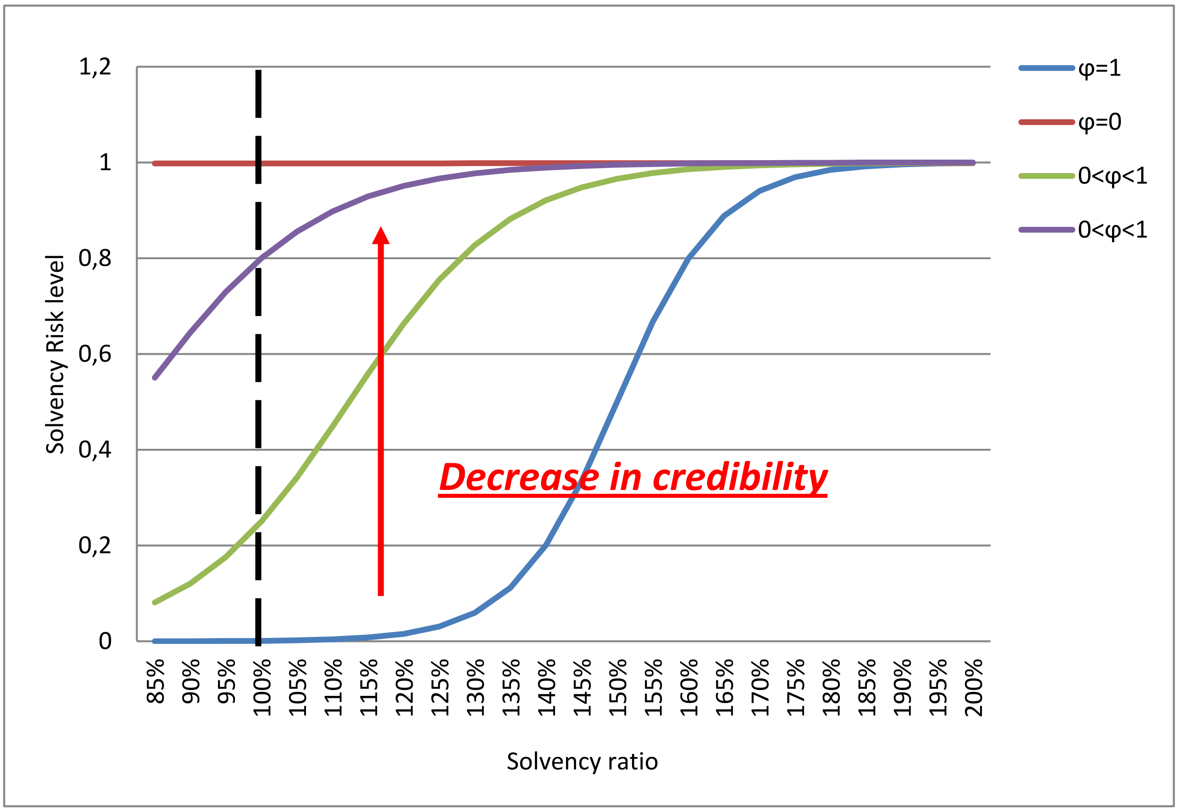
As in the Krugman analysis, we will remove the full credibility assumption in order to see how this influences the behaviour of the agents (managers of organizations providing guaranteed pensions). Assume now that the agents do not find the regulator fully credible. Hence, they allow for a possibility that in a scenario they go insolvent the regulator will bail them out by allowing for longer recovery periods or providing solvency reliefs.

Thus, in our model is means that an agent assigns a probability ϕ $(0 < \phi < 1)$ that the regulator is credible. If ϕ is equal to one the regulator is fully credible and will take actions to restore the solvency ratio immediately. The $1 - \phi$ then denotes the probability that the regulator will be flexible and will allow for a temporary insolvency.

When the solvency ratio starts decreasing due to an increase in value of liabilities or a decrease in value of assets, a provider of guaranteed pensions, is responsible for managing its solvency risk level in line with its solvency ratio under the MTM framework. Hence, the provider has to assure that it will not go insolvent even in the worst case scenario. If agents do not anticipate the regulator's intervention with a probability of 1 but rather with a probability of $\phi(< 1)$, they will not adjust their solvency risk level systematically in-line with a decrease in the solvency ratio. Instead they will keep high solvency risk level even when the solvency ratio is low. The lower the regulator's credibility is, the longer a provider of guaranteed pensions will keep a high solvency risk level. If ϕ is zero, i.e., the regulator lacks any credibility, a guaranteed pension provider will not care about managing its tail risk and hedging its liabilities. It knows that in case of going insolvent it will not have to face any severe consequences. Thus, their behaviour and investment approach will be the same us under BV framework rather that MTM framework.

As we can see in Figure 5, the lower the regulators credibility, the flatter the solvency function gets. The steepness of the function can be determined by performing estimation using data on the required coverage ratio and corresponding solvency ratio at certain point in time. In general, there are two factors that influence the shape of the function: solvency ratio at which a pension fund or an insurance company starts de-risking its portfolio and the speed it is doing it. The less credible the regulator, the later and slower de-risking takes place.

Figure 5:



6.2 Model parameterization

Further we will develop algebraic representation for our Solvency model in order to understand the dynamics of the relationship between solvency ratio and the solvency risk level (SRL). We assume that the regulator is credible and will impose an order on a guaranteed pension provider to restore its solvency ratio if it goes under 100%. Therefore, the basic idea that our model shares with the Krugman model is that with an existence of a credible regulator, the solvency function will evolve according to a smooth S-shape curve.

In order to model the S-shaped curve we will apply generalized logistic function which is known in the growth curve literature as Richards growth curve (Richards, 1959). We will assume a case with the function being symmetric, i.e., asymmetry parameter being one. Therefore the function will change monotonically with a symmetric change around μ.

The idea of using this approach comes from a paper written by Lundbergh & Terasvirta (2005) where the authors make use of generalized logistic functions to model the dynamics of the exchange rate behaviour. Their model is known as smooth transition autoregressive target zone (STARTZ) model.

The STARTZ model is used to empirically validate the Krugman model using nonlinear specifications of the conditional mean and variance depending on the position in the target zone. In other words, one can expect that the exchange rate inside the zone close to the centre of the target zone behaves as a random walk, however, when approaching one of the target zone edges, implies a tendency to move towards the central parity due to central bank's intervention. Moreover, it is assumed that the dynamics of conditional mean and variance are symmetric, i.e., the behaviour of the exchange rate is the same near both boundaries of the zone.

Following Lundbergh and Terasvirta (2005) we model the relationship between solvency risk level and the solvency ratio of a guaranteed pension provider using a generalized logistic function. The basic equation of the S-curve is the following:

$$f(t) = A + \frac{B-A}{1+e^{-a(t-\mu)}}, \tag{9}$$

where t is the transition (time) variable measured on x-axis. A is the lower asymptote, B is the upper asymptote. Parameters α and μ allows us to control for the speed and the timing of the growth of the function. Parameter a (> 0) is the growth rate, i.e., the slope of the curve, and μ is the location variable that controls for the time of the maximum growth.

Translating the parameters into our Solvency model we obtain that the transition variable (t) is the solvency ratio, lower asymptote (B) isSRL_{min} , while the upper asymptote (A) is SRL_{max} . Furthermore we normalize the values of SRL_{min} and SRL_{max} to zero and one, respectively. As a result, we can rewrite the function as follows:

$$f(solvency) = \frac{1}{1+\exp\left(-a(Solvency-\mu)\right)} \tag{10}$$

Remember that we can express SRL as an explicit function of the solvency ratio:

$$SRL = f(solvency), \tag{11}$$

and that the following conditions must hold under perfect credibility assumption:

$$f(solvency_{min}) = SRL_{min} \text{ and } f(solvency_{max}) = SRL_{max}. \tag{12}$$

Consequently, we obtain two transition functions:

$$\begin{aligned} SRL_{min} &= \frac{1}{1+\exp\left(-a(Solvency_{min}-\mu)\right)} \\ SRL_{max} &= \frac{1}{1+\exp\left(-a(Solvency_{max}-\mu)\right)} \end{aligned} \tag{13}$$

As our function implies a symmetric property, the function will behave the same at the neighbourhoods of both boundaries.

Furthermore, in order to fully determine the solution for the generalized logistic function we need to express parameters a and μ. The solution is straight forward and after simple transformations of equations under (13) we are left with a system of two linear equations with two unknowns:

$$\left\{\begin{aligned} -a(Solvency_{min}-\mu) &= ln\left(\frac{1}{SRL_{min}}-1\right) \\ -a(Solvency_{max}-\mu) &= ln\left(\frac{1}{SRL_{max}}-1\right) \end{aligned}\right\} \tag{14}$$

Solving for a and μ we obtain:

$$a = \frac{\ln\left(\frac{1}{SRL_{min}}-1\right)-\ln\left(\frac{1}{SRL_{max}}-1\right)}{Solvency_{max}-Solvency_{min}} \tag{15}$$

$$\mu = \frac{ln\left(\frac{1}{SRL_{min}}-1\right)}{a} + Solvency_{min} \tag{16}$$

Substituting equations (15) and (16) into equation (10) we obtain a formal solution that fully specifies the solvency function:

$f(Solvency) =$

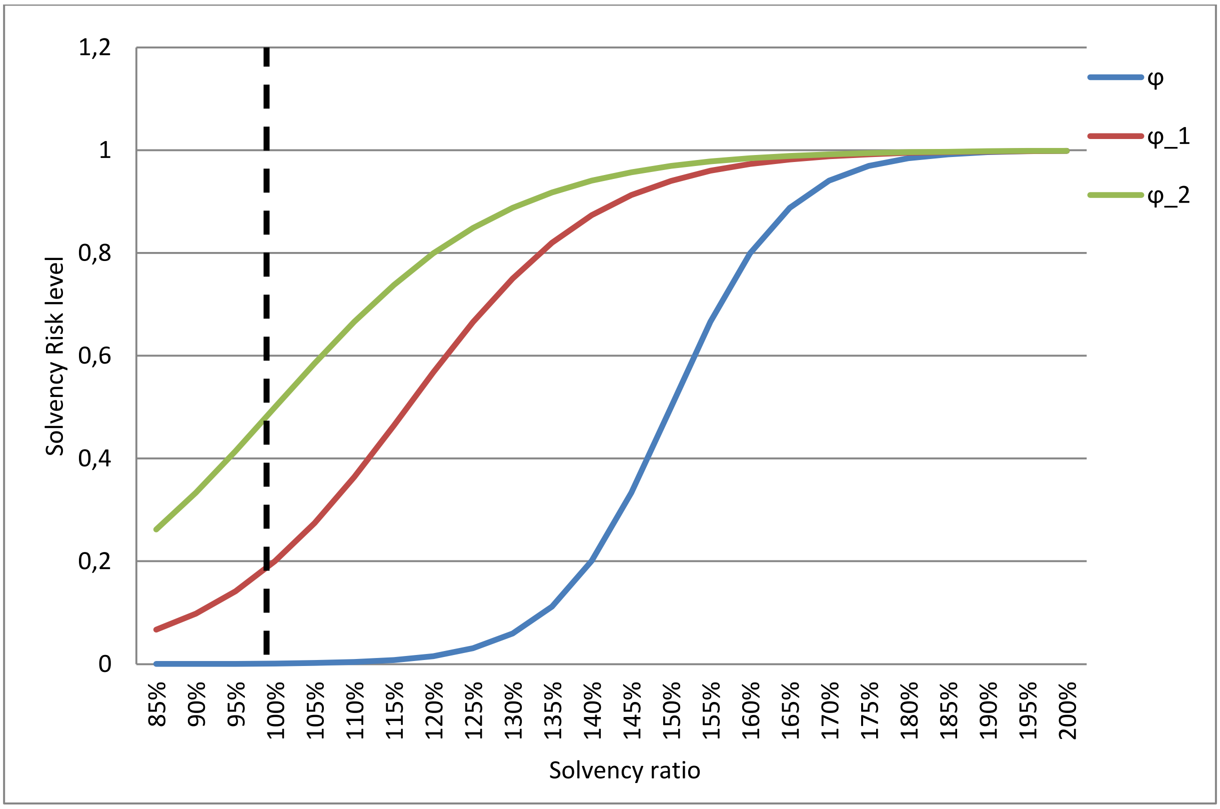
$$\frac{1}{1+exp\left[\left(-\frac{ln\left(\frac{1}{SRL\ min}-1\right)-ln\left(\frac{1}{SRL\ max}-1\right)}{Solvency\ max-Solvency\ min}\right)*\left(Solvency-\frac{ln\left(\frac{1}{SRL\ min}-1\right)}{\frac{ln\left(\frac{1}{Solvency\ min}-1\right)-ln\left(\frac{1}{Solvency\ max}-1\right)}{Solvency\ max-Solvency\ min}}+Solvency\ min\right)\right]} \quad (17)$$

Further, for better understanding we will illustrate how sensitive the model is to the values of a and μ(Figure 6).

Recall that in case of a perfect credibility a pension fund or an insurance company will manage its solvency risk level in a way to ensure that it will never go insolvent. Thus, it will always hold that $solvency_{min}(100\%) = SRL_{\min}(0)$. In case of an imperfect credibility this will not be the case, hence, $solvency_{min}(100\%) \neq SRL_{\min}(0)$.

1. ϕ = Perfect credibility : $f(solvency_{min}) = 0$ and $f(solvency_{max}) = 1$, we obtain values $a = 13.81$ and $\mu = 1.5$ (150% solvency ratio)
2. ϕ_1 =Imperfect credibility ($< \phi$): $f(solvency_{min}) = 0.2$ and $f(solvency_{max}) = 1$, we obtain values $a = 8.29$ and $\mu = 1.16$ (116% solvency ratio)
3. ϕ_2 = Imperfect credibility ($< \phi\_1$): $f(solvency_{min}) = 0.5$ and $f(solvency_{max}) = 1$, we obtain values $a = 6.90$ and $\mu = 1$ (100% solvency ratio)

Figure 6:



As we can see from the results, less credible the regulator gets, lower the values of parameters a and μ. This means that as the regulator loses credibility, the function flattens, as well as the timing of the maximum growth occurs closer to 100% solvency ratio. Generally speaking if the regulator is not fully credible a guaranteed pension provider will not manage its solvency risk level fully in line with the MTM framework. Hence, it will keep high solvency risk level even when the solvency ratio is low. The lower the regulator's credibility is, the longer a provider will keep a high solvency risk level. Recall that it is rational by the pension provider not to hedge the tail-risk since that will give better result in expectation.

6.3 Limitations of the model

Furthermore, it is essential to look at the limitations the Solvency model could encounter. Firstly, as the framework of the model is based on the ideas developed by Krugman (1991) it is wise to look at the main criticism directed towards the exchange rate target zone model and analyze if applicable for the Solvency model.

The strongest criticisms aimed at the Krugman model is that it assumes marginal interventions only. Empirical evidence has suggested that also intra-marginal intervention occurs and even more is not an exception but rather a rule (Dominguez and Kenen, 1992; Lindberg and Soderlind, 1995). This criticism could also be partially directed towards the Solvency model as we adopt the assumption of marginal intervention-only. It is plausible that the pension regulator intervenes earlier than just at the 100 per cent solvency boundary if it fears that a guaranteed pension provider might go insolvent any time soon or it sees that the other providers are getting into trouble. However, this will not affect the relationship between the solvency risk level and the solvency ratio significantly. If the regulator is credible, a pension fund or an insurance company will always adopt a responsible solvency risk management strategy thus its solvency will never be at risk and the regulator will not have any incentive to intervene intra-marginally. However, if the regulator is not credible, a guaranteed pension provider will not behave differently even if the regulator intervenes earlier. If it knows that the regulator will not fulfil its threat, intra-marginal intervention will not introduce any differences in behaviour.

It has to be highlighted that the aim of the Solvency model developed before is to analyze the behaviour of a relationship between the solvency risk level and the solvency ratio of a guaranteed pension provider only at a range where the pension fund or an insurance company is above 100 per cent solvency boundary. According to the model presented before, one would expect that if a pension fund or an insurance company goes under 100 per cent boundary it will continue decreasing its solvency risk level. However, in reality it will not always be the case. More realistically, as we discussed in Chapter 2, if a pension fund or an insurance company has encountered insolvency, but despite that does not want to increase contributions or decrease benefits, the only possibility for it to increase its solvency ratio and to recover is to uptake more solvency risk or at least stay in a constant level in a hope for higher future excess returns.

However this does not shake the core principle of the model. What we are interested in is how agents manage the solvency risk level while being fully solvent (solvency ratio 100%) and while having the ability to act. It predicts whether an agent sees the regulator as credible and hence manages its solvency risk responsibly or it does not follow appropriate MTM solvency risk management practices thereby signalling that it does not considers the regulator to be credible. When an organization providing guaranteed pensions has gone insolvent it has failed to do its homework thus what happens next and the possible ways of recovery is a completely separate discussion that has to be addressed in future research.

Conclusion

We have constructed a simple theoretical framework for a model that predicts a relationship between the solvency risk level and its actual solvency ratio for a guaranteed pension provider. It shows that expectations on whether the pension regulator is credible or not will have a large impact on behaviour. With a perfectly credible regulator pension managers will manage solvency risk level in line with solvency ratio. However, if pension managers consider that the regulator lacks credibility they will not incorporate the solvency risk into their investment decisions and consequently will be exposed to a large probability of becoming insolvent.

In sum, our model has recognized the importance of a strict and prudent regulatory enforcement in the pension industry. It has highlighted the fact that only with credible regulatory enforcement pension managers will change their behaviour and risk management practices when moving from BV regulatory framework to MTM framework.

Chapter 7
Comparative study

Notwithstanding the great diversity of policies
towards pensions around the world,
it is important that comparisons are made
and lessons are learned from the range of approaches.

~Dr David Knox, Senior Partner Mercer~

In this part of the thesis we will test how the finding of the model developed in Chapter 6 applies to three separate countries – the Netherlands, Denmark and Sweden. Firstly we will briefly discuss the regulatory enforcement and supervision in each of the countries and later by testing the implications of the Solvency model on the Netherlands and Sweden[12], we will draw some conclusions about our theoretical Solvency model and the accuracy of our hypothesis.

7.1 Regulatory enforcement and supervision

Pension systems in the Netherlands, Sweden and Denmark share somewhat common ground. Not just being regarded as the top pension systems in the world, they also have gone through some major regulatory regime changes during the last decade. One of the biggest and significant changes shared by guaranteed pension providers in all of these countries has been a move towards market based liability valuation approach (MTM). However, although all of the countries share similar strict regulations (i.e., solvency rules), the regulatory enforcement in the Netherlands differs substantially from that adopted in Sweden or Denmark. While pension regulators in Denmark and Sweden have set up tight solvency regulations accompanied by firm enforcement, the regulatory authorities in the Netherlands allow for more flexibility when it comes to enforcing the rules.

[12] As the pension supervisory practice in Sweden and Denmark are as much as the same, we will only use the data from Sweden to draw the conclusions about the accuracy of our hypothesis.

This difference is explained by the historical vehicle used to provide occupational pension. The Netherlands has installed industry wide pension funds where the collective ultimately provides the guarantee. In Scandinavia, similar pension product to the one in the Netherlands is offered by mutually owned insurance companies. Hence, mutual insurance companies in Scandinavia are comparable to the industry wide pension funds in the Netherlands. The main difference is that the mutual insurance companies are supervised under Solvency whereas the Dutch pension funds are supervised under IORP regulations[13].

7.1.1 The Netherlands

A major change in pension regulations in the Netherlands appeared in September 2002. Just after the millennium pension funds experienced a serious reduction in their solvency ratios due to the collapse of the stock market. In response to that the regulatory authority decided to tighten the regulations and issued a letter to pension funds. In this letter the supervisory framework was specified pointing out the necessary measures that had to be taken by pension funds in order to restore their solvency ratios. However, as a response to these strict requirements a wave of critic arose. It was claimed that the strict requirements will harm macro-economy and will induce a move towards DC pension schemes. Consequently the regulator somewhat relaxed the requirements (Ponds and van Riel, 2007). In addition, as a solution for the difficult solvency position, pension plans moved from final-pay scheme to average-pay scheme with conditional indexation applied to all participants[14].

Furthermore in early 2007, before the start of the economic turmoil, the new Financial Assessment Framework (FAF) was introduced. Besides adopting elements from the previously proposed regulations, FAF brought a major change along with it. The traditional actuarial liability valuation (BV) approach was replaced by fair valuation method (MTM). Moreover, the solvency test and continuity analysis were introduced as steering instruments. This meant that the pension funds had to rethink their risk management practices and investment decisions in order to control also for the short-term solvency tail risk as described in Chapter 2.

The three main requirements for the pension funds introduced starting from 2002 (Ponds and van Riel, 2007; Høj,2011):

[13] Orange Report 2010, Available at http://www.pensionsmyndigheten.se/download/18.2c8f793e1335aaf986a8000282786/OR+engelsk+20 (Acessed on 8.08.2012)

[14] http://www.ipe.com/magazine/policy-ladder-manages-risks-and-helps-funding_16473.php#.UCAUv_biaJo

- Pension funds that face solvency ratio that is below 105 per cent have to restore their solvency within one year. However, the recovery period was systematically increased after that. In 2007 the recovery period was extended to three years, the year after to five years.
- Pension funds that fall below 125 per cent solvency ratio have to present a recovery period with necessary adjustments for increasing the solvency ratio to at least 130 per cent in less than eight years. By 2004 and the new Principles on the Regulations of Financial Regulations of Pension funds the recovery period was extended to 15 years.
- Contribution rates had to be raised up to cost-covering levels.

The main underlying principle proposed by rules of FAF requires pension funds to hold sufficient solvency capital to ensure that the actual solvency ratio will not drop under 100 per cent with a probability of 97,5[15] per cent during a one year horizon.

The pension funds in the Netherlands, as well as most other large investors, got hurt by the falling asset prices following the economic downturn of 2007/2008. This in combination with falling interest rates, as the central banks flooded the market with liquidity trying to solve the crisis, created the perfect storm for the Dutch pension funds. As a result solvency ratios dropped towards historically all time low[16]. Responding to the financial crisis most of the pension funds suspended their inflation indexation, however only few increased their contributions. This was mainly explained by the extended recovery periods which allowed pension plans to rely on the suspended indexation as their main recovery strategy (Høj, 2011).

Recently, as of December 31st, 2011, the Dutch regulatory authority DNB decided to make corrections to the nominal interest rate structure as a 'response to the extraordinary economic conditions'. It is worth to note that DNB decided to base the calculations of the swap yield curve on a three-month moving average which consequently increased the discount rate pension funds could use for discounting their liabilities. Thus, essentially this policy helped pension funds to slightly recover their solvency ratios. Moreover DNB has declared its intentions to continue its policy until it becomes clear what consequences the main principles of FAF have on pension funds[17].

[15] In the life insurance industry and under Solvency II the equivalent confidence interval is 99, 5% (Maggid, 2010).
[16] In 2008 the avarage solvency ratio of total pension funds in the Netherlands was 96% (DNB, www.dnb.nl)
[17] www.dnb.nl

7.1.2 Denmark and Sweden

The bear market in the beginning of the century together with falling interest rates made it clear that the existing regulatory framework is not sustainable in the long run. Therefore, in July 2001 the Danish Financial Supervisory Authority (DFSA) introduced a new pension regulatory requirement that asked for mark-to-market valuation of liabilities. Furthermore, it also introduced stringent standards for risk management, transparency and risk assessment by introducing risk based supervision - the so called traffic light model.

In the following years, just as the regulator in Denmark, the supervisory authority in Sweden (SFSA) implemented the traffic light regime in order to assess the financial strengths and weaknesses of pension institutions. Risk based supervision was introduced in January 2006 followed by a mandated mark-to-market valuation in 2007 (Rocha et al., 2010).

The aim of the traffic light system is to ensure that pension providers hold sufficient amount of extra reserves that would allow them to cover possible adverse market developments. The stress test consists of two scenarios, i.e., the yellow light scenario and the red light scenario. When a mutual insurance companies has sufficient capital reserves it is considered to be in the green light zone (Andersen and Skjodt, 2007).

If a mutual insurance company is in the yellow zone, it gets more intensive supervision. Moreover it has to provide quarterly instead of biannual reports and has to go through more frequent on-site inspections. If a mutual insurance company has already reached the red light zone, the sanctions become much tighter and much more drastic. In that case the regulator may issue an enforcement notice that requires the pension provider to apply immediate remedial actions to bring the company to the green zone. Nevertheless, a mutual insurance companies has to provide monthly reports to the supervisor. Until it has addressed the identified deficiencies it is not allowed to bring in new contributions and the risk exposure cannot be increased and/or must be reduced.

Furthermore, in case of poor management of the management board there are several sanctions the regulatory authority is empowered to apply. The most powerful endorsements are a replacement of the board and a withdrawal of the insurance licence. Moreover, for repeated offences the police will be notified (Andersen and van Dam, 2008).

Considering the financial crisis of 2007, mutual insurance companies in Denmark and Sweden coped with the market collapse relatively well and quite quickly after the main storm managed to reach outstanding financial returns despite the stalling markets[18].
Nevertheless, due to the extraordinary market conditions in June 2012 the Swedish government decided to put a floor to the discount rates mutual insurance companies use for their liability valuation (Brenton, 2012). However mutual insurance companies were warned that this reprieve on liabilities is only temporary[19]. In June, 2012, following the Swedish example, the regulatory authority in Denmark decided to ease liability rules for guaranteed pension providers by slightly increasing the discount rate (Brenton, 2012; Wheatley, 2012). This was the first time the solvency requirements were relaxed in both Sweden and Denmark.

7.2 *Data and methodology*

Our empirical analysis is based on aggregated supervisory data on industry-wide pension funds in the Netherlands and mutual insurance companies in Sweden. We us aggregated data firstly because neither in Sweden nor in the Netherlands the pension regulator is eligible to provide data on individual insurance companies and pension funds, and secondly because we are ultimately interested in the average behaviour of the pension industry. All the data and information used is publically available and can be obtained from official annual reports and financial statements published on the official websites or available on the request from the regulatory authorities[20].

In order to asses and determine the relationship between the solvency risk level and the solvency ratio of a guaranteed pension provider we will use the estimated solvency ratios and the responding solvency risk measure (required coverage ratio). For the Netherlands we use annual observations and for Sweden biannual observations. The analysis will cover years 2007-2010 for the Netherlands and years 2008-2011 for Sweden.

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[18] M.Cobley (February 1, 2012), Danish pension fund makes record 26%return.
Available at http://www.efinancialnews.com/story/2012-02-01/atp-26-percent-return-2011, retrieved on April 13, 2012

[19] By Bloomberg, June 19 (2012) Available at
http://www.pionline.com/article/20120619/DAILYREG/120619886 (Accessed on 19.07.2012)

[20] The author thanks Malin Bjorkmo form Swedish FSA and Enrico Vroombout from DNB for providing the data and answering all the necessary questions.

The chosen time range of the data used for the analysis has a specific reason. For the Netherlands in 2007 the new Financial Assessment Framework was introduced. Thus, only since then funds were required to operate under mark-to-market regulatory framework. At this point in time (August 2012), it was not yet possible to obtain all the necessary data for year of 2011, therefore this year is excluded from the analysis. For Sweden, although MTM was introduced already in 2006, we got access to data only from 2008. Therefore, the data used for this analysis ranges from 2008-2011.

As mentioned, the two main components necessary for our analysis are the estimated solvency ratios and the responding solvency risk measure – the required coverage ratio.

As it was not possible to obtain ready data on the required coverage ratios and/or solvency ratios straight from the data provided by the regulators, we had to use certain data adjustments and extra calculations. Further we will explain the exact data we obtained and the exact extra calculations we did.

For Sweden we firstly had to calculate solvency ratios of mutual insurance companies for years 2008 -2011. In order to do that, we used the data we obtained from SFSA on the solvency margin, i.e., the amount by which an insurance company's capital exceeds its projected liabilities[21], and the capital base. We assumed that the solvency margin is approximately 4.5% of the technical reserves, i.e., the amount an insurance company sets aside from profits to cover claims[22]. Further, we used the obtained results to calculate the solvency ratios:

$$Solvency\ ratio = \frac{Capital\ base\ +\ Technical\ reserves}{Techical\ reserves}.$$

Furthermore, in order to calculate the required coverage ratios we used available data on the required capital base[23]:

$$Required\ coverage\ ratio = \frac{Required\ capital\ base\ + Technical\ reserves}{Technical\ reserves}$$

.

To calculate the required coverage ratios for the industry-wide pension funds in the Netherlands we used the end of year balance sheet at current value and data on the solvency

[21] Definition available at http://glossary.reuters.com/index.php/Solvency_Margin (Accessed on 9.08.2012)
[22] Definition available at http://moneyterms.co.uk/technicalreserves/ (Accessed on 9.08.2012)
[23] Special thanks to Swedish pension expert Marcus Karlsson from Nordic Specialist Finance who provided information on calculation methodology for the solvency ratios and the required coverage ratios for Swedish mutual insurance companies.

reserves held by pension funds at the end of the year. The solvency reserves are the buffers a pension fund is holding in order to absorb a specific shock in the financial market. The shocks are divided into six risk categories, distinguishing interest rate risk (S1), equity risk (S2), currency risk (S3), commodities risk (S4), credit risk (S5) and technical insurance risk (S6). Knowing the amount of the buffers we calculate the expected change in the assets (Δa) and the liabilities (Δl) under each of these risk categories which was necessary for the following calculations. Further, we followed the official methodology suggested by the Dutch Central Bank (see Appendix B)[24]. As the data on the solvency ratios was provided by the Dutch regulator, no extra calculations were necessary there.

Table 3 and Table 4 summarize the final data we use for our analysis for the Netherlands and Sweden, respectively.

Table 3:

This table covers annual data on the solvency ratios and the corresponding required coverage ratios for the Dutch industry-wide pension funds from year 2007-2010

Year	2007	2008	2009	2010
Solvency ratio	142.42%	92.60%	106.09%	104.66%
Required coverage ratio	114.00%	113.00%	114.00%	114.00%
Solvency risk level	14%	13%	14%	14%

Table 4:

This table covers biannual data on the solvency ratios and the corresponding required coverage ratios for the Swedish mutual insurance companies from December 2008 till December 2011.

Year/month	2008/12	2009/06	2009/12	2010/06	2010/12	2011/06	2011/12
Solvency ratio	136.79%	168.37%	173.67%	163.22%	182.52%	170.77%	143.13%
Required coverage ratio	119.83%	126.76%	130.48%	128.31%	133.19%	130.55%	120.53%
Solvency risk level	19.83%	26.76%	30.48%	28.31%	33.19%	30.55%	20.53%

[24] Special thanks to Hindrik Angerman from APG ALM department who provided information on the DNB official calculation methodology for the required coverage ratios for the Dutch pension funds.

7.3 Assumptions and estimation

Firstly we have to accentuate that we do not have enough historical data available to make a statistically significant analysis. The results presented here are only indicative illustration of the theoretical Solvency model developed in Chapter 6.

Also, as the data set is rather limited we are not able to observe how high is the required coverage ratio that responds to 200% solvency ratio for neither of the countries. This means that we are not able to determine precisely the maximum solvency risk level (SRL_{max}) neither for the Dutch industry wide pension funds nor for the Swedish insurance companies[25].Thus, in order to normalize the solvency risk level values to [0;1] we have to make the following assumptions:

1) SRL_{max} for the Netherlands is 14%
2) SRL_{max} for the Sweden is 33,19%

These values were chosen by taking the solvency risk level that corresponds to the highest solvency ratio reached by the Dutch industry-wide pension funds and the Swedish mutual insurance companies during the years 2007-2010 and 2008-2001, respectively (see Tables3 and Table 4). Hence, in general we assume that pension providers in the Netherlands do not increase the solvency risk level more than 14% but that pension providers in Sweden do not increase the solvency risk level more than 33.19%. Nevertheless, it was tested that by making these assumptions we do not change the shape of the solvency function hence the relationship between the solvency ratio and the solvency risk level.

To estimate the solvency function for the Netherlands and Sweden we use *Excel* solver to obtain the values of the parameters a and μ by applying the formula under equation (17). For the Netherlands the following values emerge –$a = 33.29$ and $\mu = 0.85$ while for Sweden the estimated values are $a = 5.45$ and $\mu = 1.31$.

[25] As we recall from the Solvency model, it is assumed that a pension fund or an insurance company has definatelly reached the maximum level of solvency risk when its solvency ratio is 200% (the upper limit of the solvency ratio in the Solvency model):

$$f(solvency_{max}) = SRL_{max}$$

As neither the Dutch pension funds nor the Swedish insurance companies have had solvency of 200% during years 2007-2010 and 2008-2011, respectively, it is not possible to observe the solvency risk level that would correspond to 200% solvency ratio.

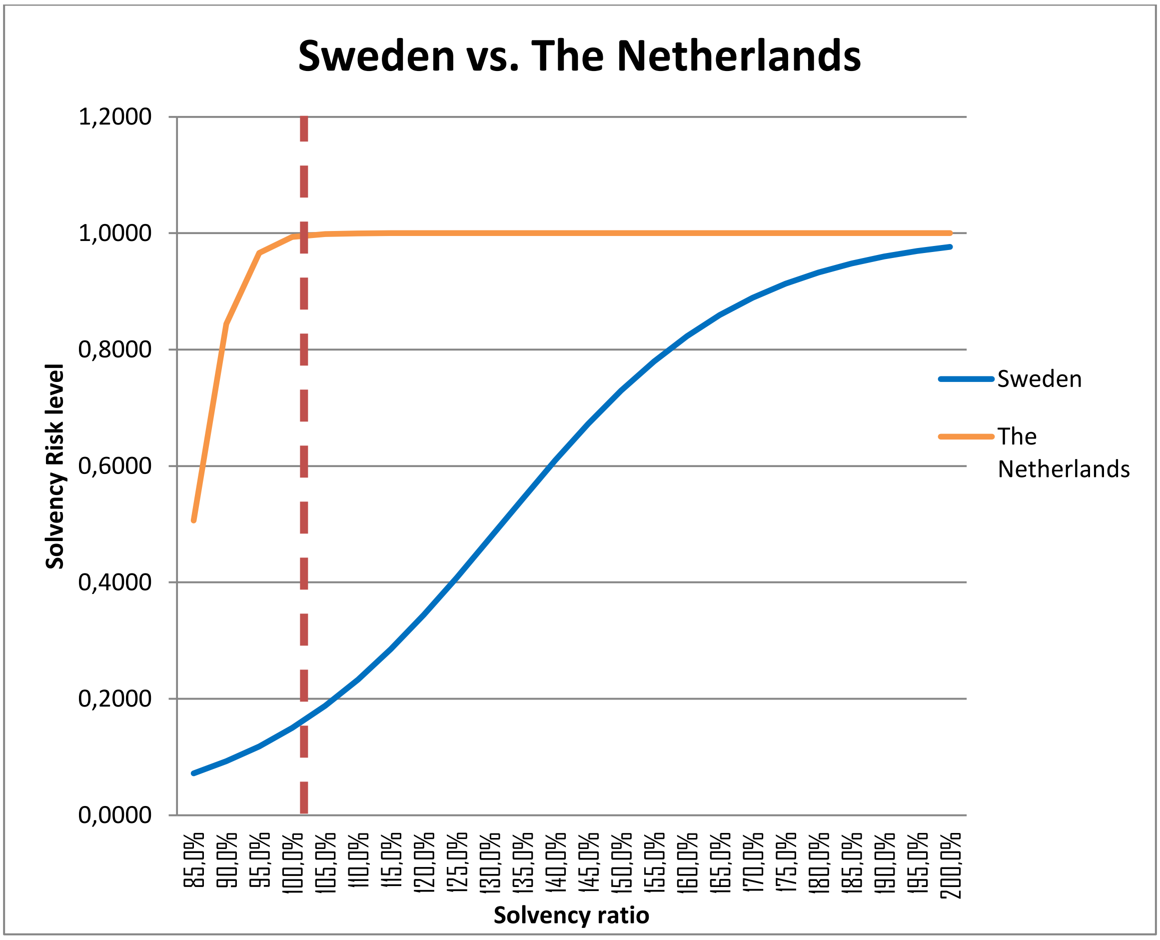
For The Netherlands, as we can already see from the data presented in Table 3, industry wide pension funds do not reduce their solvency risk level in line with a decrease in the solvency ratio. Naturally, this reflects in the estimated results - the location parameter μ is very low – only 0.85 (maximum growth of the function occurs only at 85% solvency ratio) but the growth parameter a is very high indicating that industry wide pension funds in the Netherlands de-risk their portfolio very rapidly however de-risking occurs only below 100% solvency.

From the data in Table 4 we can already see that the relationship between the solvency risk level and the solvency ratio of Swedish mutual insurance companies is significantly different from the one of the Dutch industry-wide pension funds. For Sweden the growth parameter a is lower than one for the Netherlands indicating a flatter shape of the solvency function. But the location parameter μ, on the other side, is significantly higher. This implies that the maximum growth of the Swedish solvency function occurs at considerably higher solvency – 131%. Thus, as it could already be observed from the data presented in Table 4, these results induce us to conclude that mutual insurance companies in Sweden start de-risking their portfolio timely and do it gradually unlike industry-wide pension funds in the Netherlands.

7.4 Empirical results and conclusions

Figure 7 presents the estimated solvency functions for the Netherlands and Sweden. As we can see the estimated relationship between the solvency risk level and the solvency ratio for Swedish mutual insurance companies clearly evidences the predicted smooth S-shaped curve. The estimated relationship for the Dutch industry-wide pension funds presents a different picture. The solvency function is represented by a straight line that only starts decreasing below the solvency ratio of 100%.

Figure 7:



These results indicate the following – firstly, pension managers in the Netherlands do not adjust their solvency risk level in line with the solvency ratio of their fund. Thus, they do not incorporate their risk taking capacity into their chosen investment strategies as it is required under MTM framework. This eventually could lead to insolvency. Secondly, pension managers in Sweden are explicitly taking their risk tolerance into account when choosing the asset mix for their portfolio. We can see that mutual insurance companies are decreasing the solvency risk level along with a decrease in the solvency ratio. Nevertheless, according to our estimation, they are de-risking somewhat too slow to rule out the possibility of insolvency completely.

Importantly, one has to note the limitations of the model described in Chapter 6. As it was discussed the model is not able to predict the relationship between the solvency risk level and the solvency ratio when a pension fund or an insurance company has gone insolvent. Therefore, it is very unlikely that pension providers in the Netherlands or Sweden would still keep decreasing the solvency risk level when being below 100% solvency as it is predicted by the model and visible in Figure 7.

Furthermore, we can draw the main conclusions about the credibility of the regulator. Referring back to the Figure 5, we know that a flatter solvency function indicates a decrease in the credibility. Hence, the results obtained in our analysis indicate that the pension regulator in Sweden is considered much more credible than the pension regulator in the Netherlands. In comparison, the Dutch regulator seems to lack credibility while Swedish regulator is close to being fully credible.

Returning to the hypothesis posted at the beginning of this thesis, it is now possible to state that a new regulatory framework will not change the behaviour of the pension industry without a strict and credible regulatory enforcement. Findings of our empirical analysis have proved that under MTM framework firm regulatory enforcement practiced in Scandinavian countries indeed has created a focused and ambitious approach to balance sheet risk management.

Chapter 8

Policy implications and recommendations

There is no question that moving from BV to MTM framework is challenging for organizations providing pension guarantees as it asks for restructuring of business operations and strategic de-emphasis. As a consequence, many organizations providing pension guarantees have been put under pressure which has triggered a trend moving towards defined contribution pension saving schemes.

In the last decade it has become clear that the current guarantees are unfortunately too good to be true. The problem with the current products is that they were designed to operate under the BV environment, hence, are simply not efficient under a MTM framework. Under MTM they are too expensive to maintain because all risks end up on the balance sheet and there is no such a thing as a free lunch anymore. As a consequence, pension funds and insurance companies need to adjust the current products design and pricing in order to reflect the changes in the regulatory environment.

Furthermore, the transition phase from BV to MTM is difficult implement due to the limited depth of the long-dated bond market. But as for most markets when the demand increases it is likely that the supply will increase over time. However, in the mean time the demanded supply will lead to a negative feedback loop. Excessive demands will drive the interest down leading to even more demand.

Due to these technical difficulties, a move to MTM framework forces a guaranteed pension provider to choose between two difficult options. The first option is to completely change its business practice, reinvent itself and adapt to the new rules. Although this might ask for an enormous amount of effort, it will ensure that the pension provider will be able to continue providing guarantees to its members/customers also under the new MTM framework. The alternative, thus the other option, is to abandon guarantees and move towards a solution where the members/customers has no guarantees.

Hence, if a pension fund or an insurance company wants to continue providing guarantees, it has no other way but to fully change its business model and step out of its current mindset. Nevertheless, in this thesis we saw that is not likely to happen, due to behavioural biases, without pressure from the regulator. By looking through the lessons we have learned, it becomes indisputable that during a transition from BV to MTM the regulatory authority plays a significant role in enforcing the new rules onto the pension providers and, most importantly, has the power to reinforce a change in their behaviour.

As the core component of this thesis we have constructed a theoretical Solvency model that is capable of predicting the risk taking behaviour of guaranteed pension providers. The Solvency model provides an indicating whether the pension managers are following the rules of the new regulatory framework or not. Our Solvency model can be used as a diagnostic tool. Firstly, it can be used to investigate if the regulator is considered to be credible by the pension industry. Secondly, the model can be used by the regulator as diagnostic tool on individual pension funds and insurance companies to investigate if they have changed their behaviour before the solvency ratio has fallen to dangerously low levels. Essentially, it can provide the much needed early warning signal.

In sum, it is clear that only the fittest players with a strong competitive advantage will continue to sell the current guaranteed pension products. Also, it implies that a market gap in the pension industry will open and provide a place for those who will be able to provide affordable guarantees and guaranteed products that the consumers are looking for.

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Appendices

***A**: Algebraic analysis for the Krugman exchange rate target zone model (Krugman, 1991).*

Following Krugman continuous time model the log exchange rate at time t (s_t) depends linearly on an aggregate economic fundamental at time t (f_t) and the instantaneous expected exchange rate depreciation rate$\left(\frac{E_t[ds_t]}{dt}\right)$:

$$s_t = f_t + \alpha \frac{E_t[ds_t]}{dt}. \tag{18}$$

Further, the fundamental consists of two components, namely, the log of velocity (v_t) and the log of money supply (m_t):

$$f_t = v_t + m_t. \tag{19}$$

Note that the Krugman model allows us to express the exchange rate as an explicit function of the fundamental:

$$s_t = s(f_t) \tag{20}$$

Using Ito's lemma we can express the expectation term in (1) as follows:

$$\frac{E_t[ds_t]}{dt} = \sigma^2 \frac{1}{2} \frac{d^2 s(f)}{df^2} \tag{21}$$

Further we insert (20) into (17):

$$s(f) = f + \alpha\sigma^2 \frac{1}{2} \frac{d^2 s(f)}{df^2}$$

A formal solution of the non-homogeneous differential equation is:

$$s(f) = f + A_1 \exp\left(\lambda_1 \overline{f}\right) + A_2 \exp\left(\lambda_2 \underline{f}\right) \tag{22}$$

with $\lambda_1 = -\frac{\mu}{\sigma^2} + \sqrt{\frac{\mu}{\sigma^2} + \frac{2}{\alpha\sigma^2}}$ and $\lambda_2 = -\frac{\mu}{\sigma^2} - \sqrt{\frac{\mu}{\sigma^2} + \frac{2}{\alpha\sigma^2}}$.

If there is a free float, the exponential terms will be zero as they are the ones that cause the exchange rate function to bend when approaching the target zone bands.

A_1 *and* A_2 are constants and are determined based on the assumption that the exchange rate function is flat at the lower and upper boundary of the target band. By taking the first order derivatives of the equation (21) with respect to $\overline{f}$ and $\underline{f}$, and equalizing to zero we obtain:

$$\begin{aligned} 0 &= 1 + \lambda_1 A_1 \exp(\lambda_1 \overline{f}) + \lambda_2 A_2 \exp\left(\lambda_2 \underline{f}\right) \\ 0 &= 1 + \lambda_1 A_1 \exp\left(\lambda_1 \underline{f}\right) + \lambda_2 A_2 \exp(\lambda_2 \overline{f}). \end{aligned} \quad (23)$$

Thus, we can compute the values of A_1 and A_2:

$$\left\{ \begin{aligned} A_2 &= \frac{\exp\left(\lambda_1 \underline{f}\right) - \exp(\lambda_1 \overline{f})}{\lambda_2 (\exp\left(\lambda_2 \underline{f} + \lambda_1 \overline{f}\right) - \exp(\lambda_2 \overline{f} + \lambda_1 \underline{f}))} \\ A_1 &= \frac{\exp(\lambda_2 \overline{f}) - \exp(\lambda_2 \underline{f})}{\lambda_1 (\exp\left(\lambda_2 \underline{f} + \lambda_1 \overline{f}\right) - \exp(\lambda_2 \overline{f} + \lambda_1 \underline{f}))} \end{aligned} \right\} \quad (24)$$

B*: Methodology for calculating the required coverage ratio for pension funds in The Netherlands*

(DNB Standaardtoets[26])

We express the required coverage ratio as $\lambda \frac{A}{L}$, where A represents the present actual assets and L the pension obligations. Both of the values can be retrieved from the balance sheet.

Further, the following holds:

$$\lambda A - L = \sqrt{(\lambda \Delta a - \Delta l)^T \Sigma (\lambda \Delta a - \Delta l)} \quad \text{with } \Sigma = \begin{bmatrix} 1 & \frac{1}{2} & 0 & 0 & 0 & 0 \\ \frac{1}{2} & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \tag{25}$$

where the right hand side is the surplus and the left hand side is the shock in the surplus.

The equation must be squared, divided with L and the radical sign λ must be replaced by $f \frac{A}{L}$. Hence, we obtain:

$$(f-1)^2 = \left(f\Delta\tilde{a} - \Delta\tilde{l}\right)^T \Sigma \left(f\Delta\tilde{a} - \Delta\tilde{l}\right), \tag{26}$$

where $\Delta\tilde{a}$ and $\Delta\tilde{l}$ are both column vectors and are represented as follows:

$$\Delta\tilde{a} = \frac{\Delta a}{A} \text{ and } \Delta\tilde{l} = \frac{\Delta l}{L}. \tag{27}$$

Finally, by rearranging the former equation, we arrive to the second order equation:

$$0 = (1 - \Delta\tilde{a}^T \Sigma \Delta\tilde{a}) * f^2 - 2 * \left(1 - \Delta\tilde{a}\Sigma\Delta\tilde{l}\right) * f + \left(1 - \Delta\tilde{l}^T \Delta\tilde{l}\right). \tag{28}$$

Solving for f we can obtain the value of the required coverage ratio.

[26] www.dnb.nl