Netspar

Network for Studies on Pensions, Aging and Retirement

NETSPAR ACADEMIC SERIES

International Comparison of Pension Fund Regulation

Rowan Fredrix

MSc 07/2020-009

International Comparison of Pension Fund Regulation

Maastricht University

Master thesis in Econometrics & Operations Research, specialisation Actuarial Sciences

Name: Rowan Fredrix

Student ID: i6134911

Supervisor: Prof. Dr Antoon Pelsser

Date submitted: July 24, 2020

Abstract

This study examines which short-term and long-term regulations for occupational pension funds are best at maintaining a healthy financial situation for the fund and provide the best results for the participants in terms of pension benefits. In this study, three supervisory frameworks are discussed: the Dutch, European and Canadian framework. To compare the effects of the Dutch and Canadian framework on the financial situation of the fund and the height of the benefits, a model has been developed in which a fictional pension fund develops over time under either a non-regulatory framework, the Dutch regulatory framework, or the Canadian regulatory framework. The results suggest that more or stricter regulations not necessarily lead to better results for the participants.

Table of Contents

1 Introduction

The pension system of a developed country can usually be divided into three pillars: a state or social pension, an employment-based pension, and additional private pensions. The state or social pension is usually called the first pillar. It is meant to provide a basic income after retirement for everyone and the right is usually ‘earned’ by citizenship of the country. Generally, the second pillar is an occupational pension. It is meant as a complement to the basic state pension. The rights to an occupational pension are built up during the working life. Finally, the third pillar consists of all voluntary income provisions such as life annuities or life insurances. The amount of importance that is put on each of the three pillars can differ significantly between countries.

This paper focuses on occupational pensions and its legal regulation in several countries. There exist many different pension fund regulation schemes across different developed countries. Some countries lay their focus on short-term discontinuity requirements while others are more focused on the sustainability of the pension fund in the long run and are more lenient when it comes to short-term solvency requirements. Moreover, pension fund policies mostly focus on continuity and the development of the fund in the long run, taking into account new contributions and changes in the participant file of the pension fund. This may cause a mismatch with regulation if supervision focuses too much on short-term requirements.

The research question of this study is: How should short-term discontinuity requirements and long-term sufficiency tests for occupational pension funds be combined in order to guarantee the pension rights of the fund’s members? To evaluate different supervisory instruments and the ways they can be used and combined to come to a complete regulatory framework, three supervisory frameworks are compared. More specifically, the Dutch, European and Canadian supervisory framework are considered, and the advantages and disadvantages of the existing regulations are discussed.

This paper starts by evaluating the existing literature on supervisory frameworks for occupational pension funds and by describing the tension between short- and long-term requirements in Section 2. Subsequently, the main quantitative regulations of the Dutch, European and Canadian supervisory frameworks are described in Sections 3, 4 and 5, respectively. Next, Section 6 describes the model which is used to compare the effective consequences of the Dutch and Canadian frameworks on a person’s pension. In addition, the results of the models are shown and compared. Finally, Section 7 concludes.

2 The balance between short-term and long-term requirements

Occupational pensions are initially negotiated between employer and employee. However, often employees do not get much choice in pension fund since a pension fund generally comes with the employer of choice. In that case, if an employee wants to change pension plans, it often comes down to changing employer. But with industry pension funds, this is even more troublesome. Hence, it is important that there exists a public regulator which looks out for the interests of members of occupational pension funds and to ensure their reasonable expectations are fulfilled, as also stated by Kortleve, Mulder & Pelsser (2011).

To ensure that above objectives are met, it is important that there is supervision on the funding of pension funds. This can consist of short-term requirements which ensure that the fund can cover its liabilities in case of discontinuity, or long-term requirements which test whether the continuity of the fund is secured and the promised pensions can be paid out in the future. However, to find a balance in this does not always come easy for a regulator. A country's supervisory framework is often focussed on short-term solvency requirements, which can cause a mismatch with the long-term obligations and objectives of a pension fund.

The tension between the short-term requirements by regulators and the long-term obligations that pension funds face have been widely covered in academic papers. Earlier Netspar papers concerning the Dutch and European supervisory frameworks have made explicit recommendations to give more weight to long-term regulations. De Jong & Pelsser (2010) refer to the original concepts behind the Dutch regulatory framework as stated by the *Pensioen- en Verzekeringskamer (PVK)*, the then regulator in 2001 (PVK, 2001). In their brochure, the PVK describes a method of regulation which looks at both the long and short term and which is based on three financial tests: a continuity test on the long-term solvency; a solvency test concerning the fund's risks on a one-year maturity; and a minimum test concerning the height of the liabilities and funds. However, according to De Jong & Pelsser (2010), when the regulatory framework was formed in 2007, the original concepts have been neglected due to political pressure. In their paper, they plead for more focus on the long-term ambitions of pension funds. The last changes to Dutch regulatory framework have been made in 2015. However, as will become clear in the next section, it seems that the recommendations have not been followed. This summer (i.e. summer 2020), the Dutch government has come to a new pension agreement through which the Dutch framework takes a step towards a more unregulated framework. This is also in accordance with the conclusions of this study.

Also Netspar papers concerning the European supervisory framework have argued for more weight on the long-term perspective when designing pension fund regulation (Kortleve, Mulder & Pelsser, 2011). In addition to saying that supervision should not exclusively focus on short-term requirements, they also recommend to focus more on indexation ambitions and to be more flexible when it comes to recovery periods. Furthermore, before the revision of the European framework in 2016, the use of an holistic balance sheet approach has been recommended by multiple authors (Broeders, Kortleve, Pelsser, & Wijckmans, 2012; De Haan, Janssen, & Ponds, 2012; Fransen, Kortleve, Schumacher, Staring & Wijckmans, 2013). Nevertheless, the holistic balance sheet approach has never been implemented in the European framework. Instead, the focus of the European regulatory framework lies on short-term solvency requirements and does not include any concrete or suggestive regulations concerning long-term continuity.

In contrast, the Canadian regulatory framework not only values a pension plan's funds and liabilities on a solvency basis but also on a going concern basis. A going concern valuation relies on the assumption that the pension plan will continue indefinitely. A more detailed description of the financial rules and regulations in Canada concerning occupational pension plans follows in Section 4. First, the regulatory frameworks of the Netherlands and Europe are described in Sections 2 and 3, respectively.

3 Current regulation and supervision in the Netherlands

Dutch pension fund regulation and legislation is described in the Pension Act (*Pensioenwet*, Pw) (2006) and the Pension Fund (Financial Assessment Framework) Decree (*Besluit financieel toetsingskader pensioenfondsen*, FTK Decree) (2008). Both these laws together state the financial and nonfinancial requirements to which a Dutch pension fund must legally oblige. Moreover, in the Regulation on Pension Act and Compulsory Professional Pension Scheme Act (*Regeling Pensioenwet en Wet verplichte beroepspensioenregeling*, Regulation Pw and Wvp) (2006) the meaning and implication of the Pw and FTK Decree are further explained. *De Nederlandsche Bank (DNB)*, the central bank of the Netherlands, is charged with the prudential and material supervision of the Pw and FTK Decree.

The Pw and FTK Decree first came into force in 2007, meant to provide insight into the financial situation and stability of pension funds. At the moment, a proposal for a new regulatory framework is on the table. However, the proposal is not final yet. The last changes to the FTK Decree have been made in 2015 and represent the requirements which are currently still in use. The regulatory framework following these changes is known as the new financial assessment framework (*nieuw Financieel Toetsingskader,* nFTK). This section describes the regulatory framework according to the nFTK.

Naturally, the Pw and FTK Decree are very elaborate and contain a lot of requirements for pension funds. In this paper, the focus lies on the regulations which are the most notable and significant in their impact on the financial situation and policy of a pension fund. We start by elaborating on the calculation of the funding ratio, the most prominent indicator of the financial situation of a pension fund. Most of the financial regulations are based on the funding ratio and put certain restrictions on it in one form or another. Hence, first the calculation of this key ratio is described before immersing ourselves into the financial requirements on Dutch pension funds. Thereafter, two important capital requirements are discussed: the required own funds and the minimum required own funds. Next, long-term financial feasibility tests for pension funds are described. Finally, the situations in which indexation of pension entitlements may take place are considered.

3.1 The funding ratio

Dutch pension governance mostly revolves around capital requirements and short-term discontinuity requirements. The funding ratio of a pension fund plays a crucial role in this. It is a prominent indicator of the financial position of a pension fund and is calculated as follows:

$$Funding\ ratio = \frac{Current\ value\ of\ assets}{Current\ value\ of\ liabilities} \cdot 100\%$$

Hence, the funding ratio represents the ability of the pension fund to pay out all its liabilities if it would liquidate today.

Calculating the numerator of this equation is usually straightforward. For the current value of the assets the market value is used. The current value of liabilities, also called the *technical provision*, depends on the actuarial interest rate. This is the interest rate that is used to discount the future liabilities to calculate the reserves required today. This actuarial interest is a risk-free interest rate determined by DNB. The determination of the actuarial interest rate is important, since a slightly different interest rate could mean a large increase or decrease in a pension fund’s liabilities. There are several components to the calculation of the actuarial interest rate. As described by DNB (2015) in their memorandum ‘UFR methodiek voor de berekening van de rentetermijnstructuur’ [UFR methodology for calculating the interest rate term structure], in its entirety it is made up as follows:

1. Until the so called *First Smoothing Point (FSP)*, the actuarial interest rate is based on the euro swap rate for maturities 1 to 10, 12, 15, and 20. To determine the rate for intermediate maturities, an interpolation method is used. This results in a smooth curve up and until a maturity of 20. The exact determination of the interest rate term structure until a maturity of 20 is described in a memorandum by DNB (2005) called 'Vaststelling van de methodiek voor de rentetermijnstructuur' [Determination of the methodology for the interest rate term structure].
2. The *Ultimate Forward Rate (UFR)* is a calculated asymptote to which the actuarial interest rate converges after the FSP. It is meant as a stable estimate of long-term interest rates. The UFR at time t is calculated as

$$UFR(t) = \frac{1}{120} \sum_{m \in M(t)} f(m, 20, 21)$$

   where $M(t)$ is the set of 120 consecutive monthly forward rates prior to time t and $f(m, k, k+l)$ is the forward rate from year k to $k+l$ at time m. That is, the UFR is the 120-month moving average of the 1-year forward rate at the 20-year maturity point.
3. The following extrapolation methodology is used for the actuarial interest rate after a maturity of 20 year:
   a. Based on continuously compounded forward rates after the FSP, a *Last Liquid Forward Rate (LLFR)* is estimated as follows:

$$f_c^*(t) = \frac{8}{15}\left(f_c(t, 20, 25) + \frac{1}{2} f_c(t, 20, 30) + \frac{1}{4} f_c(t, 20, 40) + \frac{1}{8} f_c(t, 20, 50)\right)$$

   where the subscript c implies a continuously compounded interest rate.
   b. Next, extrapolation of the forward rates after the FSP is done according to the following formula:

$$f_c(t, 20, 20+h) = UFR_c(t) + \left(f_c^*(t) - UFR_c(t)\right) * \frac{1 - e^{-ah}}{0.1h}$$

   with growth factor $a = 0{,}10$.
   c. Then, zero rates are extrapolated according to

$$z_c(t, 20+h) = \frac{20 z_c(t, 20) + h f_c(t, 20, 20+h)}{20+h}$$

   after which they are converted to discretely compounded zero rates again.

This methodology for calculating the actuarial interest rate has been in use since 2015 and is still being used at the moment. Every few years, the methodology is revised by the Commission Parameters and subsequently, a new advice is given. The last advice was given in 2019. DNB decided to implement the given advice concerning the actuarial interest rate, but will not do so until 1 January 2021. The advice from 2019 can be summarized by the following points:

- The FSP moves from a maturity of 20 years to a maturity of 30 years.
- The growth factor a, which determines the rate at which the curve grows towards the UFR, decreases from 0,10 to 0,02.
- The calculation of the LLFR is changed and is now calculated as:

$$f_c^*(t) = \frac{2}{3} f_c(t, 30, 40) + \frac{1}{3} f_c(t, 30, 50)$$

  Additionally, the LLFR is averaged over the last five trading days.
- Finally, the UFR is determined by the 120-month moving average of the 1-year forward rate at the 30-year maturity point, instead of the 20-year maturity point.

The complete advice is given in ‘Advies Commissie Parameters’ [Advice Commission Parameters] (Commissie Parameters, 2019).

The above described method for calculating the funding ratio is more specifically the method for calculating the *current* funding ratio. The current funding ratio is a snapshot of the financial situation of a pension fund. Due to developments on the financial markets or changes in the interest rate, the current funding ratio can fluctuate considerably. Therefore, a more stable alternative is used when for example evaluating the capital requirements for a pension fund. For this, the *policy funding ratio* is used. It is a moving average of the current funding ratios of the last twelve months. Hence, it gives a more stable and better insight into the financial situation of a pension fund.

3.2 Short-term capital requirements

There are two main capital requirements to which a pension fund should oblige according to the Pension Act. These capital requirements are the *required own funds (ROF)* and the *minimum required own funds (MROF)* of a pension fund and described in articles 131 and 132 Pw. Both of these articles put a certain capital requirement to the own funds of the pension fund. According to article 134 Pw, if a pension fund does not oblige to the requirements laid out in article 131 Pw or article 132 Pw, and cannot within a reasonable span of time, it must curtail pension entitlements in order to increase the funds solvency to a suitable, prescribed level. The content of articles 131 and 132 Pw will be explained in detail in Sections 2.2.1 and 2.2.2.

3.2.1 Required own funds

The obligation for a pension fund to have a ROF is described in article 132 Pw and elaborated in article 12 FTK Decree. The ROF is the amount of own funds a pension fund should have in order to ensure, with 97.5% certainty, that, over a one-year horizon, the value of the assets are enough to cover the liabilities. This amount is different for each pension fund and depends on its risk profile and the nature of its assets. The FTK Decree has determined ten risk categories which contribute to the ROF: Interest rate risk (S_1), Equity and real estate risk (S_2), Foreign exchange risk (S_3), Commodity risk (S_4), Credit risk (S_5), Underwriting risk (S_6), Liquidity risk (S_7), Concentration risk (S_8), Operational risk (S_9), Active management risk (S_{10}). A more extensive explanation of the ten risk categories in the standard ROF model as described by DNB and in article 24 Regulation Pw and Wvp can be found in Appendix A. The sensitivity of the value of the assets and the value of the liabilities are calculated per risk category. Then, the total ROF is determined using the following quadratic formula:

$$ROF = (S_1^2 + S_2^2 + 2 \cdot \rho_{12} \cdot S_1 S_2 + S_3^2 + S_4^2 + S_5^2 + 2 \cdot \rho_{15} \cdot S_1 S_5 + 2 \cdot \rho_{25} \cdot S_2 S_5 + S_6^2 + S_7^2 + S_8^2 + S_9^2 + S_{10}^2)^{1/2}$$

where S_i is the sensitivity for risk category $i, i = 1, \ldots 10$. As explained in article 25 Regulation Pw and Wvp, in case the interest rate risk scenario is based on a downward shift in the interest rate, correlations $\rho_{12} = 0.4$ and $\rho_{15} = 0.4$ are taken. If not, the correlations of equity and real estate risk and credit risk with interest rate risk are nil. The correlation between equity and real estate risk and credit risk is assumed to be $\rho_{25} = 0.5$.

As mentioned, article 132 Pw states that a pension funds own funds should have at least be at the level of the funds ROF. Article 138 and 139 Pw describe what a pension fund must do in case it able to meet the ROF requirement. In this event, the fund has to submit a concrete and feasible recovery plan to the supervisor within three months, in which it has to demonstrate how it will meet the requirements as laid out article 132 Pw within a maximum of ten years. In the case that the fund does not meet the requirements as laid out in article 132 Pw and cannot demonstrate to be able to within a reasonable amount of time as laid out in article 138 and 139 Pw, the pension fund has to curtail pension entitlements until its policy funding ratio reaches the level of the *critical funding ratio*. The critical funding ratio is defined as the level from which the fund can demonstrate to be able to meet the requirements of article 131 or 132 Pw within a maximum of ten years. The above described curtailments are conditional and can be spread out over a maximum period of ten years.

3.2.2 Minimum required own funds

The above described measure is one of two important measures that puts a requirement on the own funds of a pension fund. The second one is with regard to the MROF. The obligation for a pension fund to have a MROF is described in article 131 Pw and elaborated in article 11 FTK Decree.

The method of computing the MROF depends on whether the pension fund is exposed to investment risks and its commitment to management costs. Overall, we can distinguish three (sub)categories in the computation of the MROF:

1. Pension schemes in which the pension fund is exposed to investment risks, or
2. Pension schemes in which the pension fund is not exposed to investments risks, and
    a. in which the pension fund is committed to its management costs for more than five years, or
    b. in which the pension fund is committed to its management costs for five years or less.

Furthermore, for pension schemes with a capital at risk on decease and for disability pensions an additional buffer has to held by the pension fund. In case a pension fund has pension schemes of multiple sorts, these components should be separately regarded and the total MROF is calculated by summing the MROF of the individual components. A schematic representation of the total build-up of the MROF is given in Appendix C.

Article 140 Pw describes the measure with regards to the MROF of a pension fund. In the event that the policy funding ratio does fulfil the requirements as laid out in article 131 Pw six times in a row, and if, for the sixth time, the funding ratio of the pension fund also does not fulfil the requirement as laid out in article 131 Pw, the pension fund has to curtail pension entitlements until the requirements of article 131 Pw are met again. The curtailments are unconditional, but can be spread out over the duration of the recovery plan.

3.3 Long-term financial feasibility tests

According to article 143 Pw, pension funds must periodically do a long-term financial feasibility test (*haalbaarheidstoets*, HBT). The HBT was first implemented simultaneously with the nFTK in 2015. As described in article 22 FTK Decree, it is meant to provide insight into the cohesion and continuity of the financial structure, the expected pension result, and the associated risks. Article 22 FTK Decree elaborates on the implementation of the HBT by pension funds. Additionally, articles 30, 30a, 30b, and 30c of the Regulation Pw and Wvp describe the method of implementation, the method of calculation, and the standards to be used in the HBT.

The pension result is the quotient of the expected payments including expected indexations and curtailments, and the expected payments including full indexation according to price inflation and without curtailments. Hence, the pension result compares the expected change in value of the pension entitlements to the (expected) price inflation. The pension result is calculated using forecasts over a period of sixty years. Furthermore, a uniform scenario set, prescribed by DNB and identical for all pension funds, is used in the calculation of the pension result. A new scenario set is published by DNB every quarter of a year. The pension result is calculated per birthyear group and for each scenario in the scenario set. Then, the total pension result per scenario is calculated as the weighted average pension result of the birthyear groups where the weights are determined by the number of people in a birthyear group.

According to article 22 FTK Decree, pension funds must perform a HBT every year. In addition, a pension fund must perform an initial feasibility test (*aanvangsthaalbaarheidstoets*), when implementing a new pension scheme and when making significant changes in their financial policy or structure. The annual HBT must show that the pension fund is able to meet the following requirements:

1. The expected pension result of the fund must be above the lower limit as determined by the fund.
2. The deviation of the bad case pension result from the expected pension result must not be bigger than the maximum deviation as determined by the fund.

The expected pension result is calculated as the 50th percentile in the calculation of the scenario set. The bad case pension result is calculated as the 5th percentile in the calculation of the scenario set. In addition to the above requirements, an initial feasibility test must also show that the pension fund is able to meet the following two requirements after a significant change in policy or structure:

3. The premium policy is sufficiently realistic and feasible over the whole calculation horizon.
4. The pension fund has sufficient recovery capacity to recover from the MROF financial position to the ROF financial position within the duration of the recovery plan.

3.4 Pension indexation

Pension indexation is the possible annual increase of pension entitlements to compensate for possible increases in the wage- or price-index. Pension funds can choose for either conditional or unconditional pension indexation. In most pension schemes, pension indexation is conditional. This means that the right to and height of indexation depends on financial situation of the pension fund and is decided by the board. The rules and regulations concerning conditional pension indexation are described in articles 95 and 137 Pw and article 15 FTK Decree. Pension funds must have a policy regarding unconditional indexation in which the conditions for and height of indexation is stated. Furthermore, it must describe whether indexation based on the wage-index, price-index, or a fixed percentage is pursued.

According to article 137(2a) Pw and article 15(2) FTK Decree, pension funds may not grant any pension indexation in case the policy funding ratio is below 110%. In case the policy funding ratio of a fund is higher than 110%, the fund may not grant more indexation than the fund can expect to be able to realise in the future as described in article 137(2b) Pw and article 15(3) FTK Decree. This means that the height of indexation is determined in such a way that the assets available for indexation are equal to the present value of the annual indexations in the future. These requirements are not applicable to pension funds which are fully insured, or if the employer has the unconditional obligation to financially support the pension fund in order to meet the MROF and there is an unconditional indexation of minimally the price-index for active participants.

In addition to describing the conditions for and the height of regular indexation, the pension fund policy must describe the conditions for and methodology on incidental indexation, that is, indexation in order to compensate for missed indexations or curtailments on pension entitlements in the past. According to article 137(2c) Pw, incidental indexation may not be higher than a fifth of the assets available for this indexation. Here, the assets available are determined in such a way that the indexation does not have any consequences for the regular indexation as described in article 137(2b) Pw and such that the policy funding ratio does not fall below the level of ROF.

4 European regulation and supervision of pension funds

The supervision of European occupational pension funds is done by the European Insurance and Occupational Pensions Authority (EIOPA). It is established under Regulation (EU) No 1094/2010 establishing a European Supervisory Authority (European Insurance and

Occupational Pensions Authority) (2010). EIOPA is headquartered in Frankfurt and is part of the European System of Financial Supervision, in addition to the European Banking Authority (EBA) and the European Securities and Markets Authority (ESMA), both situated in Paris.

The regulation and supervision of all occupational pension funds in Europe is described in Directive (EU) 2016/2341 on the activities and supervision of institutions for occupational retirement provision (2016), henceforth IORP II. It sets out the minimum standards and requirements for institutions for occupational retirement provision (IORPs) or pension funds in all countries in the European Union (EU). IORP II replaces Directive 2003/41/EC on the activities and supervision of institutions for occupational retirement provision (2003), which needed revision after the financial crisis of 2008. IORP II came into force January 2017 and had to be adapted into the law of the individual EU countries by January 2019.

The main aims of IORP II are (1) to ensure the financial stability of all pension funds in Europe, (2) to guarantee the protection of members of the pension funds, (3) to encourage and enable cross-border activity of pension funds, and (4) to encourage long-term and responsible investments by pension funds. As mentioned, IORP II lays out a minimum set of rules to which European pension funds must oblige. Governments of individual EU countries have to adapt this set of rules in their own legislation, but may themselves choose how to give substance to these rules. Hence, the specific requirements that a pension fund has to fulfil are determined by the exact adaption of the EU rules by the relevant country.

This section discusses the quantitative requirements for IORPs as described in Title II of IORP II. These are regarded as the most significant requirements to be compared in this study. The requirements as laid out in Title II of IORP II can be divided in two parts. The first part states the requirements on the technical provision of IORPs. These are described in article 13 IORP II. The second part states the requirements on the assets or funding of IORPs and comprises of articles 14 to 19 IORP II. Accordingly, Section 3.1 discusses the main requirements on the technical provision of an IORP. Section 3.2 discusses the main requirements on the assets of an IORP.

4.1 The technical provision

As previously stated, the technical provision of a pension fund is equal to the current value of the fund's total liabilities. Article 13 IORP II describes the requirements that the EU puts on occupational pension funds. The requirements in this article with regard to the technical provision are not very specific and leave a fair amount of room for interpretation by the Member States of the EU. In this respect, articles 13(1) and 13(2) IORP II state that the home Member

State of the pension fund ensures that the fund establishes "an adequate amount of liabilities corresponding to the financial commitments which arise out of their portfolio of existing pension contracts" (European Parliament, Council of the European Union, 2016). Furthermore, article 13(3) requires occupational pension funds to calculate their technical provisions every year. However, Member States may also allow a calculation to be made every three years if, in the interim, the IORP provides the State's authority with a report on the relevant adjustments or changes.

Although the EU does not provide any concrete methods of calculation for the technical provision of an IORP, some requirements are mentioned. For one, the calculation must be done and certified by an actuary or other specialist in that field. Moreover, it must fulfil the following four requirements, as given in article 13(4) IORP II:

a. The minimum amount of technical provisions must be calculated such that all future liabilities and contributions are taken into account. Furthermore, the assumptions on which the calculations are based must be chosen prudently.
b. The maximum actuarial interest rate used in the calculation of the technical provision must be chosen prudently and in accordance with the requirements as set by the home Member State. The interest rate must be based on either the yield on the fund's assets or on a risk-free interest rate, or a combination of both.
c. The biometric tables used in the calculation of the technical provision must be chosen prudently.
d. The method of calculation and the corresponding assumptions must not change from year to another. Excepted are changes made because of, for example, changes in legislature or economic circumstances.

Any additional requirements for the calculation of the technical provision may be determined by the home Member State of the pension fund.

4.2 Requirements regarding the own funds

In addition the conditions on the calculation of the technical provision, IORP II also sets some conditions on the funding of the technical provision. These conditions are described in article 14 to 19 IORP-II and put some general requirements to the amount of assets a fund must have. We will now discuss the main requirements for the own funds of an IORP as described in these articles.

Article 14(1) IORP II states that the home Member State must ensure that every IORP has "sufficient and appropriate assets to cover the technical provisions". The home Member

State may allow a fund to not fulfil the above requirement for a limited amount of time. However, in this event, the fund must establish and submit a feasible recovery plan to ensure that the fund will have sufficient assets in the future again. In the recovery plan, the individual structure of the fund has to be taken into account.

Article 15 IORP II describes the *regulatory own funds* of an IORP. It states that every IORP must hold a buffer in order to cover any biometric risks and in order to guarantee a certain amount of pension benefits to their members. When determining this buffer, the risks to which the pension fund is exposed and the composition of the fund's assets must be taken into account. The prescribed height of this buffer may be determined by the home Member State of the IORP. However, article 17 and 18 IORP II describe the *required solvency margin (RSM)*, which is the minimum buffer an IORP must have. The calculation of the RSM depends on the type of insurance or pension scheme, some of which are described in Directive 2009/138/EC on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II) (2009), henceforth Solvency II. In case an IORP has multiple insurance of pension schemes, the RSM must be calculated separately for each scheme and summed to retrieve the total RSM of the IORP. The exact calculations per type of scheme is described in a schematic overview in appendix D.

5 Canadian regulation and supervision of pension funds

The Canadian pension system is composed of three main pillars. These pillars are slightly different from the ones described in Section 1.

The first pillar of the Canadian pension system fits the general description of the first pillar, pension benefits for seniors regulated by the state. The second pillar of the Canadian system is different from the general description, however. In Canada, the second pillar is either the Canada Pension Plan or Quebec Pension Plan, depending on the province of residence. These are mandatory public pension plans to which workers over the age of 18 contribute. The third pillar are either mandatory or voluntary retirement savings. These include workplace pensions, Registered Retirement Savings Plans (RRSPs), and Tax-Free Savings Accounts (TFSAs), and can be either defined benefit (DB) or defined contribution (DC) plans.

Given the above-described tiers of the Canadian pension system, in this study we will look at DB workplace pensions in Canada and its regulation, and compare this to the Dutch and European regulation as described in Section 3 and 4.

The primary supervisory authority of pension plans Canada is the Office of the Superintendent of Financial Institutions (OSFI). Besides pension plans, OSFI also supervises banks, insurance companies, trust companies, and loan companies. Currently, OSFI supervises more than 400 federally regulated financial institutions and 1200 pension plans. OSFI was established in 1987 in order to contribute to the safety and soundness of the Canadian financial system (OSFI, 2011). It was first established under the Office of the Superintendent of Financial Institutions Act (1985).

Federal regulation of private pension plans in Canada is described in the Pension Benefits Standards Act (1985) and the Pension Benefits Standards Regulations (1985), henceforth PBSA and PBSR respectively. Moreover, further explanation of some of the articles in the PBSA and PBSR are given in the Directives of the Superintendent pursuant to the Pension Benefits Standards Act (1985), henceforth Directives PBSA. There are also provincial laws concerning pension plan regulation. However, in this study the focus is on the federal legislation.

The federal regulations are often not specific on the requirements for actuarial methods of calculation or valuation. Instead, these requirements are described in the actuarial Standards of Practice. These are detailed descriptions of how actuaries, in all practice areas, must execute their work. They are established by the Actuarial Standards Board (ASB) and published by the Canadian Institute of Actuaries (CIA), the national organization of the actuarial profession in Canada. The currently applicable standards are effective of January 1, 2020.

This section describes the main quantitative regulations from the PBSA and PBSR. However, first the methods of valuation of the funds are discussed. These are described in the Standards of Practice (ASB, 2020) and include two main methods of valuation: going-concern valuation and hypothetical wind-up (or solvency) valuation. Subsequently, requirements concerning the funding of a pension fund, both in the situation that the fund has a deficit and that the fund has a surplus, are described. Finally, any conditions concerning the interest on pension benefits are discussed.

5.1 Methods of valuation

The PBSA and PBSR lay requirements on the funding of Canadian pension plans and, in doing this, consider two different methods of valuation: going concern valuation and solvency valuation. Article 2(1) PBSR states the following definitions for these valuations:

- “Going concern valuation means a valuation of the assets and liabilities of a plan using actuarial assumptions and methods that are in accordance with the accepted actuarial practice for the valuation of a plan that is not expected to be terminated or wound up”.

- "Solvency valuation means a valuation of the assets and liabilities of a plan using actuarial assumptions and methods that are in accordance with accepted actuarial practice for the valuation of a plan, determined on the basis that the plan is terminated".

More precise definitions and assumptions of going concern valuation and solvency valuation are given in paragraphs 3230 and 3250 of the Standards of Practice (ASB, 2020), respectively and are considered in the remainder of this section.

A going concern valuation is based on the assumption that the concerning pension plan continues indefinitely. Hence, all (future) benefits expected to be paid while the plan is ongoing have to be taken into account in the valuation, according to paragraph 3230.01 of the Standards of Practice (ASB, 2020). Further restrictions on assumptions for going concern valuation concern the discount rate to be used in the valuation and are given in paragraphs 3230.02 and 3230.03. These state that the actuary may choose one of two options when selecting the best estimate assumption for the discount rate:

- take into account the expected investment return on the fund's assets at the calculation date and the expected investment policy after the calculation date; or
- reflect the yields on fixed income investments.

Additionally, it is assumed that no additional returns are earned from an active investment strategy instead of a passive investment strategy.

According to paragraph 3250 of the Standards of Practice (ASB, 2020), for a solvency valuation, the actuary typically has to apply the standards for a hypothetical wind-up valuation, which are described in paragraph 3240. A hypothetical wind-up valuation (and thus a solvency valuation) is based on the assumption that the pension plan is wound up at the calculation date. Furthermore, the actuary must presume a scenario on which the hypothetical wind-up situation is based. Moreover, the determination of the pension entitlements must be done based on the assumption that the pension plan has neither a surplus nor a deficit.

5.2 Requirements on funding

Requirements on the funding of pension plans in Canada are stated in article 9 PBSA and articles 8 and 9 PBSR. More specifically, article 9(1) PBSA and article 8 PBSR respectively state that a pension plan has to be funded according to the standards for solvency, and that a plan is considered to meet the standards of solvency if the funding is in accordance with article 9 PBSR.

As mentioned before, the requirements states in the PBSA and the PBSR distinct two different valuation methods, going concern valuation and solvency valuation. Hence, this puts two different requirements on a pension plan's funding. First, the pension plan may not have a (positive) *going concern deficit*, also called *unfunded liability*. This occurs when the liabilities determined according to a going concern valuation exceed the assets determined according to a going concern valuation, as laid out in article 9(1) PBSR. Second, the pension plan may not have a (positive) *solvency deficit*. A solvency deficit occurs when the liabilities determined according to a solvency valuation exceed the assets determined according to a solvency valuation.

If the pension plan has either a going concern deficit or solvency deficit or both, special payments have to be made annually into the plan's fund. The height and duration of these annual special payments are described in articles 9(3) to 9(7) PBSR.

In case the pension plan has unfunded liability, this shall be funded by equal annual payments over a period of 15 years. The height of these payments shall be high enough to liquidate the unfunded liability in those 15 years.

In case the pension plan has a solvency deficit, this shall be funded by annual payments equal to the excess of the total solvency deficit divided by five over the annual going concern special payments. Hence, the solvency deficit will be liquidated in at most five years.

For a DB plan that is not a multi-employer plan, in the event that the employer is not able to make the above described payments, the employer may elect to enter in a *distressed pension plan workout scheme*, according to article 29.03 PBSA. During a negotiation period of maximally nine months, the employer and representatives of the members and beneficiaries of the pension plan try to come to a workout agreement specifying a funding schedule such that the employer can eventually nullify the deficits and be able to make the required payments again.

The requirements and conditions concerning the distressed pension plan workout scheme, the negotiation period and the funding schedule are described in articles 29.01 to 29.3 PBSA and articles 10.1 to 10.991 PBSR. Two requirements regarding the funding schedule stand out and are specified in articles 10.97(h) and 10.97(i) PBSR:

- At least 40% of the total going concern payments have to be made in the first half of the funding schedule.
- At least 40% of the total solvency payments have to be made in the first five years of the funding schedule.

Furthermore, the present value of all going concern payments and solvency payments in the funding schedule must be at least equal to the greater of the going concern deficiency and the solvency deficiency, as laid out in articles 10.97(d) and 10.97(e) PBSR.

5.3 Refund of surplus

In case the pension plan has a funding surplus, part of the surplus may under strict conditions be refunded to the employer. These are described in article 9.2 PBSA and articles 16 and 16.1 PBSR.

According article 9.2(1), the following three conditions have to be met for the surplus to be refunded to the employer:

a. the employer establishes that
    i. it is entitled to (part of) the surplus under the pension plan, or
    ii. it has a claim to (part of) the surplus, where a claim is established if at least two thirds of the members and former members of the pension plan consent to the refund;
b. the requirements under the PBSR are met; and
c. the Superintendent consents to the refund.

Article 16(2) PBSR requires that, in order for a surplus to be (partly) refunded to the employer, the surplus exceeds the greater of

a. two times the employer's contribution to the normal cost of the plan, and
b. 25% of the liabilities, determined according to a solvency valuation.

Moreover, the amount of surplus that is refunded may not be greater than the amount by which the surplus exceeds the greater of the aforementioned amounts, as laid out in article 16(4) PBSR.

5.4 Interest on pension contributions

DB private pension plans in Canada have two possibilities when it comes to attributing interest to the pension contributions of its members. This is described in article 19(2) PBSA.

The first possibility is to attribute a fixed interest to the contributions of the members. This fixed interest rate should be equal to or greater than the following rate, as prescribed by the superintendent in paragraph 5 of the Directives PBSA: "the average of the yields of the 5-year personal fixed term chartered bank deposit rate […] using the value of the last weekly series for that month, over a reasonably recent period, the averaging period not to exceed twelve months".

The second possibility, according to article 19(2) PBSA, is to attribute interest to the contributions of members "as can reasonably be attributed to the operation of the pension fund".

Whichever method is used to determine the interest to the members' contributions has to be prespecified in the pension plan.

6 Modelling the Dutch and Canadian regulatory frameworks

6.1 The model

To compare the effects of the Dutch and Canadian regulatory frameworks on the pension benefits of a single person, a model has been developed which allows us to let the pension assets and liabilities of a fund develop over time, constrained by the regulations of the Netherlands and the regulations of Canada. Hence, three models are constructed: one without any regulations, one under constraint of the Dutch regulations, and one under constraint of the Canadian regulations. The basis of the three models are the same: It is a simplified version of a pension fund, with one 25-year-old participant. The participant is assumed to retire at the age of 65 and to decease at the age of 85. Hence, for the next forty years premiums are paid into the pension fund, and the following twenty years pension benefits are paid out to the participant. The height of the premium paid into the pension fund is €6,525, corresponding to 15% of an annual salary of €43,500. Furthermore, this participant builds up €562,50 worth of pension every year, corresponding to 1,875% of pensionable earnings amounting to €30,000 (assuming a franchise of €13,500). Assuming that the participant started working at the age of 21, this corresponds to an accrued pension of €2,250 at the age of 25, and, without any curtailments or indexations, an accrued pension of €24,750 at the age of 65.

The assets of the pension fund are developed over a period of sixty years, that is, until the death of the participant. To do this, we perform a scenario analyses using the scenario set Q1 2020 published by the DNB, which entails 2000 possible scenarios for several economic parameters. The scenario set contains the following parameters:

- annual return on equities for 60 projection years and 2000 scenarios,
- annual price inflation for 60 years and 2000 scenarios, and
- several parameters to derive the interest rate structure for 75 maturities, 60 projection years and 2000 scenarios.

The assets of the fictional pension fund are divided into equities and fixed income securities. The ratio between the two is assumed to be 30% equities to 70% fixed income securities. Moreover, a duration of 20 is assumed for the fixed income securities of the fund. Lastly, we assume that the pension fund has a starting capital of €25,000, which is chosen such that the fund starts with a (solvency) funding ratio of about 110%.

For the model without any regulations, there are no curtailments or additional payments from the employer. Hence, the assets and liabilities of the fund are allowed to develop freely without any regulatory interference. Furthermore, the pension benefits are indexed each year with the inflation rate in that year. In general, the capital of the pension fund in a particular year is equal to the capital one year before, plus premiums, plus return on equities and fixed income securities. The return on fixed income securities is acquired from the derived interest rate structure. The present value of liabilities is calculated using the interest rate term structure of the corresponding year and the expected future cashflows, which are determined by the accrued pension benefits in that year. Finally, the funding ratio is calculated as capital divided by the present value of liabilities.

In the second model, the Dutch regulations as described in Section 3 are applied. These include the regulations concerning the MROF, the ROF, and the requirements for indexation. Since recalculating the MROF and ROF every year in our simulation is an extensive task which requires a lot of underlying assumptions, we refrain ourselves from this in this study, and instead use constant rates around which the MROF and ROF can usually be found in the real world. Moreover, since we cannot implement recovery plans into the model, we use the critical funding ratio to implement the ROF regulation. A MROF of 105% and a critical funding ratio of 90% are assumed. If the funding ratio of the pension fund in our model is below the MROF six times in a row, or if the funding ratio is below the critical funding ratio of 90%, curtailments are implemented. Moreover, if the funding ratio is higher than 110%, indexations are implemented equal to maximally the price inflation in that year, but restricted such that the funding ratio does not fall below 110%. In addition, prior curtailments or missed indexations can yet be compensated. These regulations influence the height of the accrued pension, hence influencing the future cashflows, and the present value of liabilities. The height of the capital stays the same. The calculations of the pension capital, the present value of liabilities, and the funding ratio are identical to the calculations in the model without regulations.

Lastly, the third model includes the Canadian pension regulations. In this model, not only the ‘regular’ solvency funding ratio is calculated, but also the going concern funding ratio of the pension fund in the model is calculated for each year. To calculate the going concern capital, the present value of all future income is added to the solvency pension capital. To calculate the going concern liabilities, not only the accrued benefits up until that day are considered, but also the accrued benefits in the future, and are subsequently discounted accordingly. Lastly, the going concern funding ratio is calculated as the ratio of the going concern capital and the going concern liabilities. As described in Section 5, Canadian pension funds must have both a solvency funding ratio and a going concern funding ratio greater than 100%. In case one of two or both requirements are not fulfilled, the employer has to make special payments into the pension fund. This does not have any effect on the accrued benefits of participants.

Furthermore, we assume that the fund, under Canadian regulation, indexes the pension benefits every year by an amount equal to that year's price inflation.

To make sure that the results of the three models are comparable, some corrections have to be made. Without corrections, the model without regulation and the model under Canadian regulation result in strictly higher pension benefits for the participant since neither of these models apply any curtailments on pension benefits and apply unconditional indexations. However, if for the model without regulation a very low funding ratio occurs at the pension date, this most likely means that the fund is not able to pay out the pension benefits in full. Hence, in case the funding ratio at pension date is lower than 100%, the accrued pension benefits are corrected by multiplying the accrued benefits by the funding ratio, resulting in the amount of pension benefits that the pension fund is expected to be able to pay.

Similarly, in the model under Canadian regulation, one assumes that employer is able to make indefinite special payments into the fund. Of course, this is not a completely realistic assumption. Moreover, for this system to be sustainable, the distribution of net employer cashflows, that is, employer refunds minus employer payments, should be centred around zero. Figure 1 shows a histogram of the net total cashflows of the employer. It shows that the distribution of the net employer payments is centred to the right of zero. The mean of the total employer cashflows in the 2000 scenarios is approximately €160,000. That is, on average, the employer receives €160,000 worth of refunds per 40 years. This indicates that the Canadian system is sustainable on average in the long-run. However, it is possible that, in a certain scenario, the employer has to make more payments into the fund than they have available themselves, or that the employer goes bankrupt due to economic circumstances. In this case, no more premiums and special payments are paid to the pension fund. Moreover, accrued benefits

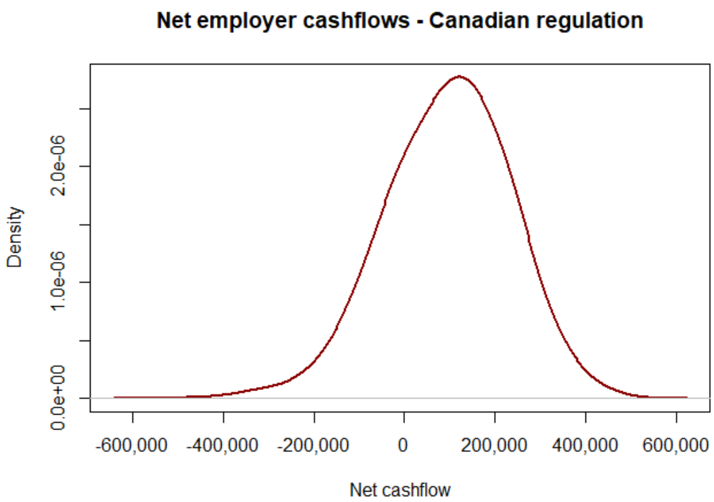

Figure 1. Distribution of the net total employer payments under Canadian regulation.

stagnate since there are no employees anymore. A second model is built for Canada, accounting for the possibility that the employer goes bankrupt. The relevant results are described in Section 6.4.

Moreover, to be able to compare the accrued pension benefits resulting from the Dutch model and the Canadian model, we correct for possibly unsustainable employer payments by splitting the accrued benefits into two parts, namely, the part that is sponsored by the employer, and the part that is not. Then, the pension benefits which are funded by the pension fund itself and not sponsored by employer benefits are used for comparison with the non-regulatory and Dutch model. This correction mainly effects the outcomes in the lower half of the pension benefits distribution since these are sponsored by the employer during bad economic scenarios.

6.2 The results

To evaluate the effects of the Dutch and Canadian regulatory frameworks on a person's pension benefits, the height of four key indicators at pension date are discussed in this section: the funding ratio, the nominal accrued pension benefits, the real accrued pension benefits (adjusted for inflation), and the pension result. Additionally, the nominal and real pension benefits under the model without regulation and the model under Canadian regulation are corrected as described above. As mentioned, the scenario set Q1 2020 by DNB, containing 2000 scenarios, was used to let the pension capital and liabilities develop within each of the three models. Hence, for each of the aforementioned indicators, and for each of the models, 2000 outcomes resulted. These results are then used to form a distribution of the relevant parameters.

Figures 2 plots the distributions of the funding ratios without regulation, under Dutch regulation, and under Canadian regulation, where for Canada both the distribution of the solvency ratios and of the going concern ratios are shown. It is immediately visible that the distributions of the Canadian solvency and going concern ratios are vastly different than the distributions of the non-regulated and Dutch funding ratios. While the distributions of the Canadian funding ratios are very symmetrical and centred around approximately 115%, the blue and green lines show very skewed distributions with short left tails and long right tails. Moreover, the peak of the distributions of the non-regulated and Dutch funding ratios lie further to the right, around 125%. In Table E1 of Appendix E.1, the mean, minimum and maximum values, and the 5^{th}, 25^{th}, 50^{th}, 75^{th}, and 95^{th} percentiles of the outcomes of the scenario analyses for all four funding ratios are shown. These also show that the outcomes under the non-regulated and Dutch models have far more extreme right-tailed outcomes than the outcomes under the Canadian models. Furthermore, it shows that, on average, the funding ratios under the Canadian

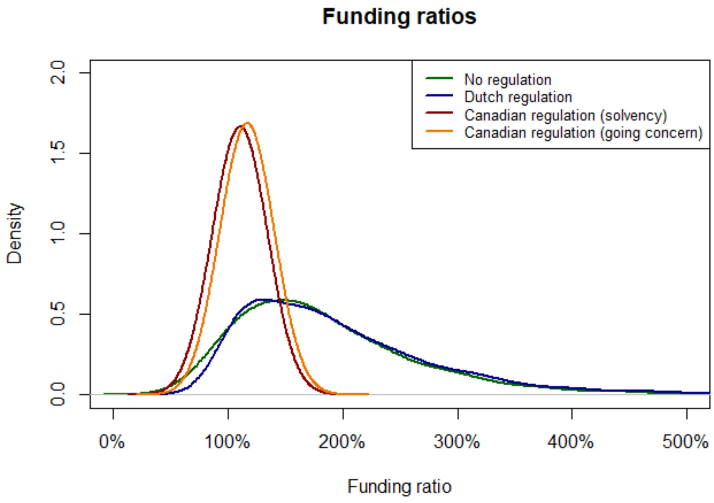

Figure 2. Distributions of the funding ratios without regulation, under Dutch regulation and under Canadian regulation.

model are lower than under the non-regulated and Dutch model. This is a direct consequence of the fact that surpluses are refunded to the employer under the Canadian model, taking away the possibility of having extremely high funding ratios. Moreover, Table 1 shows that, on average, the Dutch regulations also improve the financial situation of the fund compared to the model without regulation, having a higher mean and median value. In addition, the minimum value of the funding ratio increases from about 46.68% to almost 78.37% when applying Dutch regulations, significantly decreasing the risk for pension funds to become substantially underfunded.

Figures 3 and 4 are the distributions of the resulting nominal and real accrued pensions, respectively. The green lines represent the distributions of the nominal and real pension benefits resulting from the model without regulation. Similarly, the blue lines show the distributions of the nominal and real accrued pensions under Dutch regulation, and the red lines show the distributions of the nominal and real accrued pensions under Canadian regulation. The green lines are not visible in the figures because they are exactly equal to the red lines. This is due to the fact that under Canadian regulations no curtailments are ever made and indexation is done according to the price index, as is also the case in the model without regulation. Any deficits that the pension fund may have is nullified by special payments by the employer. Hence, the pension benefits of participants are never adjusted as a consequence of the financial situation of the fund. In contrast, under Dutch regulation, whenever the funding ratio is found to be too low, curtailments are made to participant’s pension benefits causing the slightly longer left tail of the blue lines in Figures 3 and 4. In the best-case scenarios, no curtailments have to be applied

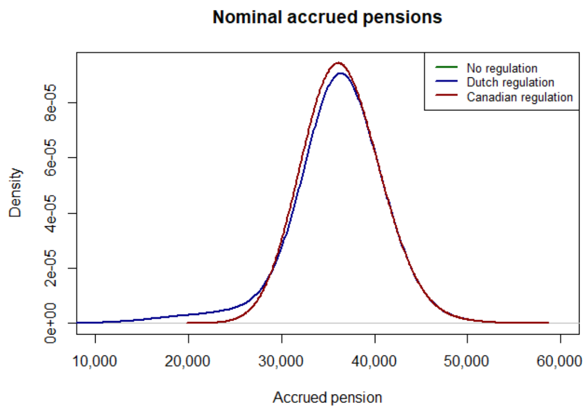

Figure 3. Distributions of the nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

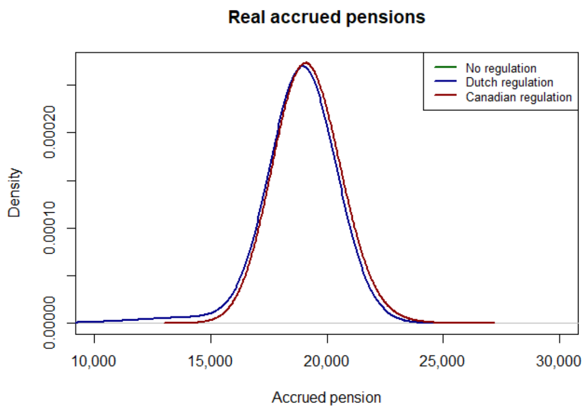

Figure 4. Distributions of the real accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

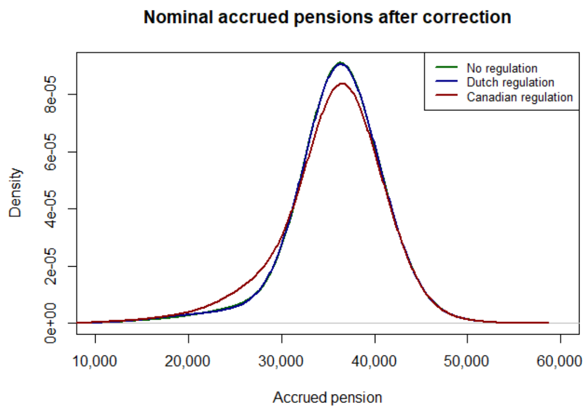

Figure 5. Distributions of the corrected nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

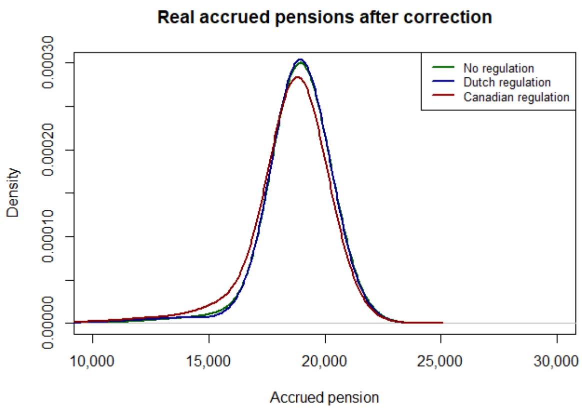

Figure 6. Distributions of the corrected real accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

under the Dutch regulation, and pension benefits are fully indexed. Hence, the right halves of all three distributions are very alike each other. These same conclusions can be drawn from Tables E2 and E3, which show the mean and relevant percentiles of the nominal and real pension benefits of all three models.

Nevertheless, for reasons explained at the end of Section 6.1, the resulting nominal and real pensions of the three models are not very comparable. Therefore, in Figures 5 and 6, the distributions of the corrected nominal and real pension benefits are shown. Again, the green lines are hard to see, but this time because they lie very close to the blue lines. This indicates that having no regulatory framework and the Dutch regulatory framework result in approximately the same amount of (expected) pension benefits at pension date. However, the Dutch framework already curtails pension benefits before the pension date in a bad-case scenario, while in a system without regulation, participants are hit with lower pension benefits at pension date when buying their annuity. Hence, the Dutch system, although not significantly

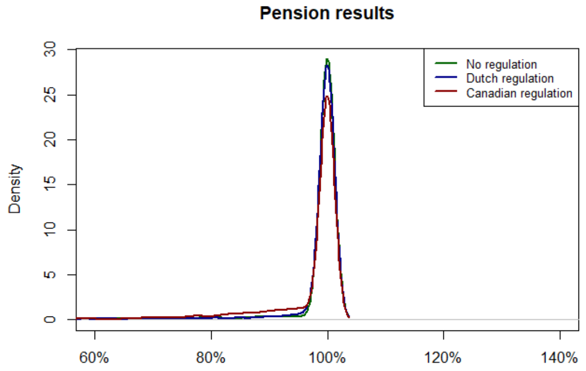

Figure 7. Distributions of the pension results without regulation, under Dutch regulation and under Canadian regulation.

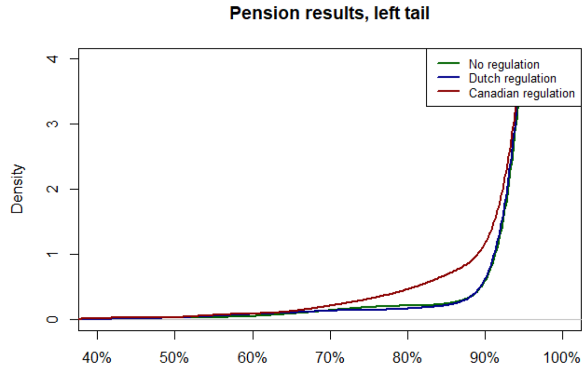

Figure 8. Left tails of the distributions of the pension results without regulation, under Dutch regulation and under Canadian regulation.

improving the outcome for the fund's participants, informs the participants in an earlier stage that their pension benefits may be lower than expected. The correction of the pension benefits resulting from Canadian regulation causes the distributions of the nominal and real pension benefits to have a slightly lower peak and fatter left tail. When comparing Table E4 to Table E2, and Table E5 to Table E3, it is visible that the lower outcomes under no regulation and under Canadian regulation decrease significantly after applying the corrections, resulting in outcomes that are more similar to the outcomes under Dutch regulation.

Finally, Table E6 in Appendix E shows the means and relevant percentiles of the pension results under the three models. The pension result is calculated as the corrected real pension benefits divided by the real pension benefits after full-indexation. By definition, the pension result can be at most 100%, which is also shown in the table. The results of the three models lie very close together. However, the pension results under Canadian regulation show slightly lower results. Figure 7 shows the corresponding distributions of the three models. Again, the three distributions are very close together, with all three having a very high peak towards 100%. To be able to analyse the distributions' behaviour in the left tails, Figure 8 focuses on exactly this. Here, it can be seen that the tails of the distribution under no regulations and under Dutch regulations lie very close together, and that the tail of the distribution under Canadian regulation is fatter than the other two. Together with the lower peak in Figure 7, this implies that, on average and after correction for employer payments, the Canadian framework is less likely to provide fully-indexed pension benefits than the non-regulatory and Dutch framework.

Although there are some differences between the outcomes of the three models, overall the results for nominal pensions, real pensions, and pension results are very similar, as can be seen in Figures 3 to 8. One might expect that this is unlikely, given the differences between the non-regulatory, Dutch, and Canadian frameworks. In the non-regulatory model, the pension fund develops over time without any interference and with unconditional annual indexation. The Dutch framework curtails pension benefits when the fund is doing bad, and indexes pensions only if the fund is doing very good (funding ratio higher than 110%), which explains the longer left tail of the blue line in Figure 3. But during the economically good times, prior curtailments and missed indexations are yet implemented. Hence, when negative and positive returns on the markets alternate, in the end, the participants still receive (almost) fully-indexed pensions, as in the non-regulatory model. Moreover, in scenarios that are predominantly negative, the Dutch framework has to implement curtailments which may not be compensated later, but the non-regulatory framework will have a low funding ratio, implying that the promised amount of pension benefits mostly cannot be paid out. Hence, we correct for this by calculating the expected pension benefits to be paid out. These are then almost equal to the pension benefits under the Dutch regulatory system. Thus, whether curtailments are implemented beforehand, or expected pension benefits are corrected at pension date, the fund's participants still receive almost the same amount of benefits. But under the Dutch regulatory framework, participants are informed about possible lower benefits much earlier, preventing a huge surprise at pension date.

Similarly to the non-regulatory model, the Canadian model does not curtail pension benefits and provides unconditional indexation. Bad economic returns are absorbed by special employer payments, and refunds are made back to the employer if the fund is doing better. However, if at the end of the ride it turns out that the employer has made much more payments than has received refunds, the system is unsustainable. Hence, in these scenarios, the pension benefits also have to be corrected, since assuming that the employer can make indefinite payments is unrealistic. As in the non-regulatory model, this increases the probability under the left tail of the distribution, as can be seen when comparing Figure 5 to Figure 3 and Figure 6 to Figure 4.

6.3 Riskier distribution of assets

One of the initial assumptions of the models was that the fictional pension fund holds 30% equities and 70% fixed-income returns. This distribution of assets is normal for regular DB pension fund. However, considering that the fictional pension fund in this study only has one 25-year-old participant, a riskier distribution of assets could be more appropriate. In addition, a riskier distribution could lead to greater differences between the three models. Hence, we increase the risk-attitude of the pension fund by increasing the amount of equities it holds to 70% of total assets. For completeness, the results are shown in Figures F1 to F8 in Appendix

F. When comparing these to the results of the initial model – that is, Figures 1 to 8 – one can see that the results are very similar but that the differences between the non-regulatory, Dutch, and Canadian models are slightly more visible when increasing the amount of risk. Nevertheless, the results are very much alike and the same conclusions can be drawn from the riskier variant as before. Hence, we see that changing the risk attitude of the pension fund has limited effect on the eventual outcomes and the differences between the three models.

Given the little impact that increasing the amount of equities has, we refrain from running more variants or lifecycle variants of the models in this study.

6.4 Including possible employer discontinuity

Under the Canadian regulatory framework, the employer plays a big role in maintaining a financially healthy fund. However, we have not yet considered the possibility for the employer to go bankrupt. In bad economic scenarios, this is a realistic possibility.

If the employer goes bankrupt, the pension fund does not receive any premiums or special payments anymore. On the other hand, since there are no active participants anymore, there is no new accrual of pension benefits. Since there are no special payments or refunds to the employer, this means that there are no regulations to control the financial situation of the fund. Hence, the Canadian regulatory framework basically turns into a non-regulatory framework in this case. Given this, we expect that there will be more extreme outcomes for the funding ratio. However, since there are no incoming premiums or payments, but also no new accrual, we cannot say how big the effects on the funding ratio will be and whether the funding ratios will increase or decrease on average. This mainly depends on the return on assets and the interest rate at which the liabilities are discounted. In addition, without new accrual of pension benefits after the discontinuation of the employer, the resulting pensions at pension date will be lower than when the employer continues indefinitely. This effect is expected to be larger than the effect on the funding ratio. Following this, we also expect the pension results to be lower in the scenarios where employer bankruptcy occurs because of the missed accruals.

Since an employer will most likely go bankrupt in sudden bad economic situations, a drop of minimally 30% in equity returns was chosen as a trigger for the discontinuity of the employer. That is, if in a scenario and at a certain time point, equities drop by 30%, the employer is considered go bankrupt, and from that time point premiums, special payments and new accrual equal zero. Annual unconditional indexation of pension benefits remain. As a consequence of the chosen trigger, bankruptcy of the employer occurs in 13,1% of all scenarios. Since the amount of affected scenarios is limited, the visible effects will most likely also be

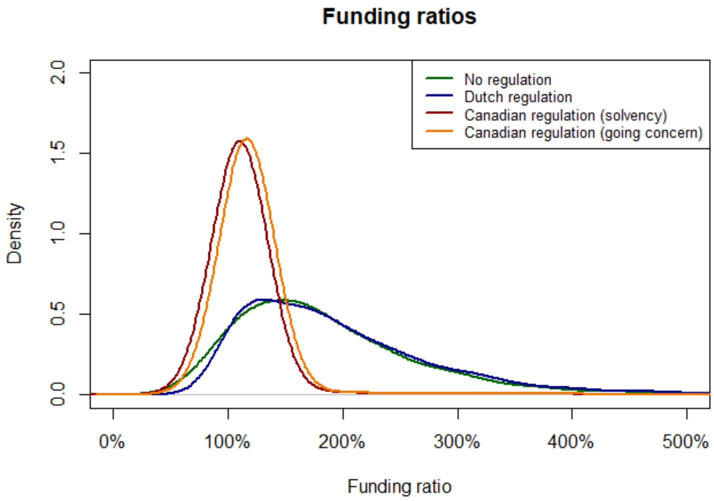

Figure 9. Distributions of the funding ratios without regulation, under Dutch regulation and under Canadian regulation, including the possibility of employer discontinuity.

limited. Lowering the threshold of the equity drop to for example 25%, the amount of affected scenarios would increase to 43,4% of the scenarios. This would also increase the effects on the outcomes of the model. However, an employer discontinuity percentage of 43,4% would be unrealistic, and for brevity, the corresponding results are not shown here.

Figure 9 shows the resulting distributions after including the possibility of employer discontinuity in the Canadian model. The distributions of the non-regulatory and Dutch model remain unchanged compared to Figure 1. At first sight, the distributions of the Canadian model do not appear very different from Figure 1 as well. However, looking closer, one can see that the tails of the distributions are much longer in Figure 9 than in Figure 1. In addition, the peak of the distributions under Canadian regulation lie slightly lower than in Figure 1. Table E7 in Appendix E.2 reports the mean and relevant percentiles corresponding to the distributions. When comparing these to the outcomes in Table E1, one can see that the minimum and maximum outcomes are much more extreme when accounting for possible employer discontinuation. This corresponds to our expectations.

In Figures 10 to 13 on the next page, the nominal accrued pension, real accrued pensions, nominal accrued pensions after correction, and the real accrued pensions after correction are shown, respectively. In Figures 10 and 11, it is immediately apparent that the red distribution is no longer equal to the green distribution, as was the case in Figures 3 and 4. In the scenarios where the employer goes bankrupt, there is no new accrual of pension benefits, hence resulting in lower accrued benefits at pension date. This explains the lower peaks and the larger left tails of the distributions of the nominal and real accrued pensions under Canadian regulation. Bankruptcy of the employer most likely does not occur in the economically better scenarios,

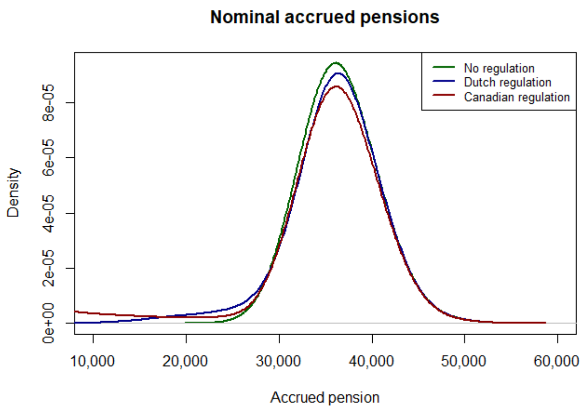

Figure 10. Distributions of the nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation, including the possibility of employer discontinuity.

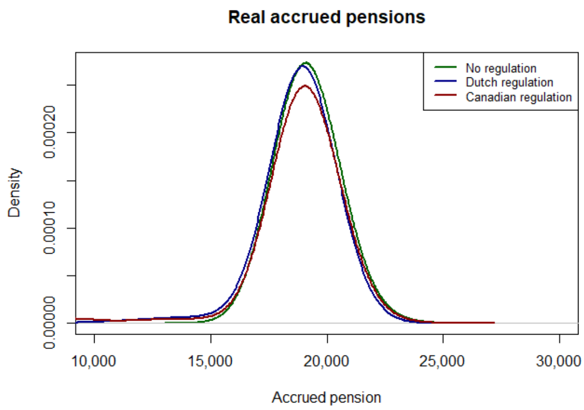

Figure 11. Distributions of the real accrued pensions without regulation, under Dutch regulation and under Canadian regulation, including the possibility

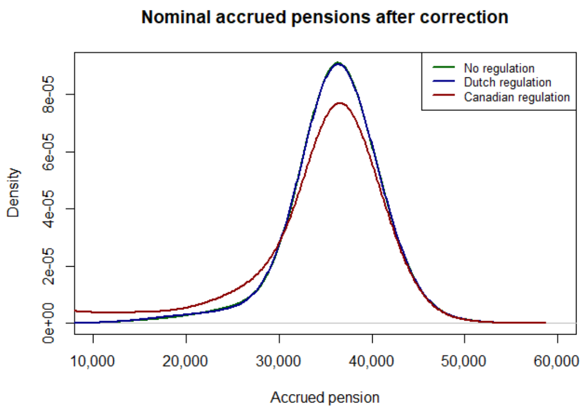

Figure 12. Distributions of the corrected nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation, including the possibility of employer discontinuity.

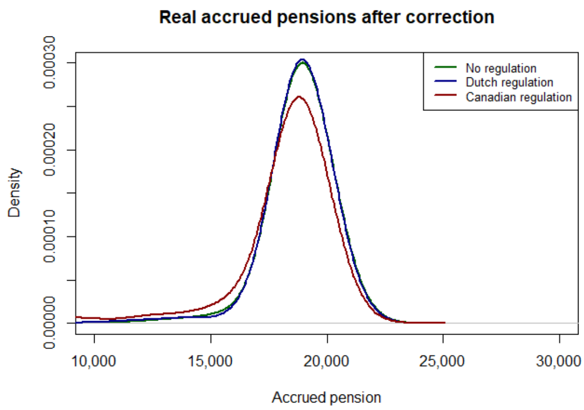

Figure 13. Distributions of the corrected real accrued pensions without regulation, under Dutch regulation and under Canadian regulation, including the possibility of employer discontinuity.

which is also visible by the unchanged right tail of the distributions. In Figure 12 and 13, where the nominal and real accrued benefits after correction are shown, the same effects can be seen. Compared to Figures 5 and 6, the peaks of the Canadian distributions are lower and the left tails are fatter. Tables E8 to E11 report the corresponding means and percentiles of the nominal and real accrued benefits. Comparing the last columns (Canadian regulation) to the last columns of Tables E2 to E5, respectively, one can see that means have decreased after accounting for possible employer discontinuation. Furthermore, it shows that the results have strictly decreased, especially the minimum values and 5th percentiles have decreased drastically. This corresponds to the fact that the employer goes bankrupt in approximately 13% of the scenarios, since in these scenarios, the accrued benefits would decrease the most. The earlier the bankruptcy occurs in a scenario, the more accrual will be missed and the lower the resulting benefits will be.

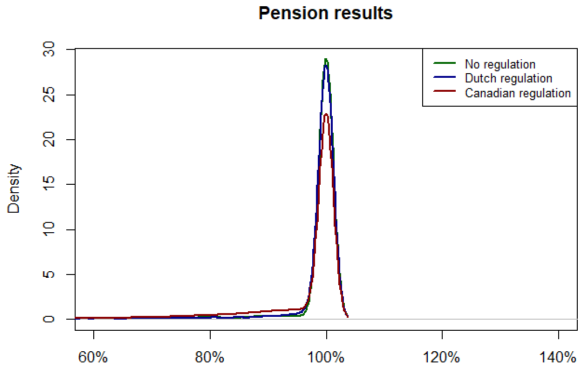

Figure 14. Distributions of the pension results without regulation, under Dutch regulation and under Canadian regulation, including the possibility of employer discontinuity.

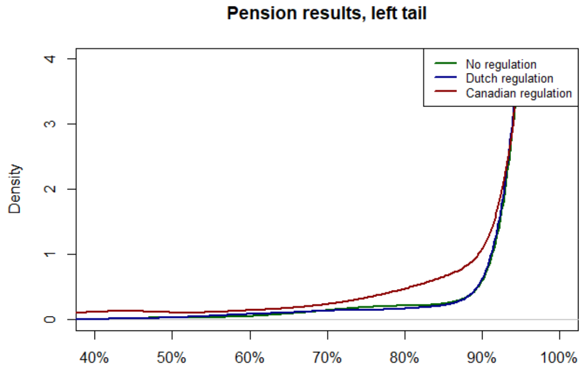

Figure 15. Left tails of the distributions of the pension results without regulation, under Dutch regulation and under Canadian regulation, including the possibility of employer discontinuity.

Finally, Figures 14 and 15 show the distributions of the pension results and the left tails of the distributions of the pension results, respectively. Comparing Figure 14 to Figure 7, one can see that peak around 100% has decreased. Given the lower accrued benefits resulting from the missed accruals after the bankruptcy of the employer, this corresponds with earlier expectations. Zooming in on the left tail in Figure 15, and comparing this to the left tail shown in Figure 8, the left tail is slightly fatter below approximately 70%.

7 Conclusion

In this study several short-term discontinuity requirements and long-term sufficiency requirements for occupational pension funds were considered. More specifically, the existing regulatory frameworks in the Netherlands, Europe, and Canada were discussed. The Dutch regulatory framework follows the European framework, and mainly uses short-term requirements to ensure a healthy financial situation for the pension funds. These short-term requirements include the ROF and MROF regulations, which put certain lower limits on the funding ratio of a pension fund. If the funding ratio falls below either of the lower limits, curtailments are implemented on the participants' pension benefits. Moreover, annual indexations may only be implemented in case the funding ratio is over 110%. Finally, Dutch pension funds have to annually do a feasibility test, in which the long-term is considered and in which they have to demonstrate that the expected pension result is feasible.

The Canadian regulatory framework is less prescriptive in its regulations and leaves more freedom of choice for pension funds when it comes to for example the chosen discount rate. In contrast to the Dutch framework, the Canadian framework considers both a solvency and going concern funding ratio. By accounting for the going concern assets and liabilities, the Canadian framework also looks at the long-term financial situation of the fund. However, the quantitative requirements for the funding ratio are lower. Both the solvency and going concern funding ratio must not be under 100%. But, if this is not the case, this still does not affect the height of the participants' pension benefits. Instead, special payments are made by the employer into the fund. In economically good times, with a funding ratio over 125%, refunds are made back to the employer. However, this system only works if the employer has enough assets itself to provide the special payments when necessary, and if the employer does not go bankrupt. In the latter case, the pension fund is left to itself, without any formal regulations to control the fund's financial situation.

To compare the effects of the Dutch and Canadian regulatory framework on a person's pension benefits, we have developed three models in which the same fictional pension fund develops over a period of 40 years. The model starts with a 25-year-old participant, and ends at their pension date at the age of 65. In the first model, we consider a non-regulatory framework, in which no regulations have been put in place and the fund is left to develop freely. In the second model, the Dutch ROF and MROF regulations, and the rules for indexation are implemented. In case the funding ratio does not oblige to the Dutch requirements, the pension benefits of the participant are curtailed, which can only be compensated again if the height of the funding ratio allows for this. In the third model, the Canadian requirements for the solvency and going concern ratios are considered. In case these are not met, the employer makes special payments into the fund. Additionally, we have developed a model in which the possibility of employer discontinuity is considered.

The results for the funding ratio show significant differences between the Canadian distributions and the non-regulatory and Dutch distributions. The Canadian curves show symmetrical distributions with very high peaks around 115%. The non-regulatory and Dutch curves are much flatter, with short left tails and very long right tails. Their peak lies around 125%. The Dutch regulatory framework resulted in the distribution with the shortest left tail, and the highest mean and minimum value, as can be seen in Table E1. This is the result of the fact that measures such as curtailments are taken relatively early in comparison to the Canadian framework. However, this could lead to lower pension benefits for the participants in case the curtailments are not compensated at a later date.

After correcting for low funding ratios at pension date in the non-regulatory model and for the employer payments in the Canadian model, the results for the three models are very similar. However, Figure 5 and 6 show that the Canadian distribution for the accrued pension benefits performs worse in the lower half of the distribution than the non-regulatory and Dutch ones. This can be seen by the slightly lower peaks and the fatter tails, implying that there is more chance of receiving lower pension benefits under the Canadian supervisory framework. When allowing for possible employer discontinuity, the differences with the other two models are even more visible and the effects are enlarged. The scenarios in which the employer goes bankrupt result in lower accrued pension benefits and more extreme funding ratios as a result of the loss of financial interference. This results in a minimal nominal pension as low as €2,250 and a minimal real pension of €1,118 under the Canadian framework. Furthermore, it allows for far lower pension results than the non-regulatory and Dutch system, as can be seen by the fatter and longer tail of the Canadian distribution in Figures 14 and 15.

Maybe in contrast to prior expectations, the non-regulatory and Dutch outcomes are very much alike. Since the Dutch supervisory framework focuses on maintaining and providing nominal pensions, one would expect that the Dutch outcomes for real pensions would be inferior to the other results for real pensions. This because the regulations are made to uphold the nominal pensions, while indexing is only allowed if the fund has an almost exceptionally high funding ratio. However, this does not seem to be the case. In spite of the different steps taken underway, at pension date, participants can expect the same level of pension benefits in a system without regulations than in a system in which pension curtailments are possible and indexations are conditional. From Table E10 and E11 it appears that the non-regulatory framework results in the highest minimum values and means for the nominal and real pensions. However, the differences with the Dutch framework are minimal, especially in real terms. An advantage of the Dutch system is that participants are sooner aware of the possibility of lower pension benefits. In the non-regulatory framework, participants might not be aware if the fund is doing bad since pension accrual and indexation are unconditional. But, if at pension date it appears that the fund has a very low funding ratio, new pensioners are suddenly informed that the expected amount of pension benefits is much lower than they thought.

Overall, we might conclude that applying the Dutch and Canadian regulatory frameworks do not materially improve the pension benefits of a pension fund's participants. The outcomes following the non-regulatory and Dutch frameworks result in better results in the lower-halves of the distributions than the Canadian framework, especially after allowing for employer discontinuity. The non-regulatory framework results in slightly higher means and minimum values for the accrued pension benefits, however, the results are very similar to the Dutch system. Moreover, the Dutch framework informs the participants of possible lower benefits in an early stage, while the notification of lower benefits in the non-regulatory framework only comes at pension date. Given this, the results imply that it would be most beneficial for the participants to have a framework in which there are no regulations. But in addition, it is recommended that the participants are notified immediately or at an early stage if the pension fund goes through bad economic times or low funding ratios. This could be done by providing annual information on the fund's financial performance, the current funding ratio, or the height of the expected benefits for the participants. This way, the participants know what to expect and this will prevent huge disappointments for the participants at pension date.

As mentioned in Section 2, the Dutch government has come to a new pension agreement. Following this agreement, the Dutch framework takes a step towards a more non-regulated framework, which is accordance with the conclusions of this study. This is reflected in the following changes. The height of accrued pension benefits will for example be less secure then before, and will more closely follow the movements of financial markets. Moreover, pension funds no longer need to hold large buffers. This has as a consequence that curtailments can occur earlier if the economy is doing bad, but it also means that indexations can be granted earlier if the economy is doing well. Furthermore, pension funds must invest according to lifecycles. Because of this, younger age cohorts will be exposed to more risk to achieve higher returns and because they have more time to recover from setbacks. Older age cohorts, on the other hand, will be exposed to less risk in order to secure the height of their accrued pensions. Although the pensions of participants will become somewhat less secure, expectations are that overall pensions benefits will increase. (Minsterie van Sociale Zaken en Werkgelegenheid, 2020). Moreover, pension funds must update their participants annually on how the fund is doing and on the expected pension benefits. As mentioned, this is line with the conclusions that are drawn from the results of this study.

References

Actuarial Standards Board. (2020, 1 January). *Standards of Practice*. Retrieved from https://www.cia-ica.ca/docs/default-source/standards/sc010120e.pdf.

Broeders, D., Kortleve, N., Pelsser, A., & Wijckmans, J. (2011). The design of European supervision of pension funds. *Netspar Design Paper 06*.

De Haan, J., Janssen, K., & Ponds, E. (2011). The Holistic Balance Sheet as the New Framework for European Pension Supervision. *Netspar Design Paper 33*.

De Jong, F., & Pelsser, A. (2010). Herziening Financieel Toetsingskader [Revision of the Financial Assessment Framework]. *NEA paper 33*.

De Nederlandsche Bank (DNB). (2005). *Vaststelling van de methodiek voor de rentetermijnstructuur* [Determination of the methodology for the interest rate term structure]. Retrieved from https://www.toezicht.dnb.nl/binaries/50-212329.pdf

De Nederlandsche Bank (DNB). (2015). *UFR methodiek voor de berekening van de rentetermijnstructuur* [UFR methodology for calculating the interest rate term structure]. Retrieved from https://www.toezicht.dnb.nl/binaries/50-234028.pdf

De Nederlandsche Bank (DNB). (2020). *Scenarioset 2020 Q1 met 2.000 scenario's* [Dataset]. Retrieved 10 June 2020, from https://www.toezicht.dnb.nl/2/50-233246.jsp.

Besluit financieel toetsingskader pensioenfondsen. [Pension Fund (Financial Assessment Framework) Decree]. (2008, 18 December). Retrieved from https://wetten.overheid.nl/BWBR0020871.

Commissie Parameters. (2019). *Advies Commissie Parameters* [Advice Commission Parameters]. Retrieved from https://www.rijksoverheid.nl/documenten/kamerstukken/2019/06/11/advies-commissie-parameters.

Directives of the Superintendent pursuant to the Pension Benefits Standards Act. (1985). Retrieved from https://www.osfi-bsif.gc.ca/eng/pp-rr/ppa-rra/pages/directives.aspx.

European Parliament, Council of the European Union. (2003). Directive 2003/41/EC on the activities and supervision of institutes for occupational retirement provision. *Official Journal, 46*(L235), 10-21.

European Parliament, Council of the European Union. (2009). Directive 2009/138/EC on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II). *Official Journal, 52*(L335), 1-155.

European Parliament, Council of the European Union. (2010). Regulation (EU) No 1094/2010 establishing a European Supervisory Authority (European Insurance and Occupational Pensions Authority). *Official Journal, 53*(L331), 48-83.

European Parliament, Council of the European Union. (2016). Directive (EU) 2016/2341 on the activities and supervision of institutes for occupational retirement provision (IORPs). *Official Journal*, *59*(L354), 37-85.

Fransen, E., Kortleve, N., Schumacher, H., Staring, H., & Wijckmans, J. (2010). The holistic balance sheet as a building block in pension fund supervision. *Netspar Design paper 18*.

Koninklijk Actuarieel Genootschap / Royal Dutch Actuarial Association. (2019). *Vaststelling van het Minimaal Vereist Eigen Vermogen* [Determination of the Minimum Required Own Funds]. Retrieved from https://www.ag-ai.nl/view/42624-Notitie+Vaststelling+van+het+Minimaal+Vereist+Eigen+Vermogen+%28mei+2019%29.pdf.

Kortleve, N., Mulder, W., & Pelsser, A. (2011). European supervision of pension funds: purpose, scope and design. *Netspar Design Paper 04*.

Ministerie van Sociale Zaken en Werkgelegeheid. (2020). *Hoofdlijnennotitie uitwerking pensioenakkoord* [Note on the outlines of the pension agreement]. Retrieved from https://www.rijksoverheid.nl/documenten/publicaties/2020/06/22/hoofdlijnennotitie-pensioenakkoord.

Office of the Superintendent of Financial Institutions. (2011). *OSFI and the Canadian Financial System.* Retrieved from https://www.osfi-bsif.gc.ca/Eng/Docs/osfi_bch.pdf

Office of the Superintendent of Financial Institutions Act, RSC 1985, c 18 (3rd Supp.), Part I. Retrieved from https://laws-lois.justice.gc.ca/PDF/O-2.7.pdf.

Pensioen- & Verzekeringskamer (PVK). (2001). *Meer transparantie betere informatie: de uitgangspunten voor een financieel toetsingskader*.

Pensioenwet. [Pension Act]. (2006, 7 December). Retrieved from https://wetten.overheid.nl/BWBR0020809.

Pension Benefits Standards Act, RSC 1985, c 32 (2nd Supp.). Retrieved from https://laws-lois.justice.gc.ca/PDF/P-7.01.pdf.

Pension Benefits Standards Regulations, SOR/87-19. Retrieved from https://laws-lois.justice.gc.ca/PDF/SOR-87-19.pdf.

Regeling Pensioenwet en Wet verplichte beroepspensioenregeling. [Regulation on Pension Act and Compulsory Professional Pension Scheme Act]. (2006, 19 December). Retrieved from https://wetten.overheid.nl/BWBR0020917.

Appendix A: The ten risk categories of the required own funds

Interest rate risk (S_1)

Interest rate risk occurs because the liabilities of pension funds generally have longer maturities than their assets. This means that changes in the interest rate do not affect the value of the assets in the same way as the value of the liabilities. Usually, a negative movement of the interest rate causes a greater increase in liabilities than in assets, which in turn lowers the funding ratio. For the determination of the interest rate risk, all financial products which are sensitive to interest rate changes are considered. This includes government bonds, corporate bonds, mortgages, high yield bonds, index-linked bonds, emerging market debt and interest rate derivatives.

The height of the interest rate risk is determined by means of two scenarios as established by DNB. One of the scenarios considers an upward shift of the interest rate curve while the other scenario considers a downward shift. For both scenarios, the cashflows of the assets and of the liabilities for each maturity are multiplied by corresponding factors which are given by DNB. The scenario with the most negative impact on the buffer of the pension fund is used for the determination of the interest rate risk.

Equity and real estate risk (S_2)

The value of invested assets of the pension fund can fluctuate due to developments on the financial markets. To be able to catch a possible blow, pension funds have to hold a buffer. The height of the buffers is calculated by considering a scenario in which the concerned invested assets depreciate. The overall buffer that has to be held for equity and real estate risk is then equal to the total depreciation of the relevant assets. As presented in Table 1, equity and real estate is divided into four categories, where each category has its own depreciation scenario.

Equity and real estate risk category	***Downward shock***
Equities developed markets, including listed real estate (S_{2A})	30%
Equities emerging markets (S_{2B})	40%
Unlisted equities (S_{2C})	40%
Unlisted real estate (S_{2D})	15%

Table A1. Categories and corresponding scenarios of equity and real estate risk.

There is assumed to be correlations of 0.75 between the different categories of equity and real estate. Hence, the total equity and real estate risk buffer is calculated as follows:

$$S_2 = (S_{2A}^2 + S_{2B}^2 + S_{2C}^2 + S_{2D}^2 + 2 \cdot 0.75 \cdot S_{2A} \cdot S_{2B} + 2 \cdot 0.75 \cdot S_{2A} \cdot S_{2C} + 2 \cdot 0.75 \cdot S_{2A} \cdot S_{2D} + 2 \cdot 0.75 \cdot S_{2B} \cdot S_{2C} + 2 \cdot 0.75 \cdot S_{2B} \cdot S_{2D} + 2 \cdot 0.75 \cdot S_{2C} \cdot S_{2D})^{1/2}$$

<u>Foreign exchange risk (S_3)</u>

Foreign exchange risk is the risk that the value of assets in foreign currencies decrease because of changes in the exchange rates against the euro. This is a risk for a pension fund since its liabilities are usually denominated in euros. As with equity and real estate risk, the total buffer for foreign exchange risk is calculated by considering a scenario in which the foreign currencies depreciate. Two categories are distinguished for foreign exchange risk with corresponding scenario shocks, as shown in Table 2.

Foreign exchange risk category	***Downward shock***
Currencies developed markets (S_{3A})	20%
Currencies emerging markets (S_{3B})	35%

Table A2. Categories and corresponding scenarios of foreign exchange risk.

When calculating the total buffer for foreign exchange risk, a correlation of 0.25 is assumed between currencies developed markets and currencies emerging markets. Moreover, a correlation of 0.5 is assumed between individual currencies developed markets and a correlation of 0.75 is assumed between individual currencies emerging markets. Hence, the total buffer for foreign exchange risk can be calculated as

$$S_3 = (S_{3A}^2 + S_{3B}^2 + 2 \cdot 0.25 \cdot S_{3A} \cdot S_{3B})^{1/2}$$

where

$$S_{3A} = \left(\sum_i S_{3\,(i)}^2 + \sum_{i,j,i \neq j} 0.5 \cdot S_{3\,(i)} \cdot S_{3\,(j)} \right)^{1/2}$$

and

$$S_{3B} = \left(\sum_i S_{3\,(k)}^2 + \sum_{k,l,k \neq l} 0.75 \cdot S_{3\,(k)} \cdot S_{3\,(l)} \right)^{1/2}$$

<u>Commodity risk (S_4)</u>

Pension funds which invest in commodities have the risk that the value of these commodities decrease. The total buffer for commodity risk is determined by considering a negative scenario where the value of the commodities decrease by 35%. No distinction is made between different categories of commodities.

Credit risk (S_5)

Credit risk is the risk that the credit spread of investments change, thereby changing the value of those investments. The credit spread of an investment is the difference in return between an investment of which the payments depend on the creditworthiness and the same investment if the payments would be paid out with full certainty. Generally, an increase in the credit spread of investments implies a decrease of the value of those investments. Thus, when calculating the credit risk buffer, a scenario is considered in which the credit spread increases. The amount of the increase in credit spread depends on the rating of the investment. Table 3 shows the different classifications of rating and the corresponding increase of the credit spread.

Rating of the investment	***Increase of credit spread***
European government bonds AAA	+ 0 basis points
AAA	+ 60 basis points
AA	+ 80 basis points
A	+ 130 basis points
BBB	+ 180 basis points
< BBB or not rated	+ 530 basis points

Table A3. Categories and corresponding scenarios of credit risk.

Underwriting risk (S_6)

The underwriting risk refers to all insurance technical bases which pose a material risk to the pension fund. In principle, only risks related to mortality are taken into account when determining the underwriting risk. Underwriting risk consists of litigation risk, trend mortality uncertainty (TMU), and negative stochastic deviation (NSD). Litigation risk are possible negative changes in the participant base over a 1-year horizon with 97.5% certainty. TMU is the uncertainty of the longevity trend. The uncertainty is larger for a higher average age of the funds participant base. Finally, NSD is the risk that the average mortality age of participants differs from the assumptions used for calculating the technical provision. Both TMU and NSD are determined for the full term of the funds liabilities.

DNB does not provide a standard methodology for calculating the underwriting risk buffer. However, it provides guidelines that pension funds may use. The methodology by DNB distinguishes by age cohorts and pension forms. The height of the individual components of the underwriting risk are calculated per pension form. The following formulas are given for calculating the litigation risk, TMU and NSD per pension form i:

$$Litigation\ risk_i = \left(\frac{c_{1i}}{\sqrt{n_i}} + \frac{c_{2i}}{n_i}\right) \cdot technical\ provision_i$$

$$TMU_i = c_{3i} \cdot technical\ provision_i$$

$$NSD_i = \frac{c_{4i}}{\sqrt{n_i}} \cdot technical\ provision_i$$

where $c_{j,i}$, $j = 1, \dots, 4$ are parameters which can be found in prespecified tables by DNB, depending on the age cohort and pension form, and n_i are the number of participants of pension form i. For completeness, the tables with parameters values $c_{j,i}$, $j = 1, \dots, 4$ as given by DNB are shown in Appendix B. Finally, the total buffer to be held for underwriting risk is calculated as

$$S_6 = litigation\ risk + \sqrt{TMU^2 + NSD^2}$$

Liquidity risk (S_7)

Pension funds have a risk of not having enough liquid assets to fulfil their payment obligations. The standard model for determining required own funds sets the sensitivity of own funds for liquidity risk equal to 0%. This is based on the assumption that pension funds manage their liquidity risk in such way that it is not material for determining required own funds. Although pension funds do not have to take liquidity risk into account when determining required own funds, they do have to take it into account, in accordance with the prudent person principle, when determining their investment policy.

Concentration risk (S_8)

Pension funds have concentration risk if they do not spread their assets sufficiently. The standard model for determining required own funds sets the sensitivity of own funds for concentration risk equal to 0%. This is based on the assumption that pension funds have an investment portfolio diversified in such way that the concentration risk is not material for determining required own funds. Although pension funds do not have to take concentration risk into account when determining required own funds, they do have to take it into account, in accordance with the prudent person principle, when determining and implementing their investment policy.

Operational risk (S_9)

Operational risk is the risk that arises as a result of failure of internal processes, human and technical shortcomings, and unexpected external events. The standard model for determining required own funds sets the sensitivity of own funds for operational risk equal to 0%. This is based on the assumption that pension funds manage their operational risk in such a way that it is not material for determining required own funds. Although pension funds do not have to take operational risk into account when determining required own funds, they do have to take it into account in the implementation of risk management.

Active management risk (S_{10})

Active management risk arises if asset managers actively manage the investment portfolio. Active management is taking deviating positions in portfolios with respect to the strategically determined investment portfolio.

DNB does not provide a standard methodology for calculating the active management risk buffer. However, it provides guidelines that pension funds may use. The buffer for active management risk is determined as the maximum loss due to active management in one year, with 2.5% certainty. The degree of active management is usually determined by the tracking error (TE). The tracking error measures the deviation in return between the actual investment portfolio and the benchmark portfolio. A higher tracking error means that the actual return has a high deviation from the return of the benchmark portfolio, thus implying a high degree of active management. Only investment portfolios with a tracking error higher than 1% need to be taken into account when calculating the active management risk buffer. Also the costs of active management, the total expense ratio (TER), are taking into account. The total active management risk buffer is then calculated as

$$S_{10} = \sum_i market\ value_i \cdot (1.96 \cdot TE_i + TER_i)$$

where i represents the investment portfolio. Furthermore, the 2.5th percentile of the normal distribution, 1.96, is used based on the assumption that the excess return following from active management is well described by a normal distribution.

Appendix B: Parameters values for calculating underwriting risk

Basispercentages solvabiliteitsvereiste verzekeringstechnische risico's					
Leeftijd	Ouderdomspensioen (OP)	Ouderdomspensioen met nabestaandenpensioen			
		Te bereiken OP, kapitaal	Reeds bereikt OP, kapitaal	Te bereiken OP, risicobasis	Reeds bereikt OP, risicobasis
30	6%	208%	23%	290%	33%
35	7%	93%	19%	131%	29%
40	8%	58%	18%	83%	27%
45	10%	39%	15%	57%	24%
50	13%	26%	12%	38%	20%
55	16%	15%	8%	23%	14%
60	21%	5%	4%	9%	6%
65	28%	10%	10%	6%	6%
70	37%	14%	14%	8%	8%
75	48%	19%	19%	11%	11%
80	63%	27%	27%	16%	16%
85	81%	37%	37%	26%	26%
90	104%	53%	53%	43%	43%

Table B1. Parameter value c_1 for determining litigation risk.

Correctieterm solvabiliteitsvereiste verzekeringstechnische risico's					
Leeftijd	Ouderdomspensioen (OP)	Ouderdomspensioen met nabestaandenpensioen			
		Te bereiken OP, kapitaal	Reeds bereikt OP, kapitaal	Te bereiken OP, risicobasis	Reeds bereikt OP, risicobasis
30	0%	1872%	199%	2612%	298%
35	0%	727%	148%	1061%	227%
40	0%	362%	106%	522%	169%
45	0%	190%	71%	280%	118%
50	0%	95%	40%	146%	75%
55	0%	38%	13%	68%	39%
60	0%	0%	0%	18%	7%
65	0%	0%	0%	0%	0%
70	0%	0%	0%	0%	0%
75	0%	0%	0%	0%	0%
80	0%	0%	0%	0%	0%
85	0%	0%	0%	0%	0%
90	0%	0%	0%	0%	0%

Table B2. Parameter value c_2 for determining litigation risk.

Basispercentages TSO					
Leeftijd	Ouderdomspensioen (OP)	Ouderdomspensioen met nabestaandenpensioen			
		Te bereiken OP, kapitaal	Reeds bereikt OP, kapitaal	Te bereiken OP, risicobasis	Reeds bereikt OP, risicobasis
30	10%	6%	6%	9%	10%
35	9%	6%	6%	9%	9%
40	8%	5%	5%	8%	8%
45	7%	5%	5%	6%	7%
50	5%	4%	4%	5%	5%
55	4%	3%	3%	4%	4%
60	3%	3%	3%	3%	3%
65	2%	2%	2%	2%	2%
70	2%	2%	2%	2%	2%
75	2%	2%	2%	2%	2%
80	2%	2%	2%	2%	2%
85	1%	1%	1%	1%	1%
90	1%	1%	1%	1%	1%

Table B3. Parameter value c_3 for determining TMU.

Basispercentages NSA					
Leeftijd	Ouderdomspensioen (OP)	Ouderdomspensioen met nabestaandenpensioen			
		Te bereiken OP, kapitaal	Reeds bereikt OP, kapitaal	Te bereiken OP, risicobasis	Reeds bereikt OP, risicobasis
30	40%	80%	30%	110%	40%
35	40%	45%	30%	60%	40%
40	40%	30%	25%	50%	40%
45	40%	25%	25%	45%	40%
50	40%	20%	20%	40%	40%
55	40%	20%	20%	40%	40%
60	35%	20%	20%	35%	35%
65	30%	15%	15%	30%	30%
70	35%	20%	20%	30%	30%
75	40%	25%	25%	35%	35%
80	50%	30%	30%	40%	40%
85	55%	35%	35%	45%	45%
90	65%	40%	40%	50%	50%

Table B4. Parameter value c_4 for determining NSD.

Appendix C: Schematic representation of the computation of the MROF

Article	***Description***		***Subtotal***
Art. 11(2)	In case the fund is exposed to investment risks:		
	- net technical provision	*a1*	
	- reinsured technical provision	*a2*	
	Reduction rate: min{ a1 / (a1 + a2) , 0.85 }	*b*	
	Subtotal of art. 11(2): 0.04 * (a1 + a2) * b		***A***
Art. 11(3)	In case the fund is not exposed to investment risks and is committed to its management costs for more than five years:		
	- technical provision	*c*	
	Subtotal of art. 11(3): 0.01 * c		***B***
Art. 11(4)	In case the fund is not exposed to investment risks and is commited to its management costs for five years or less:		
	- net management costs of past year	*d*	
	Subtotal of art. 11(4): 0.25 * d		***C***
Art. 11(5)	For pension schemes with capital at risk on decease:		
	- net capital at risk	*e1*	
	- reinsured capital at risk	*e2*	
	Reduction rate: max{ e1 / (e1 + e2) , 0.50 }	*f*	
	Subtotal of art. 11(5): 0.003 * (e1 + e2) * f		***D***
Art. 11(6)	For disability pension schemes:		
	- net claims in the past three financial years	*g1*	
	- reinsured claims in the past three financial years	*g2*	
	Reduction rate: max{ g1 / (g1 + g2) , 0.50 }	*h*	
Art. 11(6)(a)	Premiums written or earned, whichever is higher, plus the policy costs charged:	*i*	
	- until €50 million	*j1*	
	- exceeding €50 million	*j2*	
	*Subtotal of art. 11(6)(a): (0.18 * j1 + 0.16 * j2) * h*	*k*	
Art. 11(6)(b)	Average of the written gross claims in the past three financial years plus the average addition to the claims provision in these years:	*l*	
	- until €35 million	*m1*	
	- exceeding €35 million	*m2*	
	*Subtotal of art. 11(6)(b): (0.26 * m1 + 0.23 * m2) * h*	*n*	
	Subtotal of art. 11(6): max{ k , n }	*p*	
Art. 11(7)	Subtotal of art. 11(6) in last financial year	*q*	
	In case p < q:		
	- net claims provision at the end of the previous financial year	*r*	
	- net claims provision at the beginning of the previous financial year	*s*	
	Reduction rate: min{ r/s , 1 }	*t*	
	Subtotal of art. 11(7): if p < q: t * q , if p > q: p		***E***
	Total Minimum Required Own Funds A + B + C + D + E		**MROF**

Table C1. Schematic representation of the computation of the MROF.

Appendix D: Schematic representation of the computation of the RSM

Article	***Description***	***Subtotal***	
Art. 17(2)	The required solvency margin is equal to the sum of the following two components:		
Art. 17(2)(a)	- net technical provision	*a1*	
	- reinsured technical provision	*a2*	
	Reduction rate: $\min\{ a1 / (a1 + a2) ,\ 0.85 \}$	*b*	
	Subtotal of art. 17(2)(a): $0.04 * (a1 + a2) * b$		
Art. 17(2)(b)	For policies with nonnegative capital at risk:		
	- net capital at risk	*c1*	
	- reinsured capital at risk	*c2*	
	Reduction rate: $\max\{ c1 / (c1 + c2) ,\ 0.50 \}$	*d*	
	Subtotal of art. 17(2)(b): $0.003 * (c1 + c2) * d$		
	Subtotal of art. 17(2): $\mathbf{0.04 * (a1 + a2) * b + 0.003 * (c1 + c2) * d}$		***A***
Art. 17(3)	For insurances referred to in point (a)(iii) of art. 2(3) Solvency II (disability insurances):		
	- required solvency margin as described in art. 18 IORP II		
Art. 18(2)	The required solvency ratio is equal to the premium basis as described in art. 18(3) IORP II or the claims basis as described in art. 18(4) IORP II.		
	Reduction rate as laid out in art. 18(3) and art. 18(4) IORP II:		
	- net claims in the past three financial years	*e1*	
	- reinsured claims in the past three financial years	*e2*	
	Reduction rate: $\max\{ e1 / (e1 + e2) ,\ 0.50 \}$	*f*	
Art. 18(3)	Premiums written or earned, whichever is higher, plus the policy costs charged:	*g*	
	- until €50 million	*h1*	
	- exceeding €50 million	*h2*	
	Subtotal of Art. 18(3): $(0.18 * h1 + 0.16 * h2) * f$	*i*	
Art. 18(4)	Average of the written gross claims in the past three financial years plus the average addition to the claims provision in these years:	*j*	
	- until €35 million	*k1*	
	- exceeding €35 million	*k2*	
	Subtotal of Art. 18(4): $(0.26 * k1 + 0.23 * k2) * f$	*l*	
	Subtotal of Art. 18(2): $\max\{ i ,\ l \}$	*m*	
Art. 18(5)	Subtotal of Art. 18(2) in last financial year	*n*	
	In case $m < n$:		
	- net claims provision at the end of the previous financial year	*p*	
	- net claims provision at the beginning of the previous financial year	*q*	
	Reduction rate: $\min\{ p/q ,\ 1 \}$	*r*	
	Subtotal of Art. 17(3): ***if*** $\mathbf{m < n}$***:*** $\mathbf{r * n}$ ***,*** ***if*** $\mathbf{m > n}$***:*** $\mathbf{m}$		***B***

Art. 17(4)	For capital redemption operations referred to in point(b)(ii) of art. 2(3) Solvency II:			
	Subtotal of Art. 17(4):	***0.04 * (a1 + a2) * b***		***C***
Art. 17(5)	For operations referred to in point (b)(i) of art. 2(3) Solvency II (tontines): - assets		*s*	
	Subtotal of Art. 17(5):	***0.01 * s***		***D***
Art. 17(6)	For assurances referred to in points (a)(i) and (ii) of art. 2(3) Solvency II and for the operations referred to in points (b)(iii) to (v) of art. 2(3) Solvency II:			
Art. 17(6)(a)	*Subtotal of Art. 17(6)(a):*	*0.04 * (a1 + a2) * b*	*t*	
Art. 17(6)(b)	In case the fund is not exposed to investment risks and is committed to its management costs for more than five years: - technical provision		*u*	
	Subtotal of Art. 17(6)(b):	*0.01 * u*	*v*	
Art. 17(6)(c)	In case the fund is not exposed to investment risks and is commited to its management costs for five years or less: - net adminstrative expenses of past year		*w*	
	Subtotal of Art. 17(6)(b):	*0.25 * w*	*x*	
Art. 17(6)(d)	For policies with nonegative capital at risk:			
	Subtotal of Art. 17(6)(d):	*0.003 * (c1 + c2) * d*	*y*	
	Subtotal of Art. 17(6):	***t + v + x + y***		***E***
	Total Required Solvency Margin	**A + B + C + D + E**		**RSM**

Table D1. Schematic representation of the computation of the RSM.

Appendix E: Summary statistics of the results of the model

Appendix E.1: Model excluding possible employer discontinuity

Funding ratio	No regulation	Dutch regulation	Canadian regulation	
			Solvency	Going concern
Mean	185.98%	196.24%	110.61%	116.85%
Minimum	46.68%	78.37%	68.82%	76.28%
5th percentile	87.54%	102.39%	87.02%	94.20%
25th percentile	127.67%	130.96%	100.19%	106.82%
50th percentile	169.05%	175.47%	110.90%	116.76%
75th percentile	225.65%	236.77%	120.85%	126.85%
95th percentile	339.09%	359.16%	133.97%	139.73%
Maximum	669.70%	713.36%	166.49%	165.70%

Table E1. Summary table of the funding ratios without regulation, under Dutch regulation and under Canadian regulation.

Nominal pension	No regulation	Dutch regulation	Canadian regulation
Mean	€36,513.69	€35,982.84	€36,513.69
Minimum	€27,271.79	€11,553.96	€27,271.79
5th percentile	€31,249.69	€28,090.98	€31,249.69
25th percentile	€34,060.96	€33,937.65	€34,060.96
50th percentile	€36,295.63	€36,295.63	€36,295.63
75th percentile	€38,754.10	€38,754.10	€38,754.10
95th percentile	€42,483.63	€42,483.63	€42,483.63
Maximum	€51,218.44	€51,218.44	€51,218.44

Table E2. Summary table of the nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

Real pension	No regulation	Dutch regulation	Canadian regulation
Mean	€19,169.02	€18,817.87	€19,169.02
Minimum	€16,012.79	€9,014.56	€16,012.79
5th percentile	€17,546.68	€16,913.29	€17,546.68
25th percentile	€18,410.60	€18,218.26	€18,410.60
50th percentile	€19,102.13	€18,929.91	€19,102.13
75th percentile	€19,850.92	€19,646.45	€19,850.92
95th percentile	€20,985.04	€20,676.16	€20,985.04
Maximum	€24,183.19	€22,621.40	€24,183.19

Table E3. Summary table of the real accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

Corrected nominal pension	***No regulation***	***Dutch regulation***	***Canadian regulation***
Mean	€36,015.67	€35,982.84	€35,469.19
Minimum	€13,331.57	€11,553.96	€11,662.26
5th percentile	€27,929.96	€28,090.98	€25,411.20
25th percentile	€33,948.77	€33,937.65	€33,296.77
50th percentile	€36,289.00	€36,295.63	€36,127.22
75th percentile	€38,751.22	€38,754.10	€38,691.83
95th percentile	€42,483.63	€42,483.63	€42,483.63
Maximum	€51,218.44	€51,218.44	€51,218.44

Table E4. Summary table of the corrected nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

Corrected real pension	***No regulation***	***Dutch regulation***	***Canadian regulation***
Mean	€18,840.43	€18,817.87	€18,522.20
Minimum	€9,732.53	€9,014.56	€8,381.18
5th percentile	€16,830.98	€16,913.29	€15,463.11
25th percentile	€18,215.25	€18,218.26	€17,921.31
50th percentile	€18,936.03	€18,929.91	€18,739.40
75th percentile	€19,672.40	€19,646.45	€19,511.76
95th percentile	€20,706.56	€20,676.16	€20,609.46
Maximum	€22,621.40	€22,621.40	€22,796.58

Table E5. Summary table of the corrected real accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

Pension result	***No regulation***	***Dutch regulation***	***Canadian regulation***
Mean	98.40%	98.29%	96.77%
Minimum	46.68%	42.18%	40.20%
5th percentile	100.00%	97.80%	87.15%
25th percentile	100.00%	100.00%	100.00%
50th percentile	100.00%	100.00%	100.00%
75th percentile	100.00%	100.00%	100.00%
95th percentile	100.00%	100.00%	100.00%
Maximum	100.00%	100.00%	100.00%

Table E6. Summary table of the pension results without regulation, under Dutch regulation and under Canadian regulation.

Appendix E.2: Model including possible employer discontinuity

Funding ratio	***No regulation***	***Dutch regulation***	***Canadian regulation***	
			Solvency	***Going concern***
Mean	185.98%	196.24%	117.09%	123.60%
Minimum	46.68%	78.37%	34.87%	41.25%
5th percentile	87.54%	102.39%	85.53%	92.42%
25th percentile	127.67%	130.96%	99.58%	106.41%
50th percentile	169.05%	175.47%	111.08%	116.99%
75th percentile	225.65%	236.77%	122.27%	127.82%
95th percentile	339.09%	359.16%	141.40%	147.85%
Maximum	669.70%	713.36%	659.95%	692.13%

Table E7. Summary table of the funding ratios without regulation, under Dutch regulation and under Canadian regulation.

Nominal pension	***No regulation***	***Dutch regulation***	***Canadian regulation***
Mean	€36,513.69	€35,982.84	€ 34,637.15
Minimum	€27,271.79	€11,553.96	€2,250.00
5th percentile	€31,249.69	€28,090.98	€14,269.63
25th percentile	€34,060.96	€33,937.65	€33,400.85
50th percentile	€36,295.63	€36,295.63	€35,946.92
75th percentile	€38,754.10	€38,754.10	€38,577.60
95th percentile	€42,483.63	€42,483.63	€42,460.43
Maximum	€51,218.44	€51,218.44	€51,218.44

Table E8. Summary table of the nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

Real pension	***No regulation***	***Dutch regulation***	***Canadian regulation***
Mean	€19,169.02	€18,817.87	€18,138.36
Minimum	€16,012.79	€9,014.56	€1,118.23
5th percentile	€17,546.68	€16,913.29	€7,798.91
25th percentile	€18,410.60	€18,218.26	€18,125.93
50th percentile	€19,102.13	€18,929.91	€18,946.09
75th percentile	€19,850.92	€19,646.45	€19,755.33
95th percentile	€20,985.04	€20,676.16	€20,859.72
Maximum	€24,183.19	€22,621.40	€24,183.19

Table E9. Summary table of the real accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

Corrected nominal pension	***No regulation***	***Dutch regulation***	***Canadian regulation***
Mean	€36,015.67	€35,982.84	€33,745.81
Minimum	€13,331.57	€11,553.96	€2,250.00
5th percentile	€27,929.96	€28,090.98	€13,415.00
25th percentile	€33,948.77	€33,937.65	€32,240.56
50th percentile	€36,289.00	€36,295.63	€35,737.54
75th percentile	€38,751.22	€38,754.10	€38,471.80
95th percentile	€42,483.63	€42,483.63	€42,460.43
Maximum	€51,218.44	€51,218.44	€51,218.44

Table E10. Summary table of the corrected nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

Corrected real pension	***No regulation***	***Dutch regulation***	***Canadian regulation***
Mean	€18,840.43	€18,817.87	€17,585.26
Minimum	€9,732.53	€9,014.56	€1,118.23
5th percentile	€16,830.98	€16,913.29	€7,798.91
25th percentile	€18,215.25	€18,218.26	€17,614.29
50th percentile	€18,936.03	€18,929.91	€18,588.06
75th percentile	€19,672.40	€19,646.45	€19,399.99
95th percentile	€20,706.56	€20,676.16	€20,515.58
Maximum	€22,621.40	€22,621.40	€22,796.58

Table E11. Summary table of the corrected real accrued pensions without regulation, under Dutch regulation and under Canadian regulation.

Pension result	***No regulation***	***Dutch regulation***	***Canadian regulation***
Mean	98.40%	98.29%	91.96%
Minimum	46.68%	42.18%	5.89%
5th percentile	100.00%	97.80%	73.57%
25th percentile	100.00%	100.00%	95.97%
50th percentile	100.00%	100.00%	100.00%
75th percentile	100.00%	100.00%	100.00%
95th percentile	100.00%	100.00%	100.00%
Maximum	100.00%	100.00%	100.00%

Table E12. Summary table of the pension results without regulation, under Dutch regulation and under Canadian regulation.

Appendix F: Results for pension fund with increased risk

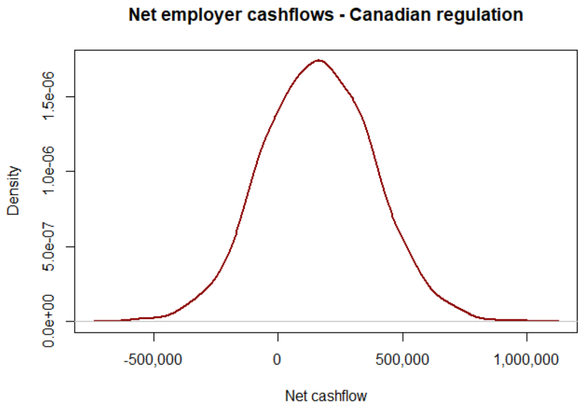

Figure F1. Distribution of the net total employer payments under Canadian regulation, assuming 70% equities.

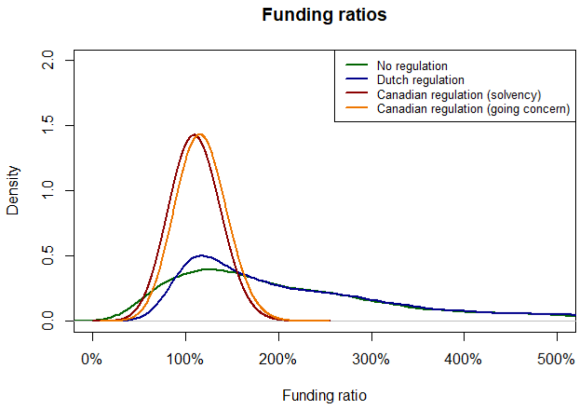

Figure F2. Distributions of the funding ratios without regulation, under Dutch regulation and under Canadian regulation, assuming 70% equities.

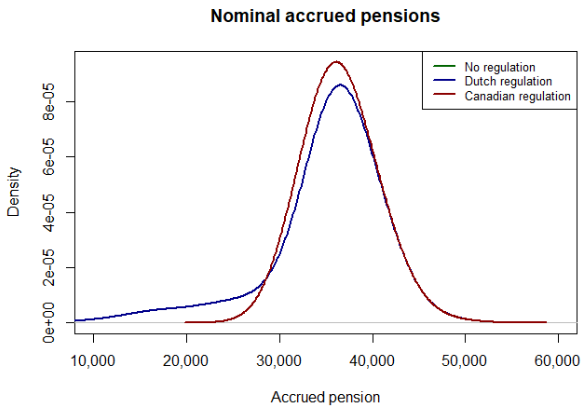

Figure F3. Distributions of the nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation, assuming 70% equities.

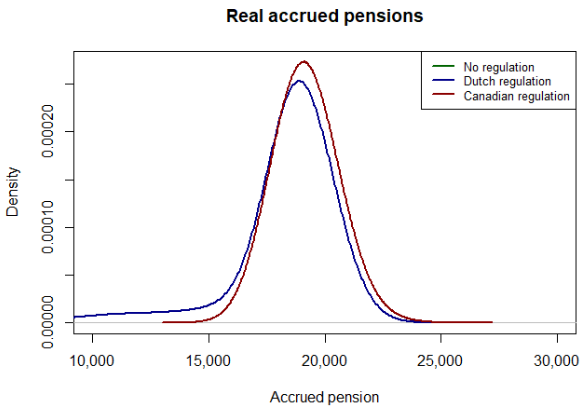

Figure F4. Distributions of the real accrued pensions without regulation, under Dutch regulation and under Canadian regulation, assuming 70% equities.

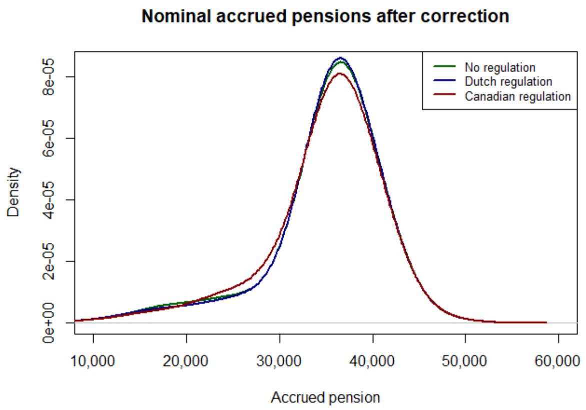

Figure F5. Distributions of the corrected nominal accrued pensions without regulation, under Dutch regulation and under Canadian regulation, assuming 70% equities.

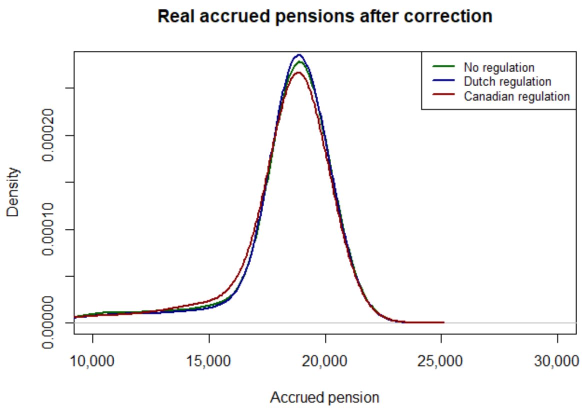

Figure F6. Distributions of the corrected real accrued pensions without regulation, under Dutch regulation and under Canadian regulation, assuming 70% equities.

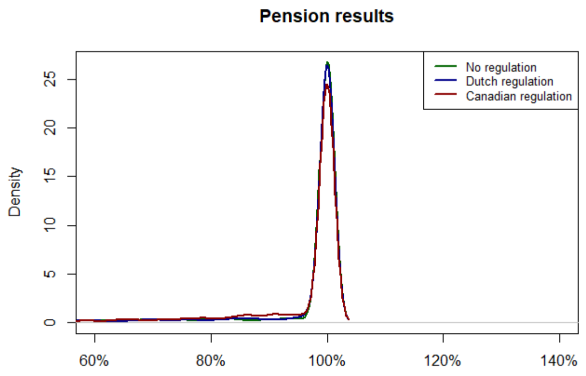

Figure F7. Distributions of the pension results without regulation, under Dutch regulation and under Canadian regulation, assuming 70% equities.

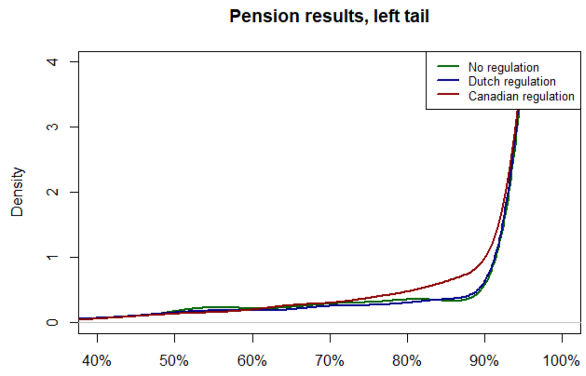

Figure F8. Left tails of the distributions of the pension results without regulation, under Dutch regulation and under Canadian regulation, assuming 70% equities.