ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics

Master Thesis Financial Economics

Discounting Dutch pension liabilities

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Date final version: 07-22-2020

Preface

This thesis about the Dutch pension system is the final proof of competence for obtaining the Master of Science (MSc) degree in Financial Economics from the Erasmus University Rotterdam. First I would like to thank Casper de Vries, my supervisor, for his guidance, support, useful feedback and especially his steady enthusiasm about the topic of my thesis. Secondly, I would like to thank my father for the inspiration at the start, the pep talks during and the last comments at the end of the writing process. I would also like to thank Peter Borgdorff, Theo Kocken and Jacintha den Haag for the interesting and informative interviews about the Dutch pension system. And at last, I would like to give my colleagues at JBR a big thank you for their support. I am happy that I can finally reassure them that I handed in the final document that was needed to officially become their full-time colleague.

Abstract

In this thesis, I investigate an alternative for the risk-free discount rate for the Dutch pension liabilities. These liabilities need to be valued over extensive periods of time and that automatically creates uncertainty. But at the same time, the system that manages and supervises these liabilities needs to give the Dutch population confidence that there will be sufficient pensions for when they retire or even for when their (grand)children retire. Therefore, it is important to be prudent, but also to give pension funds enough freedom to achieve returns on long-term investments. The current discount rate is based on the risk-free market rate and thus largely influenced by interest rate fluctuations caused by central bank policies. The guarantees that are agreed on in the Dutch pension system and the risk-free discount rate that does not represent a fundamental risk-free market rate anymore, creates unnecessary concerns about the quality of our system and restricts Dutch pension funds from providing future pensions. Therefore an alternative basis for this discount rate is needed. An growth rate can be assumed to be achievable as long as long-term historical data is used to assess the return and associated risk. By looking at the characteristics of pension funds as investors, this equity return approaches a better discount rate than the risk-free return. But these returns are still quite volatile and it is not clear whether historical returns provide sufficient evidence for future returns. Therefore, there is not enough certainty that these returns are actually achievable. Subsequently, I investigate long-term GDP growth as an alternative starting point for a discount rate. The investments of pension funds consist of a substantial share of worldwide GDP. The long-term historical World GDP growth rate lies around 3.5%. And compared to the volatility on rates of return on equity, the GDP growth rate is more stable. I also find that the distribution of the GDP growth rate is heavy-tailed. Thus, it is important that Dutch pension diversify worldwide to mitigate the risk of extreme returns. If pension funds invest in a worldwide, well-diversified portfolio based on GDP growth through financial markets, a return on their investments similar to GDP growth can be achieved plus a premium that will be picked up through investments in the equity markets.

Keywords: pension funds, discount rate, liabilities, long-term investment returns

Table of contents

1 Introduction to the Dutch Pension System

1.1 Structure of the Dutch Pension System

The Dutch capital funding pension system consists of three pillars. The first pillar includes the Dutch state pension scheme. People that are living in the Netherlands build up this pension under the General Old Age Pension Act (Algemene Ouderdomswet, AOW). The second pillar is the employment-related pension. Both the employer and the employee contribute to this pension through pension premiums. This part of the pension is managed by pension funds. Pension funds invest a part of the contributions they receive in e.g. equity, real estate and bonds and use the accumulated capital to pay out pension benefits in the future. The third pillar is the individual pension supplementary to the pension in the other two pillars, which is, for example, provided through life insurance or a bank saving scheme.

The first pillar, the AOW, functions as a pay-as-you system (PAYG). This means that pension benefits are linked to the contributions paid by individual participants. In less favorable economic times, this part of the pension system provides a stable pension benefit base. On the other hand, PAYG systems are sensitive to demographic developments such as an aging population. Currently, the working population is decreasing while the retired population that needs AOW is increasing. This puts pressure on the pension contribution of the young for the first pillar in the Dutch system.

Table 1: total income and expenses first and second pillar Dutch pension system (2016)

in million EUR	**First pillar (AOW)**	**Second pillar (pension**
Premiums	26,000	30,000
Payments	37,000	29,000

Source: CBS Statline

In the Dutch pension system, the second pillar is the capital funded part of the Dutch system, where contributed pension premiums are collectively invested. Therefore, investment risk is taken both before the retirement date and while the pension is in payment. All participants in the pension fund pay a fixed percentage of their salary to the fund and in exchange they receive a claim on a pension income in the future. For pension funds to be able to pay out these pension benefits in the future, they need to value this commitment to assess whether they have enough capital available. Whether pension comply with the standards that are mandated, for example, about capital requirements, is supervised by the Dutch national bank (De Nederlandsche Bank, DNB). The DNB monitors three aspects of the Dutch pension system: the financial position, the operational management and the board members of pension funds. The financial position of pension funds is determined by their funding ratio. The funding ratio is the ratio between the pension funds' assets and liabilities. The value of the pension funds' assets is largely determined by the present value of their investments. The value of their liabilities is determined by the present value of the current and future pension obligations.

$$\text{Funding ratio} = \frac{\text{Present Value Assets}}{\text{Present Value Liabilities}}$$

The discount rate is an important determinant of the present value of the assets and liabilities. To define this discount rate, underlying assumption should be made about the risk and return involved in the saving and investing of pension funds. Based on commitments about paying out pension benefits that are made now, an assessment of pension funds ability to meet these commitments needs to be made. This ability is represented in the funding ratio.

1.2 Risk management of pension funds

It is a difficult task to make assumptions about the long-term risk associated with the investments pension funds make. There are many different kinds of risks that pension funds need to manage. These risks include, i.a. individual and systematic longevity risk, interest rate risk, systematic risk, inflation risk and market risk.

The individual longevity risk, is the risk that we might live longer than the average life expectancy at the moment of retiring. This risk is one of the fundamental ideas of a pension fund. As soon as you retire, you consume the amount that you saved during your working life. How much you consume is based on expectations on how long you live. If a person lives longer than was expected, there is a chance that the pension benefits are gone, before the end of his life, so that there is not enough to consume and vice versa. In every kind of pension insurance, through an insurer or pension fund, we find a solution for this problem. Which comprise that the individual longevity risk is shared between participants in pools. Large pools of people provide insurance for this risk, because the people who pass away early, will leave their money for people who live longer. This idea is based on the law of large numbers, meaning that the average age of all the people in the pool should be close to the life expectancy of the population. So sharing this risk component is, besides building up enough capital through premiums, the core of the Dutch collective pension system.

The systematic longevity risk is the uncertainty about the structural growth in life expectancy that cannot be shared amongst the participants of the Pension Fund. The risk can shift from one generation to another, but it cannot be insured. It would be very complex or expensive to try to mitigate this kind of risk, so it would make sense that participants would bear it individually. Younger, working people, can still mitigate this risk because their human capital probably also increases if they live longer. Retirees on the other hand, cannot do that anymore other than through changing their consumption pattern. But for this last group, the consequences are also lower compared to the average group. This kind longevity risk has started to become more important to manage for Dutch pension funds, because life expectancy is expected to increases and the population is aging. Therefore it is important that pension funds are saving enough and that pensions are distributed equally over generations.

Thirdly, there is interest rate risk, which is one of the most complex to optimize in the context of life-cycle investing. It can have such substantial impact that it can destabilize institutions like life insurance companies and pension funds. For the management of the balance sheet, these institutions are exposed to increases and declines in interest rates. Therefore specific interest rate management strategies are required, whose effects have to be analyzed within pension funds and at a more macro financial level (Fleuriet & Lubochinsky, 2005). Apart from the direct interest rate risk that impacts returns on their investments, the funding ratio of pension systems also indirectly depends on the level of interest rates due to, for example, regulation.

Non-marketable risks are risks that cannot be reduced by trading in securities in financial markets. This kind of risk can only be traded between generations. An example of risk applies to all participants of the Pension fund is inflation risk. This is a systematic risk, although there are financial markets that offer financial products that can mitigate this risk. For example, Inflation-Linked Bonds (IBLs), which are not traded in the Netherlands, but in other countries in Europe, e.g. France. But IBLs are known to be relatively illiquid, and therefore they have a lower or higher rate of return than the corresponding nominal bonds. Which makes inflation risk harder to mitigate than other risks that can easily be hedged using financial products that are traded with high frequency.

Market risk, or systematic market risk, is the risk that investors bear due to losses that are a consequence of factors effecting the whole financial market. The CPB (Netherlands Bureau for Economic Policy Analysis) has performed multiple studies about spreading this kind of risk over generations. They find (Van Ewijk *et al.*, 2014) that around 95-99% of the market risk can be reduced by only keeping it within one generation, not across other generations as well (Kocken, 2015).

This discount rate that takes into account the different kinds of risks that influence the value of the pension fund's assets and liabilities, is called the actuarial rate.

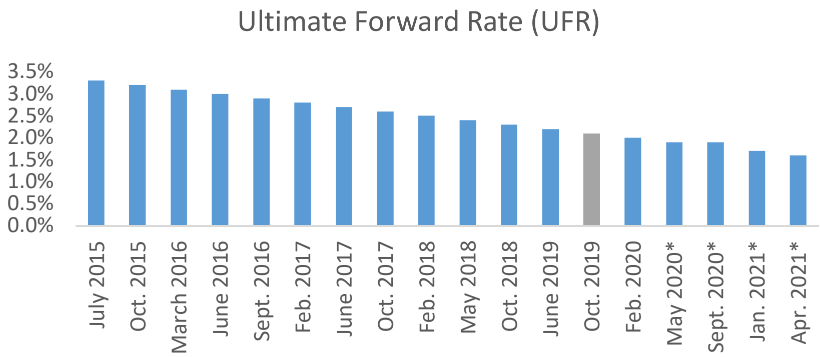
1.3 Discounting the Dutch pension liabilities

The Financial Assessment Framework (FTK) is the Dutch pension regulation that states how the liabilities (the future pension benefits) of the pension funds are required to be calculated, the amount of buffers they need to have, the required contributions for pension funds and the risks pension funds need to manage. Until the introduction of the FTK in 2007, Dutch pension liabilities used be discounted at a fixed rate of

4%. This fixed rate has been changed to a method using the risk-free rate, because this would better fit the assumption of an implicitly guaranteed pension and because it would better match the mark-to-market (MtM) approach applied to the valuation of the assets.

These implicit guarantees in the Dutch pension system, mean that people that pay premiums to a pension funds and are entitled to a certain amount of future pension. The height of this future pension is, in a certain way, partially secured in the Dutch system. Because of the commitments we make regarding secured future pensions, the Dutch pension system uses the risk-free rate as a starting point to discount pension fund's liabilities. The risk-free rate is the compensation for holding (government) bonds and bills, thus it is an investment without compensation for credit risk. The difficulty in determining the risk-free rate or its curve, is the question whether currently observed expected future rates are reliable enough to determine the value of such long-term liabilities. Also, the market for such long-term investments is relatively illiquid and therefore highly influenced by demand and supply shocks. That is one of the main reasons that the DNB sets the actuarial rate not only based on the risk-free market rate, but also on a certain interest rate term structure, namely the Ultimate Forward Rate (UFR). This UFR method is applied for bonds with a maturity of more than 20 years. This UFR is not a constant factor, but a percentage that depends on the duration of the liability. Liabilities with a longer duration are in to a lesser extent based on the risk-free market rate. So liabilities that would have to be paid out in 30 years are discounted at a higher rate than liabilities with a duration of 20 years. Every five years the Parameters Committee issues an advice on the UFR. The most recent advice dates from June 2019 (Dijselbloem *et al.*, 2019). The report advices a new UFR that implies a discount rate for pension funds liabilities of around 2.1%.

The UFR consists of three elements. The first is the starting point of the extrapolation method, so the point at which the not only market information is used to determine the forward rate. Second, the level of the UFR that the forward rate converges to for rates in the far future. And at last, the extrapolation method, the method that is used to create the discount rate structure from the starting point to the level of the UFR.



Graph 1: the UFR estimated at different points in time between 2015 and 2021

The choices that the Parameters Committee needs to make regarding these three elements are not objective. They state that they try to approach a scientific justification, but there is no unambiguous evidence that convinces that the method is the most suitable way to determine a discount rate for long-term pension liabilities. Pension liabilities are discounted over extensive periods of time, so a small change in the applied discount rate, has a large impact on its valuation. Subsequently, the rate that is chosen has large impact on the measured financial health of the Dutch pension system. This measured financial health is used to base the arrangement within the Dutch pension system on, for example, the amount of premiums we need to pay or whether funds need to curtail their pension payments. At the same time, it is an estimation with very little certainty. Apart from that, the way we try to approach the right discount rate is largely influenced by fluctuations in interest rates. Interest rates have been volatile, therefore the actuarial rates needs to be adjusted regularly which causes changes in the funding ratios of pension funds. This interest rate risk, as described earlier in this Chapter, is complex and difficult to hedge. Apart from that, there are some other problems related to the calculation and the assumptions regarding this essential discount rate.

This is where I contribute with this research about what could be a more appropriate, more fundamental and most importantly, a more stable starting point to determine whether out pension system will be able to provide pensions for current and future generations.

In Chapter 2, I provide a theoretical framework for pension fund systems and its relationship with GDP growth. In Chapter 3, I analyze the actuarial rate under the current pension system. In Chapter 4, I assess whether expected returns on equity and bonds could be a better starting point for a discount rate for pension liabilities. In Chapter 5, I analyze the fundamentals GDP growth based on historical data. In Chapter 6, I assess whether GDP growth would be an appropriate starting point to determine a discount rate for pension liabilities.

2 Theoretical framework

Dutch pension funds and the system they operate in, are highly important both on the level of individuals being able to enjoy a sufficient pension after retiring and on the level of pension funds as investors that impact the Dutch and global economy. The interaction between these two levels becomes clear when I look at the neoclassical view on pension fund schemes.

2.1 The neoclassical view on pension fund schemes

In the neoclassical view on Pension Fund schemes, there is interaction between the growth in Gross Domestic Product (GDP), the savings rate and capital accumulation. The current economic production activity is created by today's working generation and by the capital invested. Part of the production is paid out in wages. The working generation consumes part of those wages and saves the rest by contributing premiums to the pension funds. Pension funds (partially) invest these premiums in the national, but also the worldwide economy, by buying assets in different firms. These firms produce output (GDP) and according to the marginal output per employee, they pay the working generation their wages.

The retired generation is dissaving and is consuming part of the capital stock by selling the assets. The constancy of this 'consumption fund' is guaranteed by the renewed saving of the working generation. In a stationary economy, saving of the working generation is matched by the dissaving of the retired generation in such a way that the amount of consumption goods incorporated in the per capita stock remains constant.

When dealing with a capital funded system like we have in the Netherlands, conventional economics have two models in mind. On the supply side of savings, there is a life-cycle model. Examples of these models are Modigliani's life-cycle theory (Modigliani, 1986) and the one-commodity Diamond (Diamond, 1965) type life-cycle model. Modigliani's model is in turn, an elaboration of Keynes's 'foresight' motive of saving decisions (Keynes, 1936). On the demand of savings side, the reference model depends on the relationship between savings and investment as found in the conventional neoclassical growth model of Solow (1956). The neoclassical growth models led to steady-state analysis, which is one of the most important constructs in public finance and it is the underlying of much of the development in literature. The neoclassical theory was constructed to explain the low-frequency growth observations and is used to analyze steady-state behavior. But it also appeares to be of use for understanding movements in: consumption, capital and labor input, investment, factor incomes and output and is therefore also relevant for pension systems.

These variables in the neoclassical theory can be applied to investigate the dynamics in a pension scheme. In short, a simplified model of the Dutch capital funded system can be described as follows. One generation accumulates savings in a Pension Fund during their working life. At the start of each period, these savings are saved through pension funds. The pension funds lend these savings to firms in return for financials assets in these firm. The ownership of financial assets, represents the capital stock of the pension funds and is uniformly distributed among the retirees. The firms that received money from the pension funds, hire the younger generation of workers. At the end of the period, the capital consists of: the replacements of the capital goods consumed in the production process, the wage paid to the workers and the return on the capital advanced. Workers use their wage to consume and through their savings at pension funds they indirectly buy assets from the other generation, which will later provide their pension. The retirees consume all their financial resources and then pass away. In this model, the pension funds passively function as a buffer between generations. In this economy, the capital stock is constant from one period to the next. There is no net savings since the value of the assets bought by the workers is precisely equal to that sold by the retirees. The savings of the workers match the dissaving of the retired generation.

The way this model functions, shows that a well-functioning capital funded pension scheme implies the existence of financial reserves held in assets that represent ownership shares in the capital stock. A scheme in which the pension funds own large fractions of government bonds, does not function as well as a fully capital funded scheme, because it normally does not lead to the formation of new capital and corresponding financial reserves. It only does, if governments invest capital in, for example, infrastructure and education. These kind of investment do increase productivity, at least for the next generation. According to the neoclassical principles, the capital stock increases if there is an increase in the supply of savings. (Cesaratto, 2007).

The Solow model (1956) predicts that countries with high investment rates have higher levels of income. High investment rates can be provided by high savings rates. A country with a capital funded system, automatically arranges high savings levels and therefore essential investments. GDP (income) growth provides the possibility for the working generation to save. Through pension funds this creates a growing capital base. This capital base will provide a ‘consumption fund’ for the retired generation. The amount of payments that can be made to the retirees depends on the capital accumulation that is provided by the working generation. If the income of the working generation depends on the GDP growth and therefore their savings rate, then the growth in capital does depend on GDP growth as well.

Robert Solow (Solow, 1956) introduced a simple growth model with substitution between capital and labor, with labor augmented by technological change. The model describes some key facts about economic growth. It describes that real output per worker on average grows at a more or less constant rate.

The growth rate of tangible capital fluctuates around that same rate, so the capital-to-output ratio is more or less constant. The capital share in income is close to constant, so, along with a constant capital share, this implies a constant rental price for capital. Finally, output per worker and the real wage grow on average at a common rate. So the Solow growth model shows that the capital per worker converges towards a steady state where it remains constant. Auerback and Kotlikoff (1995) adopt a Cobb-Douglas production function in per capita terms to show this. Constant capital per worker implicates that when this state is reached, assuming a certain population growth, savings rate and capital depreciation, there is also no long-term per capita GDP growth. In that steady state, there can still be GDP growth, but as long as technology does not improve labor productivity, there is constant capital per capita and constant GDP growth per capita. Countries that are far away from this steady state, grow faster than countries that have almost completely converged to it. To achieve the steady state, capital needs to be invested and accumulated into the economy (Hanna, 2006).

Because of current Dutch pension regulation, pension funds are required to assume the risk-free rate as return on their assets, because these assets will be needed to provide for the technical provisions, or liabilities the Dutch system is committed to, based on the guarantees to be able to pay out the promised pensions. Therefore, actual investments in this risk-free asset class, like government bonds, is part of Dutch pension funds' investment policy. Namely, about 35% of their investments consists of government bonds. So this risk-free rate assumption, forms a certain restriction on the allocation of their capital to invest in

2.2 A simple model of the capital funded pension scheme

There are many different neoclassical growth models that compare and evaluate pension schemes. To understand the fundamentals of long-term growth, I present a simple overlapping generations model due to Diamond (1965) who built on work of by Samuelson (1958). The Diamond model assumes a constant population growth rate of n such that $L_{t+1} = L_t(1+n)$. And it assumes there are two overlapping generations: young active workers and an old retired generation. So individuals live for two period, one in which they are young and working and one in which they are old and retired. The utility of an individual born in period t is:

$$U_t = \ln c_{1,t} + \frac{1}{1+\rho} \ln c_{2,t\_1}$$

the notations $c_{1,t}$ and $c_{2,t+1}$ are respectively the individual's consumption in period 1 and in period $t+1$. The ρ is the subjective discount rate.

The working generation receives a wage that depends on the capital-labor ratio. Part of their wage is what they consume in period 1 ($c_{1,t}$) and the rest is what they save. The savings are collected by the pension funds and invested in assets. These investments, and the yield that pension funds are able to achieve, are providing the consumption in period 2 ($c_{2,t+1}$).

In the second period of his life, the individual does not earn any wage anymore, so the following intertemporal budget constraint applies:

$$w_t = c_{1,t} + \frac{1}{1 + r_{t+1}} c_{2,t+1}$$

where w_t is the real wage in period t and r_{t+1} is the real rate of return on savings in period $t+1$. The individual chooses consumption in such a way that U_t is maximized, subject to the budget constraint. At the optimum the following Euler equation holds:

$$c_{2,t+1} = \frac{1 + r_{t+1}}{1 + \rho} c_{1,t}$$

Substituting in the budget constraint gives the consumption level in the two periods:

$$c_{1,t} = \frac{1 + \rho}{2 + \rho} w_t$$

$$c_{2,t+1} = \frac{1 + r_{t+1}}{2 + \rho} w_t$$

With the consumption of a young person, I can also compute the saving rate s during period 1:

$$s = \frac{w_t - c_{1,t}}{w_t} c_{1,t}$$

$$s = \frac{1}{2 + \rho}$$

The firms in this economy use the labor from the working generation and the capital investments from their savings as inputs to produce output, or create GDP growth. The production function is given by the Cobb-Douglas production function:

$$Y_t = K_t^{\alpha} (A_t L_t)^{1-\alpha} \quad \text{with } 0 < \alpha < 1$$

Where Y is aggregate output, K is the aggregate capital stock and L is employment (which is equal to the number of young individuals). The A stands for technology and grows at the rate of technological progress g. Technology enables L to produce more output with the same labor input. I assume that there is no depreciation of the aggregate capital stock.

Firms try to maximize their net present value, by employing the optimal amounts of labor and capital against factor prices that are given. This gives to the following first-order-conditions:

$$(1-\alpha)\frac{Y_t}{L_t} = w_t$$

$$\alpha\frac{Y_t}{K_t} = r_t$$

Which means that the value of these firms at the beginning of the period *t* is given by:

$$V_t = K_t(1+r_t)$$

The goods market clears every period. This means that aggregate investment is matched with aggregate saving. Assuming no depreciation, the change in the capital stock is equal to aggregate investments. Aggregate saving is the amount saved by the working generation minus the dissaving of the retired generation. The consumption of the retired generation is equal to their financial wealth, which depends on the value of the firms. Their income is the capital income on the shares of the firms. From that then follows that dissaving of the older generation is:

$$K_t(1+r_t) - K_t r_t = K_t$$

rearranging this equation yields the following expression:

$$K_{t+1} - K_t = K_t(1+r_t)$$

Equilibrium in the goods market gives:

$$K_{t+1} - K_t = s w_t L_t - K_t$$

and taking into account the first-order-conditions changes this equation into:

$$K_{t+1} = s(1-\alpha)Y_t$$

By dividing the Cobb-Douglas production function and this last equation by $A_t\, L_t$, the equation above can be rewritten in terms of effective labor units:

$$k_{t+1}(1+g)(1+n) = s(1-\alpha)y_t$$

where $y_t = Y_t / (A_t L_t)$ and $y_t = K_t / (A_t L_t)$. Combining the equations, then leads to the law of motion of k:

$$k_{t+1} = \frac{s(1-\alpha)k_t^{\alpha}}{(1+g)(1+n)}$$

Taking the logarithm gives the first order linear difference:

$$\ln k_{t+1} = c + \alpha \ln k_t \text{ , where } c = \ln \frac{s(1-\alpha)}{(1+g)(1+n)}$$

When *k* remains constant over time, the steady state occurs:

$$k^* = \frac{s(1-\alpha)k^{*\alpha}}{(1+g)(1+n)}$$

where the * denotes that the variable is assessed in the steady state. As α < 1, it is stationary and converges to the steady state where $\frac{c}{1-\alpha}$. Filling in the expressing $s = \frac{1}{2+\rho}$, the equation then is in agreement with the following function expressing the value of *k*:

$$k^* = \frac{(1-\alpha)}{(2+\rho)(1+g)(1+n)}^{\frac{1}{1-\alpha}}$$

The main goal of this model is to analyze the macroeconomic effects of a pension scheme.

2.3 Connection to the Dutch Pension System

For the assessment of the value of the assets and liabilities of Dutch pension funds, the neoclassical view can be useful. The neoclassical model is based on the idea that firms maximize their net present value by employing capital and labor. The capital component in the Dutch pension system mainly depends on the regulation that limits pension funds in investing in financial markets and therefore taking a share in the production of firms. The funds that pension funds have available to invest in also depends on the amount that the working generation saves, which is in turn determined by the size of the working generation.

Dutch pension funds have, by looking at the magnitude of the capital they own, a substantial share in World GDP of around 2% (see Table 2). In the table the assets from the collective balance sheet of all Dutch pension funds under supervision of DNB are show, valued at market value. The investments shown in the table are the aggregate amounts that pension funds have invested for the risk of the fund and the participants in e.g. equities, real estate, government bonds, valued against their market value. A specification of these categories is shown in Table 4.

Saving funds from the younger generation and investing those funds in a worldwide, diversified portfolio based on the fundamentals of GPD growth, could provide pension funds with a rate of return on their assets and investments of at least the GDP growth. Investing in World GDP also diminishes the effect of demographical changes the financial situation of Dutch pension funds, since pension funds rely on the global working generation producing output.

Table 2: Dutch pension funds assets and investments vs. World GDP

in billion USD	2002	2004	2006	2008	2010	2012	2014	2016	2018
Assets	557	750	985	845	1,030	1,253	1,416	1,361	1,537
Assets % of World GDP	1.6%	1.7%	1.9%	1.3%	1.6%	1.7%	1.8%	1.8%	1.8%
Investments	n.a.	n.a.	n.a.	579	751	922	1,139	1,271	1,328
Inv. % of World GDP	n.a.	n.a.	n.a.	0.9%	1.1%	1.2%	1.4%	1.7%	1.5%
World GDP	34,674	43,816	51,448	63,612	66,051	75,085	79,333	76,165	85,911
Real World GDP growth	3.0%	5.4%	5.5%	3.0%	5.4%	3.5%	3.6%	3.4%	3.6%

Source: DNB, IMF

So since pension funds' capital investments are substantial. Pension funds can invest a constant capital per worker in countries that reached their steady state, which will yield, as the neoclassical model describes, a constant output per worker (conditional convergence). The wage of the working generation depends on their productivity (output per worker) and productivity can be measured by GDP. Savings and therefore investments of pension funds depend on the savings rate (pension premium as percentage of salary). Pension funds invest all the savings of the working generation in capital that stimulates labor productivity and technical development. So capital grows at the same rate as effective labor, that is raw labor augmented by the benefits of technical progress and therefore capital per worker does not change. Constant output per worker growth will mean constant GDP growth and therefore constant savings per worker growth and constant capital growth per worker.

2.4 Evaluation of the Dutch capital funded pension system

In every pension system, it comes down to a claim or entitlement on future production. Namely, the goal of the Dutch pension system is that we will be able to consume in the future. This is either paid from saved or invested funds in a capital funded system or through a transfer of income from the working population to the retired generation in a PAYG system. How much we will be able to consume when we are retired is important to estimate and this is where purchasing power counts. For purchasing power, future goods and services are needed. If there is less supply of goods and services, the higher prices will be, which in turn decreases the value of the Dutch pensions. (Van der Lecq, 2020).

The Aaron condition (Aaron, 1966) compares rate of return for participants from a capital funded system to the return of a PAYG system. This condition assumes that both the wage rate and labor participation rate are the same for each worker and that the population growth rate is constant and exogenous. The condition essentially shows that a PAYG system is only worth more if the total compensation of the working population grows faster than the real return on invested capital, so after deducting inflation:

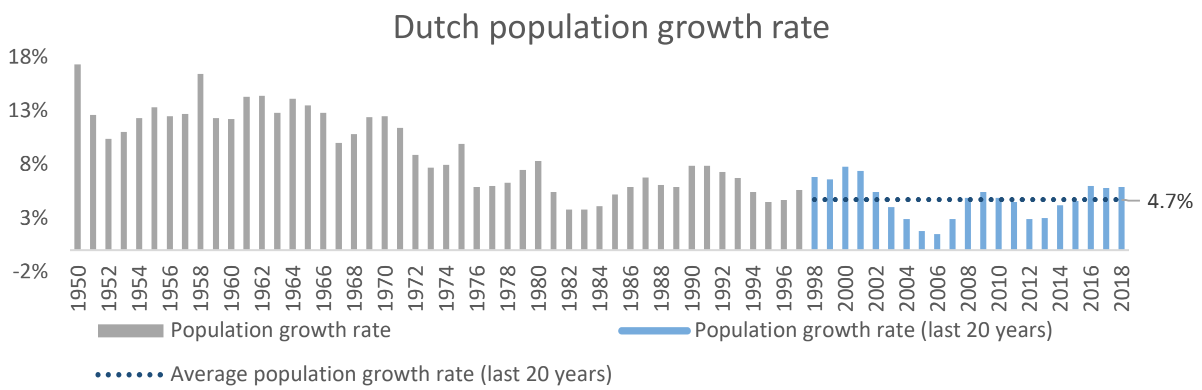
$$\omega_{t-1} N_{t-1} q < (1+\gamma)\omega_{t-1}(1+n)L_{t-1} p$$

Where ω_t is the wage rate of the working generation and L_t the number of people this working generation consists of. The γ is the growth rate of wages and the n denotes the population growth rate. Both of these growth rates are assumed to be exogenous. The left part of the inequality represents the pension liabilities of the current retirees and the right part represents the contribution of the working generation. The rate of return of an individual earned within a capital funded system depends on the fraction of their current income individuals receive when they are retired (q) compared to their contribution to the pension system during their working life (p). The rate of return on a capital funded pension system for individuals is given by the return on invested capital (r). If this return on invested capital is lower than the growth rate of wages and of the population, a PAYG pension system is the better option compared to a capital funded system. This is shown in the following inequality:

$$(1 + r) < (1 + \gamma)(1 + n)$$

This means that a PAYG system is more appropriate for a country where productivity and therefore collective wage growth is higher than the return on invested capital. These collective wages are also higher when the working population is larger compared to the retired generation. Currently, it seems that this ratio is deteriorating and that therefore a capital funded systems might be the better option.

But when I look at demographics in the Netherlands, I find that the population growth rate has been varying around the average of 4.4% in the period from 1998 till 2018 (see Graph 2). And the CBS (Dutch Central Agency for Statistics) reports that in 2018, collectively agreed (CAO) wages rose by 2%. Although, the Dutch Bureau for Economic Policy Analysis (CPB, 2018) describes that the real wages have barely increased. Subsequently, this means that if the return on capital in the Dutch pension system at least matches the population growth, the choice to fund the major part of the Dutch pension system through a capital funded system, is the right choice.



Graph 2: the Dutch population growth rate over the period 1950-2018 and the average population growth rate of the last 20 years of data (1998-2018) (CBS, 2020)

I further investigate this return on capital in the following chapters, but if I look at Table 2, I see that the world GDP growth has been around 3.5% since 2012. This indicates that at least the growth rate of the world economy is below the Dutch population growth. If this world GDP growth rate is an indicator for return on capital, a PAYG system would be more appropriate.

3 Analysis of the current pension system and actuarial rate

3.1 Guarantees in the Dutch capital funded pension scheme

As mentioned in Chapter 1, in the Dutch system commitments are made now to pay out pension in the future. The current pension regulation is based on thinking in nominal certainty. The required equity capital is based on a secured level measure of 97.5% and a normal distribution is assumed. This supervisory framework of DNB no longer fits the current situation to which pension funds need to adjust their management. The pension liabilities and pension funds' capital have increased drastically compared to the premiums that are being collected. Therefore, premiums of the working generation are not sufficient anymore to absorb potential losses on investments. With a discount rate based on the risk-free rate, many Dutch pension funds do not have any capital buffers left, so the investment risk lies with the participants. The actual level of secured pensions lies far below this 97.5%. Also, the risk-free valuation of the future pension payment commitments does not have much to do with the actual value of that participants derive from their pension.

Another consequence of this choice is that pension funds are not allowed to assume riskiness of their liabilities. Namely, the riskiness of the liabilities should match the riskiness of the pension assets or investments of pension funds. In the Dutch current system, the working generation is promised to be able to consume certain amount of pension benefits when they are retired. Since this depends on the rate of return on the capital pension funds invest, it should match the risk of the return as well. In the Dutch system the return is partially used to payout pension benefits, so by guaranteeing those benefits, the liability that comes with this guarantee should be discounted with the risk-free rate.

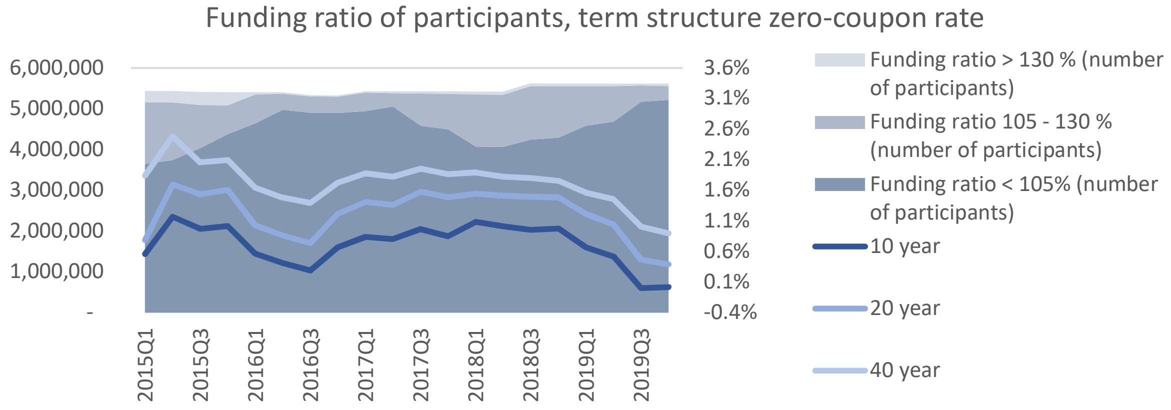
First of all, discounting with the risk-free rate, does not make the world less uncertain. It creates false certainty. The economies pension funds operate in, change in at a rapid pace, so assumptions we make now about risk and return will have changed in magnitude, volatility and composition a few years from now. In 2019, Microsoft ($1,050b), Amazon ($943b) and Apple ($920b) were the three companies with the largest market capitalization in the world according to the Financial Times and Google Finance (2019). While in 1996, this Financial Times list consisted of General Electric ($137b), Royal Dutch Shell ($128b) and Coca Cola ($117b). It becomes increasingly difficult to analyze economic outcomes with statistical models because the world has become more uncertain. We observe booms and busts in the economy, amplified by times of euphoria and people influencing each other more because of globalization. The systematic risk in the economy is difficult to estimate and therefore we cannot link guarantees about future income to it. Even if we use the risk-free rate, as maximum prudential level, we still do not know what could happen in the future and whether out pension savings will be enough to provide an guaranteed or agreed amount of pension payments during retirement.

Secondly, DNB uses a normal distribution to estimate whether pension funds will be able to make certain future pension payments. The chances that funding ratios of Dutch pension funds will dive below a certain level is higher than DNB predicts. The possibility of extreme values seems to be larger than we estimate. Independent on the guarantees we agree on in the Dutch pension system, this should be taken into account.

3.2 Volatile interest rates

In the current Dutch pension system the discount rate used for the valuation of the pension liabilities, is linked to the risk-free rate, which is in turn influenced by interest rates levels in the market. This dependency of the valuation of the pension liabilities on interest rates results in a high pro-cyclical system in which funds have to hedge a large part of their investments with costly interest rate derivatives in order to manage this interest rate risk.

In the Graph 3 below, you can see that the yield on long-term zero-coupon bonds (risk-free bonds) has been decreasing the last years. It also shows the effect this has on the funding ratio of pension funds, namely, the share of funds with a funding ratio below 105% increases. In the beginning of 2015, in terms of participants of the pension funds, the pension funds that had a funding ratio below 105% accounted for 3.5 million participants. At the end of 2019, the participants in pension funds that had a funding ratio below 105% totaled already more than 5 million.

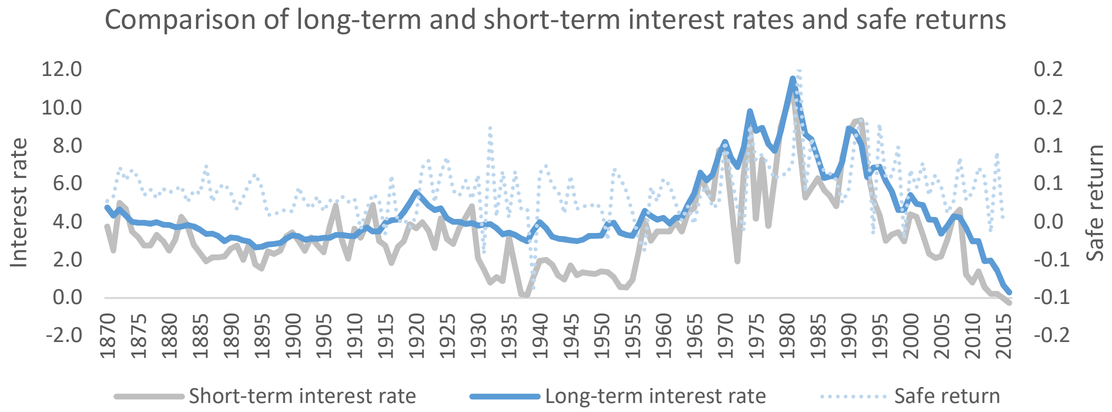


Graph 3: Funding ratio tranches based on the number of participants and the term structure of zero-coupon rates (10, 20 and 40 years)

Since the discount rate pension funds need to use to assess the present value of their liabilities, is highly dependent on these observed decreasing interest rates, this discount rate has also decreases. This causes the value of the liabilities to rapidly increases. As interest rates decline, the pension funds are required to either increase pension premiums or reduce benefits to support suddenly higher technical provisions. It also forces pension funds to invest in costly interest rate hedges or risky gambles to survive and to be able to meet their obligations.

It is quite puzzling why these rates, on for example government bonds with long maturities, are declining and what it means. The return on government bonds is considered to be risk-free because the chance that investors do to not receive their money back at maturity is small. Governments can always increase taxes to pay for their financing. You would therefore also expect that these returns do not vary much over time and therefore have a low volatility. Dimson *et al.* (2009) find a standard deviation for bonds worldwide of 10.3% over the period 1900-2000.

One of the factors that makes the returns on bonds volatile is the influence of interest rate fluctuations. If interest rates decrease drastically, it is easier to lend against a low rate and therefore also the return on bonds is lower. By looking at the movements in the long-term data of Jordà *et al.* of long-term and short-term interest and comparing these movements with the yearly safe returns (on bonds and bills), I try to find whether they show a similar pattern. The historical yearly safe returns ultimately determine the expected return on long-term bonds, which in turn, is used to determine the risk-free rate applied in the Dutch pension system. In Graph 4, I observe that the interest rate and the yearly safe returns show a similar trend.

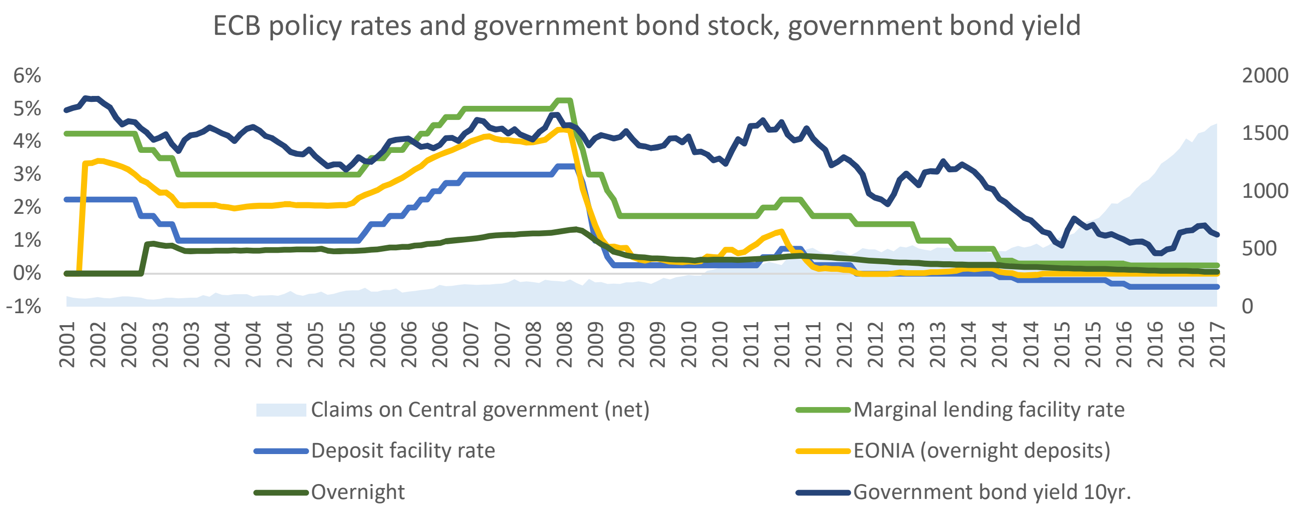


Graph 4: long-term and short-term interest rates compared to safe returns (return on bonds and bills)

So when interest rates decrease or increase, the risk-free rate, respectively seems to decrease or increase as well. In Graph 4, the same effect as in Graph 3 can be observed, the interest rates has always fluctuated, but has quite drastically decreased recently.

Policies of central banks, like the ECB (European Central Bank) have been (partially) responsible for this trend. They have effective tools to manipulate interest rates, for example, in order to increase or decrease the money supply in the economy. Policy rate are charged to commercial banks, subsequently these commercial banks charge a lower interest rates to companies and households. In that way policies of the ECB, and of similar institutions like the Fed (Federal Reserve System) in the US, largely influence the level of the interest rates. It is often the case that the returns on bonds in the market are a reflection of the policies of central banks, instead of a reflection of the market. As you can see in the Graph 5, the 10 year government bond yield roughly follows the trend of decreasing policy rates (e.g. the overnight rate) of the ECB.

Currently, Central banks deliberately lower interest rates because they try to incentivize banks to provide more loans and thereby stimulate the economy. Since 2015, when the ECB started to buy more government bonds, the interest rate has further diminished. By buying government bonds, the supply of funds increases in the economy, while the demand remains the same. This decrease the interest rates. Monetary policies of the ECB and the Fed influence the market in such a way that the market rate is not market-conform anymore. In some countries like Sweden, the interest rates even became negative. Negative rates are not a natural phenomenon, since that would mean that people would prefer to consuming in the future instead of now (Eijffinger & Hoogduin, 2019).



Graph 5: ECB policy rates and government bonds stock and yield

There are some other possible explanations for the low interest rates. Because of large fractions of bad loans on banks' balance sheets, many banks have become undercapitalized. To make sure banks are still able to provide loans to the economy, central banks have used quantitative easing to support banks. These quantitative easing policies of central banks are now structurally depressing interest rates. Another explanation for low interest rates could be secular stagnation. Productivity growth stagnates because of stagnation in innovation, underinvestment in public utilities, which decreases the demand for capital which in turn could cause decreasing interest rates. A last explanation could be excess savings due to an aging population and increasing uncertainty.

Before the Dutch pension system converted from a fixed rate to a market-based rate (UFR method) to discount pension liabilities, one of the main arguments to do so, was that this would be a more objective and fundamental way of measuring future risk. There is a lot of uncertainty about what causes interest rates to fluctuate and in general, the volatility of interest rates creates uncertainty about the value of the pension liabilities relative to the value of the assets that pension funds own. This causes funding ratios, that we use to measure the financial health of pension funds, to fluctuate as well. Part of this uncertainty can be solved by hedging the fluctuations in the interest rate risk. This secures pensions of the people near retirement, but will be at the costs of younger people. Younger people, would like the Pension Fund's capital to be invested in different assets categories that return at least enough to follow indexation. In order to keep funding ratios in line with the requirements of DNB, pension funds constantly need to adjust to this varying interest rate. Especially in the current situation, in which interest rates seem to be low and not market-conform, this does not seem to be desirable. Pension funds are forced to make short-run, suboptimal adjustment; they need to hold on more capital, or even have to curtail pension payments and are not able to create excess returns for indexation anymore. So because their financial health is partially measured by a volatile and uncertain discount rate, they become more short-term orientated, are forced to make choices that might not be necessary and might not contribute to their long-run goal to provide pensions for current and future retiring generations.

4 An actuarial rate based on expected return

Stock and bond markets consist of two different markets. The primary market fulfills the purpose of raising money through the sale of equity, bonds and other securities. The secondary market provides a trading platform for securities that have already been issued. The first market depends on a liquid and efficient secondary market. The need for these markets is driven by the need for funds by larger corporations that need capital to fund long-term investments and by investor's demand to invest in a part of those companies or a part of the horizon of the investment. On the one hand these financial markets serve firms with a long investment horizon and on the other hand they serve many different investors with short investment horizons. Dutch pension funds match the essence of these markets quite perfectly. They have long investment horizons and capital savings that needs to be managed and invested efficiently in order to provide a decent pension for retirees. Invested capital of pension funds generates future income that can be used to pay out pension benefits to pensioners. The Dutch society has delegated decisions concerning lifetime portfolio investing to pension funds. The primarily rationale for pension funds is that they make these intertemporal consumption decisions on the behalf of the Dutch population and enable intra-generation risk sharing on the longevity risk. According to this interpretation, Pension Funds should decide on their investment and pay-out policies as if they solve the intertemporal consumption planning problem (Teulings & De Vries, 2006).

Solving this problem has been made difficult because pension funds are restricted by the current pension policy. For pension funds to be able to make optimal investment decisions, the current Dutch system is too rigid due to guarantees. Pension Funds are bound to almost completely guarantee benefits at a certain level that is promised to all pensioners. Therefore they have to assume a risk-free actuarial rate on their liabilities. To make the Dutch system more flexible and give pension funds more freedom to invest optimally, we need a system that slightly adjusts to economic fluctuation. Towards the end of the build-up period, the investments can gradually be converted into pension benefits, in a payout collective that we currently already have. In this chapter, I investigate whether the results that pension funds can achieve on their investment portfolio is the appropriate way of determining pension liabilities, so the amount of pension benefits they are able to pay out. By looking at the future pensions from a perspective with slightly more uncertainty on the liabilities side, I try to find a measure that is more fundamental on the asset side.

4.1 Risk and return relationship between pension assets and liabilities

In earlier chapters, the relationship between the certainties regarding the payments of the pension benefits in the future and the discount rate on the liabilities that come with those certainties, was introduced. The risk and return of the pension assets should match the risk and return of the liabilities. If you would assume, for example, a discount rate equal to equity returns and at the same time guarantee a risk-free return, a mismatch would be created. Based on that, a retired generation, would receive a payout based on equity returns with the risks that match a risk-free return on for example bonds. So by partially letting go of the guarantee on future pension payments, we would allow pension funds to take into account the upside and downside of the financial markets that comes with investments in equity and therefore apply a discount rate that matches the risk on those investments.

The value of both the assets and liabilities would follow the same market trend, which would be more meaningful than the funding ratio fluctuations that are currently caused by changes in the interest rate that is influenced by policies of central banks. We can start looking for a measure that would be reasonable, for valuation purposes, to assume about future risk and returns on the assets of pension funds and, at the same time, would also be a stable and fundamental discount rate.

The right investments are inseparable from the ability of pension funds to save enough and to be able to pay out pension benefits to pensioners in the far future, if not into infinity. The long-term return on these investments can, to some extent, be estimated by looking at historical returns over an extensive period of time. So in the next paragraph I investigate these long-term returns and analyze their movements to assess whether they would be the right counterpart of pension liabilities, so the ability of pension funds to pay retirees their pension.

4.2 Long-term achievable investment returns and their volatility

When the economy is doing well, the investment climate is positive and the pension funds are able to generate high returns on their investments. Pension Funds can then use these returns to apply indexation to pensions. When the economy is performing poorly, this is more difficult and the funds will lose on their investments. Which could mean pension funds are forced to, for example, curtail pensions.

Shiller's analysis of historical U.S. data (Shiller, 1981) is the starting point of literature about equity returns and the corresponding risk premium over safe assets. This was further researched by Campbell with data from Sweden and the UK (1999) and extended with other advanced economies by Dimson *et al.* (2009) and Barro and Ursuà (2008). The general outcome of these studies is that equity investments generate a large premium over safe assets. Barro and Ursuà find a premium of 7% and Dimson *et al.* one of 6% with the use of arithmetic means. And Campbell (1999) reports a mean return premium of 4.7%.

In Dimson *et al.* (2009) a group of 16 countries is used to investigate long-term returns on equities, bonds, bills, inflation, and the exchange rate over the period from end-1899 to end-2000. This group of countries accounted for 88% of the total value of the equity market around 2000. Looking at these long-term data of equity and bonds returns (Dimson, *et al.*, 2009), the arithmetic mean return on equities worldwide is 7.2% and on bonds worldwide is 1.7%.

Jordà *et al.* (2019) have recently looked at extensive periods of data to assess long-term returns. By looking at financial data of a similar group of 16 advanced economies from 1870 to 2015, they analyze the aggregate real rate of return in the economy. The risky returns, including total returns on residential real estate and equities, show a high average real return of about 7%. Real estate performed better than equity before World War II, but after, equities outperformed real estate. Although equities show a much higher volatility. Equities show more booms and busts in the period after World War II. Regarding returns on bonds and bills, they find that these real safe returns have been relatively volatile and often even more than real risky returns. During peaceful periods, the average safe returns are around 1%-3% for most of the countries. So this investment class has offered investors a relatively poor risk-return trade-off. Finally, the authors find that the risk premium (risky returns minus safe returns) during times of peace, has been stable around 4%-5%.

4.3 Estimate of a discount rate based on long-term equity and bond returns

The table below shows a summary of the results from the data of Dimson *et al.* (2009) and Jordà *et al.* (2019) showing the equity and bond returns of the different countries they investigated.

Table 3: long-term average equity and bond returns

	Jordà *et al.* (2019)				Dimson et al. (2009)					
Country	**Equity return**	**Period**	**Bond return**	**Period**	**Equity return**	**Std. Dev.**	**Period**	**Bond return**	**Std. Dev.**	**Period**
Australia	7.8%	1870-2015	2.2%	1900-2015	9.0%	17.7%	1900-2000	1.3%	13.0%	1900-2000
Belgium	6.2%	1870-2015	3.0%	1870-2015	4.8%	22.8%	1900-2000	1.2%	12.1%	1900-2000
Canada	-	-	-	-	7.7%	16.8%	1900-2000	2.4%	10.6%	1900-2000
Denmark	7.5%	1873-2015	3.6%	1870-2015	6.2%	20.1%	1900-2000	3.3%	12.3%	1900-2000
Finland	10.0%	1896-2015	3.2%	1870-2015	-	-	-	-	-	-
France	3.2%	1870-2015	1.5%	1870-2015	6.3%	23.1%	1900-2000	0.1%	14.4%	1900-2000
Germany	7.1%	1870-2015	3.2%	1870-2015	8.8%	32.3%	1900-2000	0.3%	15.9%	1900-2000
Ireland	-	-	-	-	7.0%	22.2%	1900-2000	2.4%	13.3%	1900-2000
Italy	7.3%	1870-2015	2.5%	1870-2015	6.8%	29.4%	1900-2000	-0.8%	14.4%	1900-2000
Japan	6.0%	1886-2015	2.5%	1881-2015	9.3%	30.3%	1900-2000	1.3%	20.9%	1900-2000
Netherlands	7.0%	1900-2015	2.7%	1870-2015	7.7%	21.0%	1900-2000	1.5%	9.4%	1900-2000
Norway	5.7%	1881-2015	2.6%	1870-2015	-	-	-	-	-	-
Portugal	4.5%	1871-2015	2.2%	1871-2015	-	-	-	-	-	-
South Africa	-	-	-	-	9.1%	22.8%	1900-2000	1.9%	10.6%	1900-2000
Spain	5.8%	1900-2015	1.4%	1900-2015	5.8%	22.0%	1900-2000	1.9%	12.0%	1900-2000
Sweden	8.0%	1871-2015	3.3%	1871-2015	9.9%	22.8%	1900-2000	3.1%	12.7%	1900-2000
Switzerland	6.5%	1900-2015	2.4%	1900-2015	6.9%	20.4%	1911-2000	3.1%	8.0%	1911-2000
United Kingdom	6.8%	1871-2015	2.3%	1870-2015	7.6%	20.0%	1900-2000	2.3%	14.5%	1900-2000
United States	8.5%	1872-2015	2.85%	1871-2015	8.7%	20.2%	1900-2000	2.1%	10.0%	1900-2000
Equally weighted average	**6.7%**	-	**2.6%**	-	**7.6%**	-	-	**1.7%**	-	-
World	**7.2%**	-	-	-	**7.2%**	**17.0%**	-	-	-	-

Source: Jordà et al. (2019), Dimson et al. (2009)

A Dutch Pension Fund investment portfolio can roughly be constructed by taking into account the long-term returns on equity and bonds combined with data about the investment portfolio composition of Dutch pension funds.

Table 4: investment categories Dutch pension funds (2019)

in Billion EUR	**Value**	**% of total**	**Assumed return**	**Weighted return**
Government bonds	467	30%	2.2%	0.7%
Equities - Mature markets	397	26%	7.2%	1.8%
Credits	212	14%	3.0%	0.4%
Real estate	144	9%	7.0%	0.6%
Equities - Emerging markets	86	6%	9.2%	0.5%
Private equity	60	4%	2.0%	0.1%
Infrastructure	30	2%	2.0%	0.0%
Hedge funds	26	2%	2.0%	0.0%
Other invesments	132	8%	2.0%	0.2%
Total investments (for risk of fund)	**1,554**	**100%**	**-**	**4.4%**

Source: DNB, MSCI, Jordà, (2019) Dimson(2009)

Table 5: overview parameter values 2015-2019

Investment category	**Geometric net**	**St. Dev.**
AAA Government bonds	2.5%	8.0%
Credits	3.0%	8.0%
Listed equity	7.0%	20.0%
Other securities	7.5%	25.0%
Non-listed real estate	6.0%	15.0%
Commodities	5.0%	20.0%

Source: Report Committee Parameters June 2019

As value for the return on government bonds (Table 4), I use the data of Jordà (2019) and Dimson (2009). Assuming pension funds invest an equal amount in all countries is the sample those two articles use, the equally weighted averages are 2.6% and 1.7%. Combining those two gives a return on bonds of 2.2%, which is similar to the UFR determined by the Committee Parameters of 2.1%. The same data is used to arrive at the assumed rate of return on the mature markets investment category. The countries are all mature markets, so Dutch pension funds' investments in equities in these countries is expected to yield 7.2%. For the return on equity in emerging markets, I use the MSCI index on emerging markets that documents a the performance of investments in this index of 9,2% over the period from the end of 1998 till the beginning of 2019.

For return on credits, I use the parameter from the report of the Committee Parameters (2019) of 3% (see Table 5). On real estate I assume a rate of return of 7% from Jordà (2019), that separates risky returns in equities and housing returns. The other investment categories are not substantial, so I assume a prudent rate of return of 2%.

Combining these long-term rates of return on different investment categories Dutch pension funds invest in, weighted on their current share in these categories, yields an aggregate rate of return of 4.4%. But Dimson *et al.* (2009) shows that the volatility of these returns on bonds and equities is respectively 10.0% and 20.2%. This volatility indicates a certain risk connected to this expected rate of return on the portfolios of Dutch pension funds. The fluctuations in the valuation of the pension liabilities that would be caused by using equity return as a discount rate is undesirable. Discounting liabilities at the same rate and therefore also connecting the value to the same volatility as the return on the assets is not prudent.

In the US pension system, pension liabilities are discounted using the expected return on risky assets, so stocks and other alternative investments including private equities, hedge funds, real estate, and commodities. US pension funds also invest a major part of their funds in those risky assets. These investment potentially offer a high long-term return, but their value fluctuates with the short-term fluctuations in financial markets. The returns on these financial markets is expected to decrease in the long-run due to low expected interest rates and lower economic growth. Therefore, US pension funds are forced to adjust the discount rate based on the fluctuating expected risky returns. The fluctuations of such a discount rate causes funding ratios to constantly change as well. The instability of these returns diminish confidence in the system to be able to provide for future pensions. Therefore, applying the rate of return on equity as a discount rate for pension liabilities does not seem to be appropriate. Even the rate of return on bonds, the safe return, shows substantial volatility. A more stable and fundamental measure would be needed for the valuation of pension liabilities. Such a rate of return could be a proxy or a safe lower bound for expected returns on the assets and investments of Dutch Pension funds. In search for a more fundamental and therefore stable economic measure, I investigate the fundamentals of GDP growth and its applicability as a base or lower level for return on long-term investments.

5 Fundamentals of GDP growth

5.1 GDP and GDP growth as a measure

The Gross Domestic Product (GDP) measures the monetary value of final goods and services produced in a country or region in a given period of time. It represents the sum of value added by all its producers, so different industries operating in the economy, households and the government. Value added includes the value of the gross output less the value of intermediate goods and services consumed in production. GDP accounts for all domestic production, regardless of whether the income accrues to domestic or foreign institutions. GDP gives information about the size of the economy and how an economy is performing. Especially the growth rate of real GDP is often used as an indicator of the performance of the economy. To analyze GDP and GDP growth I use data from the World Bank (WB) and the International Monetary Fund (IMF).

The GDP measure of the WB is computed at purchaser prices and is expressed in U.S. dollars. The WB GDP measure embodies the sum of gross value added by all producers in an economy that are resident there, plus product taxes and minus subsidies that are not included in the value of the products. Depreciation of fabricated assets or for depletion and degradation of natural resources is not taken into account.

So GDP represents the production or output within an economy. GDP growth therefore, measures growth of the economy in terms of an increase in output volume or in real incomes of its residents with respect to the previous period. As I showed in Chapter 2, neoclassical growth models explain this increase as a result of an more capital invested, an increase in labor input or a higher level of technology.

The WB manages an extensive database with GDP growth data for a large set of countries. GDP growth is calculated using the least square methods. The percentage GDP growth measure that they provide represents the annual growth rate of GDP at market prices based on constant local currencies. For regions and other aggregates of countries, constant U.S. dollars are used with 2010 as the common reference year. The contribution of each industry to the growth in the output of the economy is measured by the growth in the value added. This value added can be calculated by using a set of base year prices and then subtracting the cost of intermediate inputs in constant prices as well. In that way volume and price effects are separated. By using constant prices, the volume component is isolated and in that way added value will be expressed in volume terms. But this double deflation method requires detailed information of the structure of prices of inputs and outputs. So in most of the industries, value added can better be extrapolated from the base year using single volume indexes of outputs. This is often the case in the services industries. The value added is in that case estimated using labor inputs (real wages or number of employees).

To obtain comparable series of constant price data for computing aggregates, the WB rescales GDP and value added by industrial origin to a common reference year. Because rescaling changes the implicit weights used in forming regional and income group aggregates, aggregate growth rates are not comparable with those from earlier editions with different base years. To avoid distortions in the growth rates, the discrepancy is left unallocated. As a result, the weighted average of the growth rates of the components generally does not equal the GDP growth rate (World Bank, 2020).

The IMF also provides data and information about GDP growth. In the IMF World Economic Outlook (2019) different economic factors that contribute to GDP growth are described. Private consumption shows the highest percentage as share of GDP growth, then fixed investment and public consumption. Inventories and net foreign balance are either negative or small. Furthermore, it is expected that the combination of higher growth than in advanced economies and this group's rising weight in global GDP translates into an increase in emerging market and developing economies' share of global growth, from 76% (2019) to 85% (2024). Emerging markets show a continuous growth in investments.

Especially for the services industry, but also for governments, GDP is more difficult to measure. The value added of these activities, is often not directly measurable and is in that case imputed from labor input. The same difficulty in determining the value added applies for the improvements in production processes and the quality of goods and services. This kind of output does not immediately yield in physical output growth, because it often only creates benefits or value for the consumer. The IMF estimated for 2019 that the developments of digitalization would have a modest impact of the on productivity, and a larger impact on consumer welfare than on labor productivity. Services and technological progress have become more and more important over the past years, so this might have caused more underestimation of the GDP growth. If GDP would be underestimated because not all technological developments can measured in value added to the economy, this would not make GDP growth less appropriate for determining a discount rate for pension funds. Namely, Dutch pension funds can invest in technology through investments in companies that develop it or process it in their products and services. In that way, the technology is valued by the market and pension funds can achieve a return on it.

Table 6: long-term GDP growth

Country / region	Jordà 1870-2015	World Bank 1961-2016	IMF 1980-2019	Average
Australia	3.6%	3.5%	3.1%	3.4%
Belgium	2.3%	2.7%	1.9%	2.3%
Canada	n.a.	3.3%	2.4%	2.9%
Denmark	2.8%	2.4%	1.8%	2.3%
Finland	3.6%	2.9%	2.2%	2.9%
France	2.6%	2.8%	1.8%	2.4%
Germany	2.8%	2.0%	1.7%	2.2%
Ireland	n.a.	4.8%	4.8%	4.8%
Italy	3.8%	2.5%	1.2%	2.5%
Japan	4.2%	3.8%	1.9%	3.3%
Netherlands	3.2%	2.9%	2.2%	2.7%
Norway	3.1%	3.2%	2.4%	2.9%
Portugal	3.4%	3.3%	2.2%	3.0%
South Africa	n.a.	3.1%	2.2%	2.6%
Spain	3.2%	3.4%	2.3%	3.0%
Sweden	2.9%	2.6%	2.4%	2.6%
Switzerland	2.3%	1.7%	1.8%	1.9%
United Kingdom	2.0%	2.4%	2.1%	2.2%
United States	3.4%	3.1%	2.6%	3.0%
East Asia & Pacific	n.a.	5.1%	n.a.	n.a.
Europe & Central Asia	n.a.	2.2%	n.a.	n.a.
Latin America & Caribbean	n.a.	3.7%	2.5%	3.1%
North America	n.a.	3.1%	2.6%	2.8%
South Asia	n.a.	5.1%	6.0%	5.6%
Middle East & North Africa	n.a.	4.4%	3.1%	3.8%
Sub-Saharan Africa	n.a.	3.5%	4.0%	3.8%
World	n.a.	3.5%	3.5%	3.5%

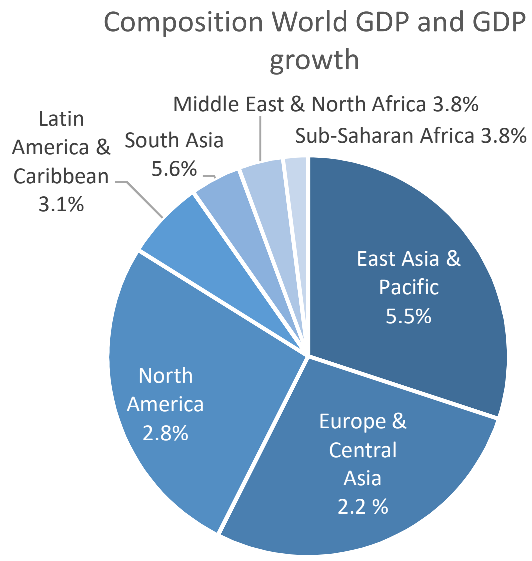
Source: Jordà et al. (2019), World Bank Database, IMF

Also, for emerging markets or developing countries, value added in the economy is harder to measure than for advanced economies, because a part of their economy is informal, it is not officially registered as production output. In both cases these measurement errors lead to underestimation of the volume of output. Since the purpose of this research is to define an appropriate rate of return to apply as a discount rate valuing the liabilities of pension funds, this would mean an underestimation of this discount rate as well. This would give a discounted value that would be overvalued, which is not a negative side effect. It would mean that the informal economic activity not being included in the GDP growth, is automatically creating a prudent lower level for the discount assumptions regarding the future liabilities. On the other hand, this problem of informal economic activity is different from technological progress not being part of GDP growth, because besides the fact that it is not measured, Dutch pension funds can also not invest in it. This makes this issue less relevant for this research.

5.2 GDP growth worldwide

GDP growth of aggregate groups of countries are useful when looking at GDP growth from a long-term investment perspective. Economies nowadays are not restricted to the country borders anymore. With the number of larger, international companies on the rise, products and services are produced all over the world.

Worldwide GDP was around 84-85 trillion U.S. dollars in 2018. Of which East Asia (25 trillion), Europe & Central Asia (23 trillion) and North America (22 trillion) comprise almost 85%.

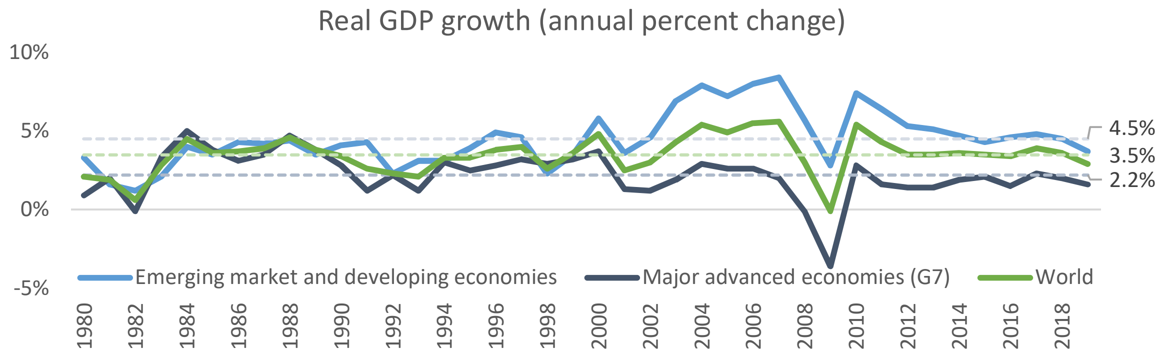


Graph 6: Composition of World GDP and GDP growth

For the aggregates East Asia & Pacific, North America, Latin America & Caribbean, South Asia and Sub-Saharan Africa, the WB has a long-term dataset available from 1961 till 2016. For Europe & Central Asia and the Middle East & North Africa the data period is somewhat shorter, respectively from 1971 till 2016 and 1969 till 2016. In Graph 6, the GDP growth of the seven large aggregate are shown. With East Asia & Pacific and South Asia showing the highest GDP growth of 5.1% over this period. The more advanced regions, Europe & Central Asia and North America, have lower average GDP growth rate, of respectively 2.2% and 2.8%. As you can see in Graph 7, the overall, average GDP growth of emerging markets and developing countries lies around 4.5% and that of Major advanced economies around 2.2% (IMF, 2020).

Beside the IMF data, the World Bank provides an extensive database on macroeconomic measures per country. Also the aggregates of countries they provide, are useful for this research. Assuming that Dutch pension funds use the growth of regions as a basis for their investment decisions rather than on individual country level, I analyze a set of aggregates. It is difficult to apply the same analysis to this dataset as to the data of Jordà *et al.* (2019), because their PPP GDP per capita data is only available from 1990. Therefore I will calculate GDP per capita based on their GDP per capita data in constant 2010 and current U.S. dollars. Besides that, I also look at the annual GDP growth measure that the WB provides in their database.

As I showed in the Diamond Growth Model (1965) in Chapter 2, capital accumulation and savings in the economy and productivity and technological progress determine the steady state and therefore the long-term growth of the economy. It can be assumed that advanced countries have already accumulated more capital, are closer to their steady state and therefore show lower, but stable growth rates. Developing or emerging markets are still converging towards their steady state and so they show higher GDP growth levels.



Graph 7: Real GDP growth in annual percentage change

5.3 Volatility of GDP growth

If we look at Table 7, we see that the standard deviation of world GDP growth is clearly lower than that of world equity and bonds returns. Annual logarithmic returns follow a non-normal distribution and are often fat-tailed, with extreme events more likely to occur. Even for investors with well diversified portfolios, like pension funds, individual equity markets are risky.

Comparing GDP growth per country to bond and equity returns per country, for each country in Table 7, GPD growth has a lower standard deviation that equity returns. This difference in volatility is caused by differences in the fundamental risk drivers between GDP growth and bonds and equities. Chapter 3, for example, shows that safe returns on bonds are influenced by both the short-term and long-term risk rate or interest rate in the market. Equity returns can be determined by various factors influencing the expectations about the financial performance of companies. GDP growth seems to be more rigid and apparently only fluctuates when the state of the world changes drastically, during crises, for example.

Table 7: comparison of volatility GDP growth, bond returns and equity returns

Region	St. dev. GDP growth	St. dev. Bonds	St. dev. Equity
Australia	1.7%	13.0%	17.7%
Belgium	2.0%	12.1%	22.8%
Canada	2.2%	10.6%	16.8%
Denmark	2.4%	12.3%	20.1%
Finland	3.1%	-	-
France	2.1%	14.4%	23.1%
Germany	2.0%	15.9%	32.3%
Ireland	4.6%	13.3%	22.2%
Italy	2.7%	14.4%	29.4%
Japan	3.9%	20.9%	30.3%
Netherlands	2.3%	9.4%	21.0%
Norway	1.8%	-	-
Portugal	3.5%	-	-
South Africa	2.4%	10.6%	22.8%
Spain	3.0%	12.0%	22.0%
Sweden	2.2%	12.7%	22.8%
Switzerland	2.1%	8.0%	20.4%
United Kingdom	2.0%	14.5%	20.0%
United States	2.1%	10.0%	20.2%
World	1.6%	10.3%	17.0%

Source: Worldbank database, Dimson (2009)

6 Dutch pension funds achieving GDP growth

The investments of Dutch pension funds are a substantial share in World GDP of around 2%. From a balance of payments point of view, they account for a large stock of net foreign investment as Dutch pension funds diversify investments internationally. Only around 15% of their funds are invested in the Netherlands. By investing the savings of younger generation in worldwide production output, pension funds could achieve at least the worldwide GDP growth rate as return on their investments. As long as the output of the economy increases at a certain rate, investing in the companies producing this output, is supposed to yield at least the long-run average GDP growth rate. By creating a portfolio with companies in different countries that is similar to the (World) GDP composition, a share in the worldwide GDP can be approximated plus the equity risk premium if they invest in it through equity. With pension funds holding a significant share in the world GDP, the GDP growth can be taken as prudent, lower bound of their returns.

The current aggregate return that was achieved over the long-run based on Dutch pension funds' current investment portfolio composition from Chapter 4 is 4.4%. The global GDP growth over an extensive period of more than 40 years, as shown in Chapter 5, is about 3.5%. The difference between these two captures a risk premium of 0.9%. This risk premium is a reflection of the risk that is associated with investments that pension funds currently make in equity, real estate, bonds, credits, etc. GDP growth is less risky, do yields a lower return. In Jordà (2019) the authors find a risk premium for equities on top of safe returns (bonds and bills) of around 5%. To achieve a share in the world GDP growth, pension funds can create a portfolio of equities, bonds and other investments by diversifying across industries and countries based on the share industries and countries represent in world GDP. But this means that those investments through financial markets, will pick up some of the risk of those financial products. Dutch pension funds do not invest all their funds in equities, so it is logical we find a lower risk premium than the total risk premium between safe and risky returns.

A combination of assumptions made about the composition of the pension funds' investment portfolio and GDP growth could result in a measure that would be appropriate an expected return measure for the discounting of pension liabilities. Since the economy becomes more globalized and GDP is not limited to country borders anymore, Dutch pension funds can diversify in different countries and select investments based characteristics different regions worldwide. Therefore, I do not only focus on GDP growth of individual countries, but on an aggregate of seven regions. These aggregates are, East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, North America, South Asia, Middle East & North Africa and Sub-Saharan Africa.

6.1 Composition of Dutch Pension funds' investment portfolio

For the composition of the portfolio of Dutch pension funds, I assume a 50% percentage of investments in bonds and bills and 50% investment in equities. For simplicity, I do not further analyze the shares pension funds have in different industries across the world. Therefore I also do not investigate the contribution in GDP growth of different industries. I assume that Dutch pension funds diversify across these different industries, to achieve a portfolio that automatically hedges fluctuations in the performance of certain industries.

6.2 Population weighted GDP growth

To determine the rate of return that could be achieved by investing a share in GDP growth, I use three methods. For the first two methods, I only use the GDP growth of countries for which there is more than 20 years of data available. I also remove the countries that did not have data in the last year of the dataset. For the first method, I use the population size as percentage of the world population as determinant of the share of each country in a World GDP portfolio. The sum of these shares for each country multiplied by the long-term GDP growth in that country represents the weighted return of a simulated portfolio in world GDP (refer to the appendix for a specification of the countries used). This calculation yields a population weighted GDP growth of 4.9% (see Table 9).

For the second method I use the following ratio:

$$\text{Risk-reward ratio GDP growth} = \frac{\text{GDP growth}}{\text{Standard deviation GDP growth}}$$

that shows the relationship between the GDP growth in a country with respect to the associated volatility. Therefore it represents a trade-off between risk and return, which indicates which countries have a high rate of return per unit of GDP growth. After ordering these risk-return rates from high to low, I select the 50 countries with the highest ratio and perform the same population weighted calculation on the GDP growth for this group of countries. This results in a GDP growth of 4.9% (see Table 9).

For the third method, I use the population weighted GDP growth of aggregates of countries instead of individual countries. This results in a population weighted GDP growth of 4.3% (see Table 9).

Table 8: long-term GDP growth per region

Region	Average GDP growth	Population in mln (2018)	GDP growth population weighted
East Asia & Pacific	5.1%	2,328	1.6%
Europe & Central Asia	2.2%	918	0.3%
North America	3.1%	364	0.1%
Latin America & Caribbean	3.6%	641	0.3%
South Asia	5.1%	1,814	1.2%
Middle East & North Africa	4.3%	449	0.3%
Sub-Saharan Africa	3.5%	1,078	0.5%
Total		**7,593**	**4.3%**

Source: World Bank Database

6.3 Achievable GDP growth

A summary of the three methods I used before to compute a measure for population weighted GDP growth is shown in Table 9 below. The average of the three methods, and the World GDP growth weighted average measure of the World Bank and the IMF, gives an average of 4.4%. This percentage of growth rate would be achievable for Dutch pension funds if they build a worldwide, diversified portfolio weighted on the (population) size of each country.

Table 9: different methods used ot compute population weighted GDP growth

	Population weighted GDP growth
Method 1 - Population weighted	4.9%
Method 2 - Risk-return	4.8%
Method 3 - Aggregates	4.3%
World GDP	3.5%
Average	**4.4%**
Bonds (50%)	2.2%
Equity (50%)	4.4%
Pension Fund achievable return	**3.3%**

To actually obtain a share in GDP growth, pension funds need to invest in companies that produce this output through financial markets. This will automatically add volatility to the GDP growth, but at the same time also rewards for the extra risk that pension have to bear.

In the first chapters of this research, I started with an analysis of the characteristics and behavior of bond (safe) returns and the risk-free rate based on these returns. Then, I investigated equity returns and whether these have the appropriate characteristics to be applied as a discount rate. Later I introduced GDP growth as a possible discount rate. To assess risk associated with these three measures, I calculated the standard deviation. Apart from the standard deviation, the financial industry also uses downside risk measures to further characterize the asset risk, since it is widely recognized that large losses are more frequent than an normal distribution based statistic like the standard deviation suggests (Hyung & De Vries, 2001). We have seen that based on the volatility of the bonds, equities and GDP growth, GDP growth has the lowest volatility. In the literature, I discover that the probability distribution of GDP growth, like equity and bonds returns, also shows extremely high and extremely low values.

De Hek *et al.* (2018), discover that GDP growth of many countries shows heavy tails. They find a good fit of GDP growth using the heavy-tailed Cauchy distribution for almost all countries in their sample. And they conclude that these findings suggest the possibility that there exist universal mechanisms that give rise to general laws governing the growth dynamics of firms and economies. Moreover, they find that both very low and high GDP growth rates will occur much more frequently than predicted by the normal distribution. Also others find evidence for the fat-tailed shape of the GDP growth distribution. Canning *et al.* (1998) find that, in the cross section, the distribution of GDP growth shows fat tails. According to Gabaix (2011), this result might be a consequence of the fat-tailed distribution of firm size. Also Wang and Yao (2001) provide evidence that GDP growth rates are not normally distributed. By using normality tests and frequency histograms, they find that extreme output changes occur more often than what is expected using a normal distribution. Lucas (1993) describes that it might be possible that GDP is characterized by rapid and persistent growth episodes (economic miracles) in the context of a model that highlights learning associated with new activities and spillovers of this to the creation of more developed products. He also seems to believe that the process through which countries may or may not choose to involve in such activities is somewhat accidental and difficult to identify empirically.

In order to discover more about the shape of the distribution of GDP growth, its long-term, historical behavior and the risk associated with it, I investigate the behavior of extreme values of GDP growth, in other words, the tails of its distribution. By estimating the Hill estimator and the tail index, I compare the GDP growth of different countries and aggregates of countries.

6.4 Estimation of tail indices for GDP growth

By looking at equity rates of returns, I have showed in previous chapters, that on the one hand, they are more volatile than GDP growth rates. But we know, on the other hand, that this extra risk is rewarded with a risk premium. The risk premium is a reward for higher volatility of the return on equity above GDP growth (Y). But, standard deviation does not exclude the possibility that the shape of the distribution of GDP growth is similar to that of equity returns. It is important to assess the shape of the tails of GDP growth and compare it to that of equity returns, in order to properly determine whether GDP growth is more appropriate to base a discount rate for liabilities on.

Thus, in the following part I try to estimate a measure to discover whether these extreme returns occur for equity returns in my dataset and whether GDP growth shows the same extreme values in its distribution. In order to compare the movements of GDP growth with the current risk-free rate movement in extreme situations. I also analyze the extreme values in the distribution of safe returns, which include the return on bonds and bills.

A scientific way to look at worst-case or extreme scenarios is to use Extreme Value Theory (EVT). EVT shows that the chance that very low (or high) values occur, can be estimated by looking at the lowest (or highest) values, so by looking at the tails of the distribution. The EVT approximates the distribution of those lowest and highest values of random variables as the sample size increases. One of the advantages of this method is that is does not require complete knowledge of the distribution that the random variable follows.

A definition of heavy tail distributions is given by Feller (1971). Feller states that the distribution of the returns F(x) has a heavy upper tail for the positive returns X_i, if (for large x)

$$1 - F(x) = x^{-\alpha}L(x) \text{ as } x \rightarrow \infty, \quad \alpha > 0$$

and the function $L(x)$ is such that for any $x > 0$

$$\lim_{t\to\infty} \frac{L(tx)}{L(t)} = 1.$$

The tail of the distribution consists of two parts, the slowly varying $L(x)$ function and the power parts. The $L(x)$ function is a measure for the scale of the distribution. The tail of the distribution is determined by the power part $x^{-\alpha}$. The value of $F(x)$ dependents on the distribution. The coefficient α is called the tail index and indicates the number of extreme events. The larger the tail index α, the less extreme is the behavior of the of the returns. So a lower tail index (α) indicates more extreme values, thus a heavy tail and a higher tail index corresponds to less extreme values and therefore a thinner tail. The tail of a heavy-tailed distribution is not exponential, like the tail of a normal or lognormal distribution.

To estimate the tail index for safe returns, equity returns and GDP growth of individual countries, I use the Macrohistory Database from Jordà, Schularick and Taylor. These data are used in the article "The Rate of Return on Everything" as well. They provide a measure for Real GDP per capita (PPP) for the period of 1870 to 2015. So for each country in this sample, there are about 145 years of yearly return rate data available. Every country in the sample qualifies as an OECD country, so the whole sample of countries can be assumed to be quite homogenous. To be able to perform a tail index analysis, more than those 145 years of data per country is needed to observe the right k. Therefore, I cannot perform the tail analyses on each individual country. So to create a more extensive and therefore more useful set of data, I combine the yearly data of 16 OECD countries. This gives a sample of 2,482 years for real GDP growth and of 2,448 years for nominal GDP growth. For nominal equity returns the available data consists of 2,334 years. In the nominal equity returns dataset and the real GDP (PPP) dataset, I exclude Germany, because of a outliers in the returns during the hyperinflation period around 1922-1923. For the long-term nominal interest rate, I use 2,448 years of data and for the nominal safe returns 2,168 years.

Table 10: Descriptive statistics tail analysis

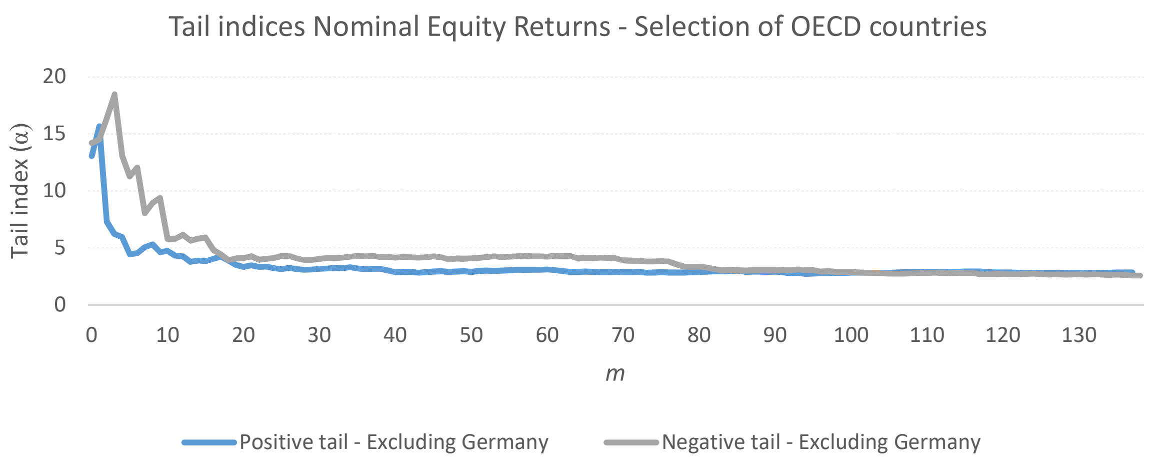
Variable	**Average**	**St. dev.**	**Observations**
Real GDP growth (PPP)	2.0%	5.0%	2,482
Real GDP growth	1.9%	5.2%	2,482
Nominal GDP growth	7.2%	11.5%	2,448
Nominal equity returns	10.0%	21.9%	2,334
Nominal long-term interest rate	7.2%	305.6%	2,448
Nominal safe returns	5.3%	4.9%	2,168

Source: Jordà et al. (2019)

For each of these samples I estimate the tail index (α) for both the positive and the negative tail by using the Hill estimator (Hill, 1975):

$$\hat{\alpha} = \left(\frac{1}{m} \sum_{i=1}^{n} \ln\left(X_{(i)}\right) - \ln\left(X_{(m+1)}\right)\right) \right)^{-1}$$

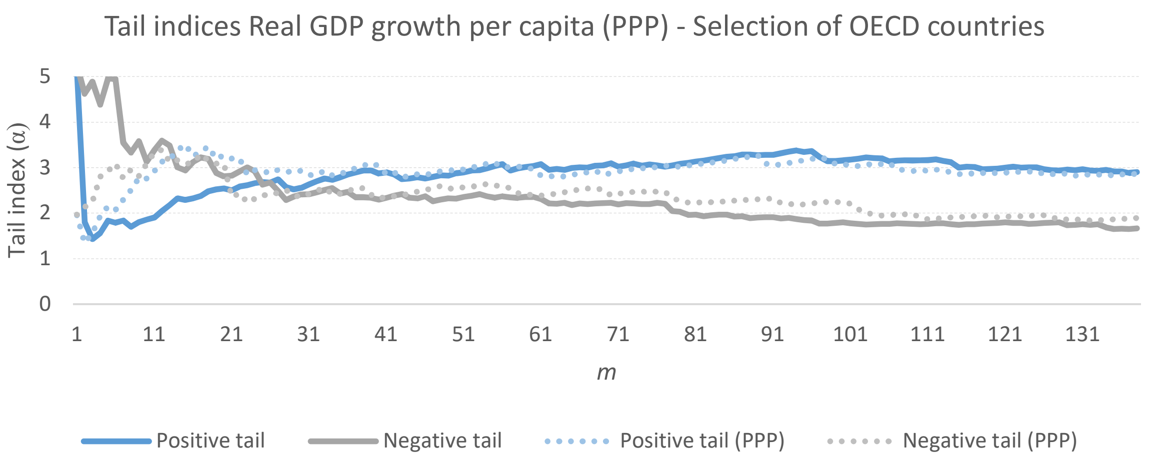
where *m* is the chosen threshold to measure the tail index and *X* is the variable of which the tail is estimated, e.g. GDP growth rates or equity returns. To arrive at the tail index (α), the inverse of the Hill estimator is calculated.



Graph 8: Tail indices of Nominal equity returns of a selection of OECD countries, excluding Germany

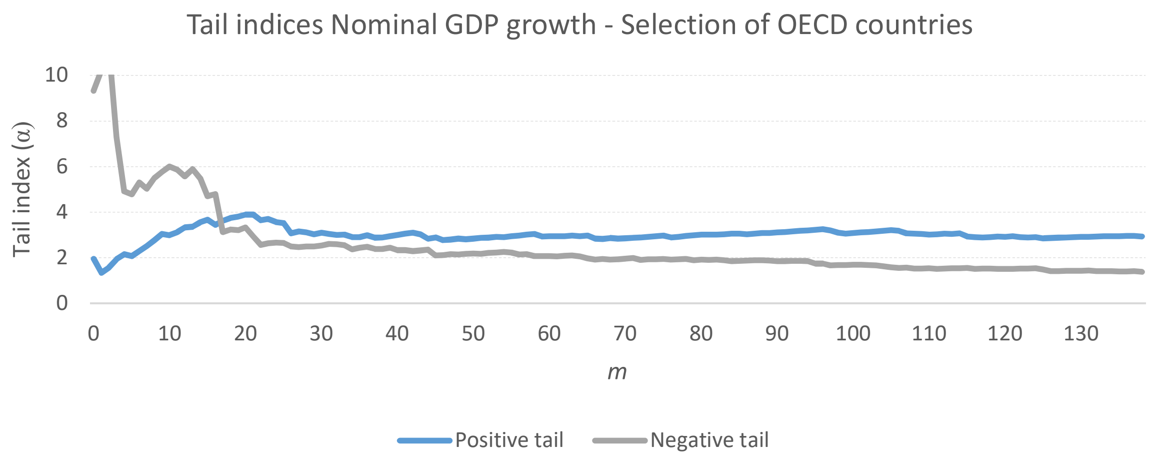
As was expected from the standard deviation and the general characteristics of equity returns calculated in Chapter 5, equity returns are not just relatively volatile, but the returns are also heavy-tailed. Around m = 20/30, the tail index stabilizes. The value of the tail index at this point is around 3 for the positive tail and around 4 for the negative tail.

For GDP growth I look at both nominal and real GDP growth for the estimate of the tail index. For real GDP growth I also show the purchasing power parity (PPP) measure of GDP growth, in order to see whether this influences the results.



Graph 9: Tail indices of Real GDP growth per capita (PPP) of a selection of OECD countries, excluding Germany

The tail index of real GDP growth seem to stabilize around $m = 30$. At this point the positive tail has an tail index of around 3 and the negative tail has a tail index of about 2.5. Besides the slightly higher tail index around $m = 20$ for the positive tail for the PPP measure, the two measure do not seem to differ much.



Graph 10: Tail indices of Nominal GDP growth of a selection of OECD countries

Nominal GDP growth shows similar results. The positive tail has an index of around 3 and the negative tail index is about 2.5 at $m = 20/30$.

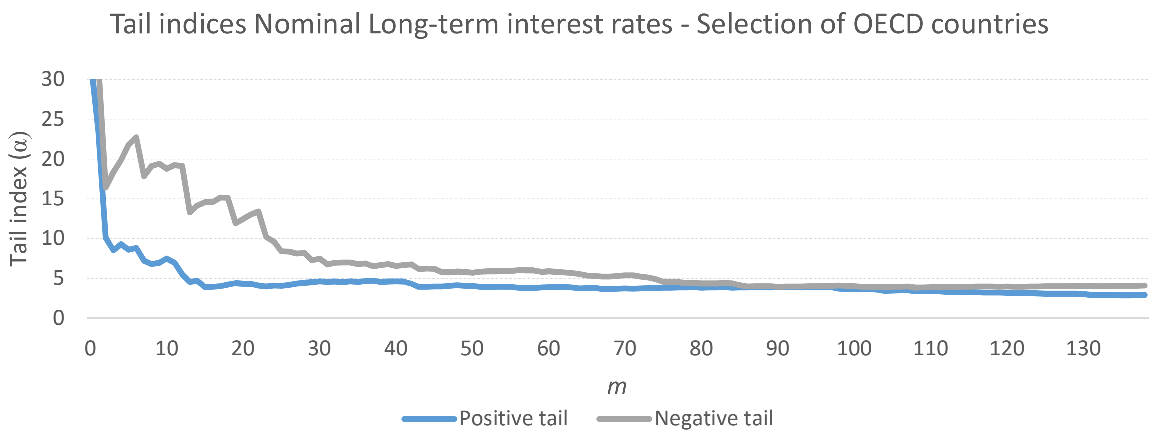
These results indicate that the distribution of both the nominal and the real GDP growth rate is heavy-tailed. This means that extreme values are more likely to occur compared to, for example, a normal distribution. Comparing the tails of equity returns and GDP growth shows that the shape is similar. Economically this could be plausible if GDP growth and equity returns are affected in the same way by extreme events that occur in the economy, or that GDP growth is more correlated with equity returns during extreme events. For example during a crisis, stock markets collapse, which also negatively influences the functioning of the economy. General economic stagnation occurs because the economy is not supported by a well-functioning financial market. The overall lower volatility of GDP growth suggest that the less extreme events only influence equity returns. So financial market can for example, be negatively influenced by events and also recover from it in the short-run, while this does not also necessarily affect GDP growth. The fact that the volatility of the GDP growth rate is lower than equity returns, although the tails are similar, suggests that the scale of the GDP growth rate must be smaller. To investigate this, I compute the scale of the Nominal GDP growth and Nominal Equity returns using the scale estimator from Hyung & De Vries (2001).

$$\text{Scale estimator} = \left(\frac{m}{n}\ln\left(X_{(k+1,n)}\right)\right)^{\hat{\alpha}}$$

The scale estimator for the positive tails around *m* = 30 is around 0.0023 for nominal GDP growth and around 0.0110 for nominal equity returns. This scale is the represented by the *L(x)* variable in the formula given by Feller (1971) at the beginning of this chapter. So since return on equity and GDP growth rates show a similar tail index, it is logical that the scale (*L(x)*) is different. So, like the difference in volatility already suggests, I find that the scale of the GDP growth distribution is smaller than that of equity return.

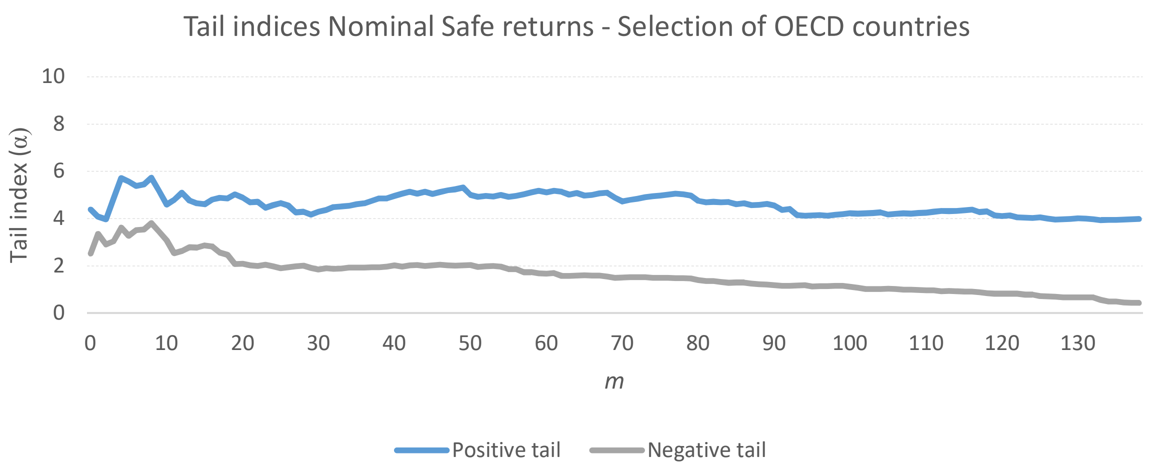
The fact that the distribution of the GDP growth rate is heavy-tailed, indicates that worldwide diversification, so global investing in GDP growth is crucial. Investing in different countries, with different GDP growth distributions with different scales, lowers the risk of such a portfolio.

Important determinants for the discount rate applied in the current Dutch pension system, are the long-term interest rate and the return on bonds (and bill), or the risk-free rate. To be able to compare the results for GDP growth with the current discount rate, I perform the same tail index analysis on the long-term interest rate and the safe return.



Graph 11: Tail indices of Nominal Long-term interest rates of a selection of OECD countries

The data on the long-term interest rate shows that both the positive tail and the negative tail index seems to be relatively high. Around *m* = 20/30, the tail index for the positive tail is around 5 and that for the negative tail is around 8. This suggests that the tails of the long-term interest rate are not heavy-tail and that the positive and negative values are relatively less extreme than those of the rate of return of equity or the GDP growth rate.



Graph 12: Tail indices of Nominal Safe returns of a selection of OECD countries

For the safe returns, the tail indices for the positive and the negative tail also differ quite a lot. The positive tail around m = 20/30 lies around 4.5 and the negative tail around 2. So at least in the negative tail, also the safe returns, show extreme values and therefore seems to have a heavy tail. The positive tail seems to have a relatively higher tail index, which would suggest that this side of the probability distribution is not so heavy-tailed. The more extreme lower tails of safe returns are the values influencing the UFR and the actuarial rate, which in turn influences large, negative fluctuation in funding ratios of pension funds.

6.5 Analysis of the relationship between investment returns and GDP growth

The achievable GDP growth that results from the previous analyses, is not directly achievable in the sense that Dutch Pension funds cannot invest in a financial market that trades in financial assets that return GDP growth. These returns can practically only be achieved when pension funds buy shares in companies that produce output, which in turn results in GDP growth.

Various supply-side models assume that GDP growth of the underlying economy flows to shareholders in stages. It first transforms into corporate profit growth, then the aggregate earnings growth translate into stock price increases. GDP and aggregate earnings seem to be remarkably similar throughout the period 1929-2008 (MSCI index, 2010). But investors do not have a claim on all GDP growth. A part of the GDP growth is caused by capital increases, such as new share issuances, rights issues or IPOs. These factors increase aggregate earnings but are not accessible to current investors. Even when these investors would invest in new companies, they would have to dilute their holdings in the "old" economy. A simple measure of this dilution was suggested by Bernstein and Arnott (2003). They find a 2% difference between U.S. GDP growth (the aggregate market growth) and the performance of the aggregate U.S. index. Also Jordà *et al.* find that the trend long-run real rate of return on wealth, so risky (equity and housing) and safe (bonds and bills) returns, has consistently been much higher than the real GDP growth rate. Despite some variation, they find that the return on wealth is larger than GDP growth in every country in every time period that they consider. The also find that prior to the Global Financial Crisis this gap was widening and that the returns on housing partially explain this effect. Also Rognlie (2015) notes that recent trends in wealth and income could be influenced primarily by what has happened in housing. Measured as a ratio to GDP, rental income has been growing slightly.

Dimson *et al.* (2009) provide two explanations for why, even over very long periods, we find no direct and link between stock market performance and GDP growth. One might be measurement error. Second, we may be misguided in expecting a relationship since GDP can grow without generating wealth gains to equity holders. So they state that GDP growth does not mean shareholder value.

Nevertheless, I find that GDP growth and equity returns have similar tail indices, which suggests a link. The difference between the two rates of return is characterized by the difference in scale, which represents the difference in riskiness and therefore the difference in risk premium. This feature of the GDP growth rate makes it a more appropriate discount rate over equity returns.

Eventually, financial markets are a reflection of what occurs in the economy, which is represented by GDP. Arnott and Ryan (2001) for example, do expect to find a positive relationship between a country's equity market performance and its real dividend growth since over sufficiently long intervals, higher equity returns will be associated with higher corporate profits, which in turn are likely to lead to higher dividends. But they give several reasons this might not directly show in the data. Tax regimes incentives, capital needs relating to growth opportunities and therefore payout policies, but also varying attitudes towards shareholders and varying stages in economies are some possible explanations.

Siegel (1998) also gives two reasons for the difference between stock market growth and GDP growth. First, large listed companies are often large multinational operating internationally. Their profit depends on worldwide economic growth instead of domestic. The current globalized economy were a large part of the production is executed by large, multinational companies, is not well reflected in the GDP per country. Second, he states that expected economic growth is largely factored into stock prices at the beginning of the period, but that in some emerging countries, investors' expectations are sometime too optimistic.

The first reason can be addressed by looking at aggregate GDP of different countries. In this research, parallel to GDP growth of different countries, I looked at the GDP of aggregates of countries.

Another reason that GDP growth might be lower than the returns of stocks of the companies that produce this GDP output could be related to the fact that not all added value in the economy is captured in GDP growth. Like I showed in the previous Chapter, technological innovations and improvements to products and services are becoming increasingly important in the rapidly changing economy. But they are hard to measure and therefore not at all or only partially taken into account in the GDP growth. In the Cobb-Douglas production function in Chapter 2, these technological developments are assumed to lead to an increase in labor productivity, but the IMF estimated for 2019 that the developments of digitalization have a modest impact of the on productivity, and a larger impact on consumer welfare than on labor productivity. These technological developments are often executed by technological companies. If these companies are creating valuable products and services, this will be translated returns on capital as well. This can be translated into realized returns through the equity markets, through private equity or through holding bonds. Pension Funds are able to participate in the growth of these companies by holding those investments in their portfolio. So even though these innovations are hard to measure in terms of GDP growth, pension are able to take a share in their growth.

So this technological development is not always captured in the GDP growth, while pension funds can indeed take a share in the returns it yields. With technological progress becoming increasingly important, this effect and other measurement difficulties, suggest that there will always be a gap between long-term GDP growth and the returns on shares in assets that create GDP growth.

To see whether an increase in nominal GDP growth of the economy has an effect on nominal equity returns (R_e) in financial markets, I perform a regression on these two variables with nominal equity return as the dependent variable and nominal GDP growth (Y) as independent variable.

$$R_e = \beta_{GDP} Y$$

The null hypothesis is defined as:

$$H_0: \beta_{GDP} = \beta_{GDP}^0 = 0$$

To test this hypothesis, I perform and F-test using the F statistic:

$$F = \frac{\beta_{GDP} - \beta_{GDP}^0}{SE(\hat{\beta}_{GDP})} = 0$$

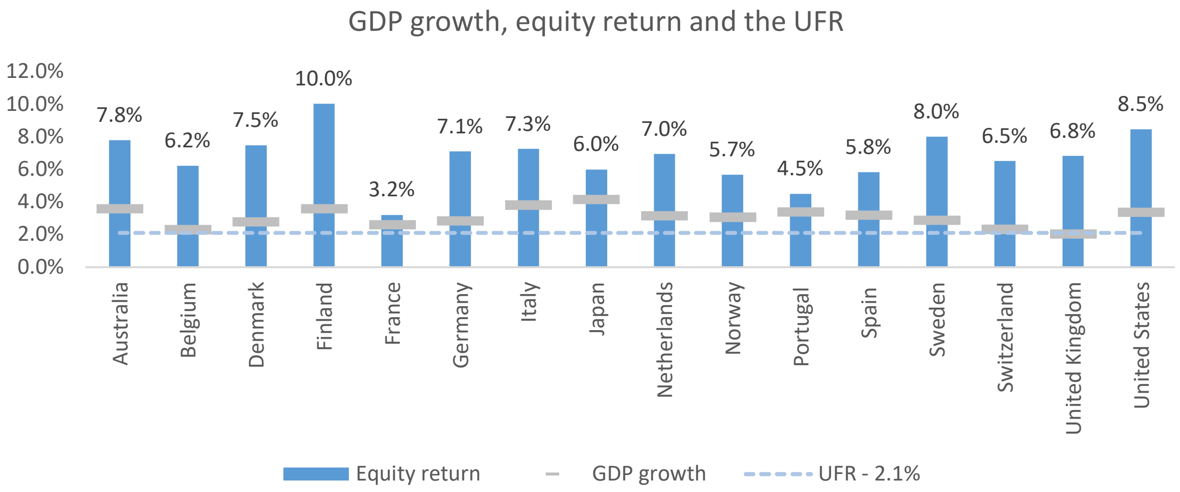
Table 12: the effect of nominal GDP growth on equity returns

VARIABLES	Nominal equity return			
Nominal GDP growth	0.323***			0.244***
	(0.0430)			(0.0686)
Nominal GDP growth (1 year lead)		0.452***		0.451***
		(0.0429)		(0.0628)
Nominal GDP growth (1 year lagged)			0.345***	-0.350***
			(0.0901)	(0.0700)
Constant	0.0854***	0.0751***	0.0929***	0.0757***
	(0.00586)	(0.00577)	(0.0127)	(0.00647)
Observations	2,151	2,154	2,148	2,095
R-squared	0.026	0.049	0.007	0.068

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

This results from this regression are shown in Table 12 above. Although the R-squared is low, GDP growth seems to be significantly and positively correlated with equity returns. I also added a one year lagged and a lead variable of GDP growth to the regression. Both of these variables are significant, which suggests the effect of GDP growth on equity returns is distributed over different years. Although, with the F-test, I could not reject the null hypothesis, so I cannot state that there is a significant relationship between nominal GDP growth and nominal equity returns.

Even though GDP growth and investment return are not directly correlated, as you would expect, the expected future GDP based on its distribution could be helpful to determine an prudent lower bound. Graph 14 below shows that in the long-run (1870-2015), GDP returns of this diverse group of countries moves around a level above the UFR of 2.1%. The difference between the GDP growth level and the equity return is the difference in risk. On top of the GDP growth a risk premium applies for equities.



Graph 14: GDP growth compared to equity return and the UFR

Conclusion and Discussion

Conclusion

Pension liabilities need to be valued over extensive periods of time. The current Dutch pension system provides implicit guarantees, which means that people that pay premiums to a pension funds and are therefore entitled to a certain amount of future pension. Because of the commitments we make to pay out certain future pensions, the Dutch pension system is bound to use the risk-free rate as a starting point to discount pension fund's liabilities. The guarantees that are agreed on in the Dutch pension system and the risk-free discount rate that does not represent a fundamental risk-free market rate anymore, creates unnecessary concerns about the quality of our system and restricts Dutch pension funds from providing future pensions. I investigated whether equity returns or GDP growth could be a more appropriate, more fundamental and most importantly, a more stable starting point to determine whether the Dutch pension system will be able to provide pensions for current and future generations.

In this thesis, I investigate the return and associated risk of different rates of return, based on long-term historical data. I find a growth rate based on GDP growth rates, that can be assumed to be achievable on the investments of Dutch pension funds. I find that the yearly world GDP growth rate has a lower standard deviation (1.6%) than that of worldwide investment in bonds (10.3%) or equities (17.0%). Also, for a group of 16 individual countries, I find that the standard deviation of GDP growth for each country is relatively lower than the volatility of equity and bonds returns. As I compute population weighted world GDP growth rates following three different methods, I find a weighted, World GDP growth rate of 4.4%. Assuming a Dutch pension fund portfolio with 50% bonds and 50% equity, this yields a portfolio return of 3.3%. Investigating the tails of the GDP growth distribution compared to the tails of equity returns, I find that the tails of these two distributions have a similar, heavy-tailed shape. An explanation for this difference, is the scale of the distributions. Namely, the GDP growth distribution has a lower scale than the equity returns distribution, which also explains the difference in volatility. Because they have more or less the same tail index, the difference in volatility can only be explained by a difference in scale. Despite the chance that extreme world GDP growth values can occur, the world GDP growth rate is a fundamental economic measure and has been relatively stable over extensive periods of time. It is important that Dutch pension diversify worldwide to mitigate these extreme returns. But if pension funds invest in a worldwide, well-diversified portfolio based on GDP growth through financial markets, a return on their investments similar to GDP growth can be achieved plus a premium that will be picked up through investments in the equity markets. Under the right regulation and supervision, we preserve the well-functioning pension system we currently have. But with some adjustment, financial markets can be used by pension funds, as long-term investors, to achieve a share in world GDP and so fulfill future obligations to pay out pension, without curtailing pension benefits and retaining additional capita.

In the new pension agreements that is recently agreed upon in the Netherlands, the expected return is implemented as pensions payments become more dependent on projected yields. This makes future pension benefit slightly riskier, but it gives participants of Dutch pension funds a steady pension system and at the same time, a clear idea about what they can and cannot expect about their future pension.

Discussion

In this research I tried to discover whether there is a better alternative for the risk-free discount rate we currently apply. I tried to get an idea of the fundamentals of GDP growth and investigated whether the world GDP growth would be an appropriate measure. I mainly looked at the GDP growth rates of different countries and regions. But future research could focus more on the composition of GDP in terms of different industries and their associated risk. Apart from that, the data for developing countries and emerging markets was not available over extensive periods of time. This forced me to focus on the data of OECD countries, which makes the findings of this research more relevant for those countries than for developing countries.

Appendices

Table [xa]: Population weighted GDP growth

Country / region	Average GDP growth	St. dev. GDP growth	Population in mln (2018)	GDP growth population weighted
Albania	3.0%	7.2%	3	0.003%
Algeria	3.7%	7.3%	42	0.050%
Andorra	2.6%	3.7%	0	0.000%
Angola	3.8%	7.1%	31	0.037%
Antigua and Barbuda	3.9%	4.8%	0	0.000%
Argentina	2.5%	5.3%	44	0.035%
Armenia	3.3%	11.1%	3	0.003%
Aruba	3.3%	5.7%	0	0.000%
Australia	3.5%	1.7%	25	0.027%
Austria	2.8%	2.0%	9	0.008%
Azerbaijan	4.2%	12.9%	10	0.013%
Bahamas, The	3.2%	6.7%	0	0.000%
Bahrain	4.1%	4.0%	2	0.002%
Bangladesh	4.3%	3.7%	161	0.219%
Barbados	1.2%	3.1%	0	0.000%
Belarus	2.7%	6.5%	9	0.008%
Belgium	2.7%	2.0%	11	0.010%
Belize	5.0%	3.9%	0	0.001%
Benin	3.7%	3.0%	11	0.014%
Bermuda	2.8%	4.2%	0	0.000%
Bhutan	7.5%	4.9%	1	0.002%
Bolivia	3.7%	2.7%	11	0.013%
Bosnia and Herzegovina	9.7%	18.2%	3	0.010%
Botswana	8.2%	5.9%	2	0.006%
Brazil	4.0%	4.1%	209	0.267%
Brunei Darussalam	1.7%	6.1%	0	0.000%
Bulgaria	2.1%	4.6%	7	0.005%
Burkina Faso	4.5%	3.1%	20	0.028%
Burundi	2.5%	5.6%	11	0.009%
Cabo Verde	6.5%	4.8%	1	0.001%
Cambodia	6.0%	8.8%	16	0.031%
Cameroon	3.7%	5.4%	25	0.030%
Canada	3.3%	2.2%	37	0.039%
Central African Republic	1.4%	6.3%	5	0.002%
Chad	3.5%	8.3%	15	0.017%
Chile	4.1%	4.5%	19	0.024%
China	8.2%	6.8%	1,393	3.620%
Colombia	4.1%	2.1%	50	0.065%
Comoros	2.7%	3.0%	1	0.001%
Congo, Dem. Rep.	1.6%	6.0%	84	0.042%
Congo, Rep.	4.1%	5.5%	5	0.007%
Costa Rica	4.5%	2.9%	5	0.007%
Cote d'Ivoire	4.2%	5.3%	25	0.033%
Croatia	2.2%	3.2%	4	0.003%
Cuba	3.1%	5.8%	11	0.011%
Cyprus	4.9%	4.5%	1	0.002%
Czech Republic	2.0%	3.7%	11	0.007%
Denmark	2.4%	2.3%	6	0.004%
Dominica	2.4%	5.1%	0	0.000%
Dominican Republic	5.3%	4.9%	11	0.018%
Ecuador	3.8%	3.1%	17	0.021%
Egypt, Arab Rep.	5.2%	2.7%	98	0.163%
El Salvador	2.2%	3.6%	6	0.004%
Equatorial Guinea	14.7%	28.0%	1	0.006%
Estonia	4.1%	5.4%	1	0.002%
Eswatini	5.1%	4.7%	1	0.002%
Ethiopia	5.8%	6.5%	109	0.202%
Fiji	3.2%	4.3%	1	0.001%
Finland	2.9%	3.0%	6	0.005%
France	2.8%	2.1%	67	0.060%
Gabon	4.2%	9.3%	2	0.003%

Source: World Bank Database

Table [xb]: Population weighted GDP growth

Country / region	Average GDP growth	St. dev. GDP growth	Population in mln (2018)	GDP growth population weighted
Gambia, The	3.6%	3.7%	2	0.001%
Georgia	2.3%	10.1%	4	0.001%
Germany	2.0%	1.9%	83	0.022%
Ghana	3.7%	4.3%	30	0.015%
Greece	2.9%	4.7%	11	0.004%
Greenland	2.9%	4.4%	0	0.000%
Grenada	3.4%	4.0%	0	0.000%
Guatemala	3.9%	2.3%	17	0.009%
Guinea	4.3%	2.3%	12	0.007%
Guinea-Bissau	2.8%	6.8%	2	0.001%
Guyana	2.1%	4.9%	1	0.000%
Haiti	1.4%	3.8%	11	0.002%
Honduras	4.0%	2.9%	10	0.005%
Hong Kong SAR, China	6.1%	4.6%	7	0.006%
Hungary	2.2%	2.7%	10	0.003%
Iceland	3.9%	4.1%	0	0.000%
India	5.3%	2.9%	1,353	0.956%
Indonesia	5.3%	3.3%	268	0.189%
Iran, Islamic Rep.	4.2%	8.9%	82	0.047%
Iraq	7.5%	17.9%	38	0.039%
Ireland	5.0%	4.5%	5	0.003%
Isle of Man	5.9%	4.1%	0	0.000%
Israel	5.0%	3.5%	9	0.006%
Italy	2.4%	2.6%	60	0.020%
Jamaica	1.5%	4.2%	3	0.001%
Japan	3.7%	3.8%	127	0.062%
Jordan	5.5%	6.1%	10	0.007%
Kazakhstan	3.0%	6.8%	18	0.007%
Kenya	4.8%	4.5%	51	0.033%
Kiribati	1.5%	9.5%	0	0.000%
Korea, Rep.	7.3%	4.1%	52	0.051%
Kuwait	4.7%	7.8%	4	0.003%
Kyrgyz Republic	2.2%	7.3%	6	0.002%
Lao PDR	6.5%	2.7%	7	0.006%
Latvia	3.9%	5.6%	2	0.001%
Lebanon	5.4%	13.1%	7	0.005%
Lesotho	4.8%	5.8%	2	0.001%
Liechtenstein	3.8%	3.0%	0	0.000%
Lithuania	4.3%	5.0%	3	0.002%
Luxembourg	3.7%	3.3%	1	0.000%
Macao SAR, China	6.6%	8.5%	1	0.001%
Madagascar	2.0%	3.9%	26	0.007%
Malawi	4.3%	4.9%	18	0.010%
Malaysia	6.4%	3.3%	32	0.027%
Maldives	5.9%	7.1%	1	0.000%
Mali	4.2%	5.0%	19	0.011%
Malta	5.4%	4.1%	0	0.000%
Marshall Islands	2.7%	6.1%	0	0.000%
Mauritania	4.0%	5.9%	4	0.002%
Mauritius	4.5%	2.9%	1	0.001%
Mexico	3.9%	3.5%	126	0.066%
Micronesia, Fed. Sts.	1.3%	3.3%	0	0.000%
Moldova	3.1%	4.7%	3	0.001%
Monaco	2.9%	3.5%	0	0.000%
Mongolia	4.8%	5.3%	3	0.002%
Montenegro	2.6%	4.1%	1	0.000%
Morocco	4.7%	3.7%	36	0.023%
Mozambique	5.1%	6.0%	29	0.020%
Myanmar	5.9%	5.3%	54	0.042%
Namibia	3.2%	3.0%	2	0.001%
Nepal	3.8%	2.7%	28	0.014%
Netherlands	2.9%	2.3%	17	0.007%

Source: World Bank Database

Table [xc]: Population weighted GDP growth

Country / region	Average GDP growth	St. dev. GDP growth	Population in mln (2018)	GDP growth population weighted
New Zealand	2.5%	2.3%	5	0.002%
Nicaragua	2.8%	6.0%	6	0.002%
Niger	2.7%	5.7%	22	0.008%
Nigeria	3.8%	7.1%	196	0.100%
North Macedonia	1.4%	3.6%	2	0.000%
Norway	3.1%	1.8%	5	0.002%
Oman	8.5%	14.8%	5	0.006%
Pakistan	5.2%	2.3%	212	0.148%
Panama	5.4%	4.3%	4	0.003%
Papua New Guinea	4.0%	4.7%	9	0.005%
Paraguay	4.8%	3.5%	7	0.004%
Peru	3.7%	4.7%	32	0.016%
Philippines	4.4%	2.9%	107	0.062%
Poland	3.8%	2.6%	38	0.019%
Portugal	3.3%	3.5%	10	0.004%
Puerto Rico	3.3%	3.8%	3	0.001%
Romania	2.3%	5.3%	19	0.006%
Russian Federation	0.8%	6.3%	144	0.015%
Rwanda	4.8%	10.1%	12	0.008%
Samoa	2.1%	3.4%	0	0.000%
Saudi Arabia	5.1%	11.8%	34	0.023%
Senegal	3.1%	3.6%	16	0.007%
Serbia	3.2%	4.6%	7	0.003%
Seychelles	4.5%	6.1%	0	0.000%
Sierra Leone	2.7%	7.1%	8	0.003%
Singapore	7.3%	4.1%	6	0.006%
Slovak Republic	4.0%	3.1%	5	0.003%
Slovenia	2.2%	3.8%	2	0.001%
Solomon Islands	3.3%	5.7%	1	0.000%
South Africa	3.0%	2.4%	58	0.023%
Spain	3.4%	3.0%	47	0.021%
Sri Lanka	4.8%	2.0%	22	0.014%
St. Kitts and Nevis	3.9%	3.9%	0	0.000%
St. Lucia	3.6%	4.2%	0	0.000%
St. Vincent and the Grena	3.1%	5.7%	0	0.000%
Sudan	3.9%	5.2%	42	0.022%
Suriname	2.9%	4.9%	1	0.000%
Sweden	2.6%	2.1%	10	0.004%
Switzerland	1.7%	2.1%	9	0.002%
Tajikistan	1.9%	10.2%	9	0.002%
Tanzania	5.2%	2.0%	56	0.040%
Thailand	6.0%	3.6%	69	0.056%
Togo	4.0%	5.8%	8	0.004%
Tonga	2.0%	2.4%	0	0.000%
Trinidad and Tobago	3.3%	5.0%	1	0.001%
Tunisia	4.5%	3.3%	12	0.007%
Turkey	4.8%	3.9%	82	0.053%
Turkmenistan	5.6%	9.9%	6	0.004%
Tuvalu	2.6%	5.4%	0	0.000%
Uganda	5.8%	2.9%	43	0.033%
Ukraine	-1.1%	8.3%	45	-0.006%
United Arab Emirates	4.9%	7.5%	10	0.006%
United Kingdom	2.4%	2.0%	66	0.022%
United States	3.0%	2.0%	327	0.134%
Uruguay	2.3%	4.1%	3	0.001%
Uzbekistan	4.3%	4.5%	33	0.019%
Vanuatu	3.1%	4.6%	0	0.000%
Venezuela, RB	2.8%	5.2%	29	0.011%
Vietnam	6.5%	1.5%	96	0.083%
West Bank and Gaza	4.5%	7.3%	5	0.003%
Yemen, Rep.	2.0%	6.3%	28	0.008%
Zambia	3.3%	4.6%	17	0.008%
Zimbabwe	3.1%	7.5%	14	0.006%
Total			**7,440**	**5.0%**

Source: World Bank Database

Table [x]: Population weighted GDP growth taking into account volatility

Country / region	Average GDP growth	St. dev. GDP growth	GDP growth / St. Dev.	Population in mln (2018)	GDP growth population weighted
Vietnam	6.5%	1.5%	4.23	96	0.183%
Tanzania	5.2%	2.0%	2.68	56	0.088%
Lao PDR	6.5%	2.7%	2.43	7	0.014%
Sri Lanka	4.8%	2.0%	2.43	22	0.031%
Pakistan	5.2%	2.3%	2.23	212	0.328%
Australia	3.5%	1.7%	2.01	25	0.026%
Uganda	5.8%	2.9%	1.98	43	0.074%
Colombia	4.1%	2.1%	1.95	50	0.061%
Malaysia	6.4%	3.3%	1.93	32	0.060%
Guinea	4.3%	2.3%	1.92	12	0.016%
Egypt, Arab Rep.	5.2%	2.7%	1.92	98	0.152%
Korea, Rep.	7.3%	4.1%	1.81	52	0.113%
India	5.3%	2.9%	1.80	1,353	2.115%
Singapore	7.3%	4.1%	1.76	6	0.012%
Norway	3.1%	1.8%	1.72	5	0.005%
Thailand	6.0%	3.6%	1.68	69	0.124%
Guatemala	3.9%	2.3%	1.66	17	0.020%
Costa Rica	4.5%	2.9%	1.59	5	0.007%
Indonesia	5.3%	3.3%	1.58	268	0.419%
Mauritius	4.5%	2.9%	1.53	1	0.002%
Bhutan	7.5%	4.9%	1.51	1	0.002%
Canada	3.3%	2.2%	1.50	37	0.036%
United States	3.0%	2.0%	1.49	327	0.296%
Philippines	4.4%	2.9%	1.49	107	0.138%
Poland	3.8%	2.6%	1.45	38	0.043%
Burkina Faso	4.5%	3.1%	1.44	20	0.026%
Israel	5.0%	3.5%	1.44	9	0.013%
Isle of Man	5.9%	4.1%	1.42	0	0.000%
Austria	2.8%	2.0%	1.42	9	0.007%
Nepal	3.8%	2.7%	1.40	28	0.032%
Botswana	8.2%	5.9%	1.38	2	0.005%
Honduras	4.0%	2.9%	1.37	10	0.011%
France	2.8%	2.1%	1.36	67	0.056%
Bolivia	3.7%	2.7%	1.36	11	0.012%
Cabo Verde	6.5%	4.8%	1.36	1	0.001%
Belgium	2.7%	2.0%	1.36	11	0.009%
Paraguay	4.8%	3.5%	1.36	7	0.010%
Tunisia	4.5%	3.3%	1.35	12	0.015%
Malta	5.4%	4.1%	1.33	0	0.001%
Hong Kong SAR, China	6.1%	4.6%	1.32	7	0.013%
Slovak Republic	4.0%	3.1%	1.31	5	0.006%
Belize	5.0%	3.9%	1.30	0	0.001%
Liechtenstein	3.8%	3.0%	1.27	0	0.000%
Panama	5.4%	4.3%	1.27	4	0.007%
Morocco	4.7%	3.7%	1.27	36	0.050%
Netherlands	2.9%	2.3%	1.26	17	0.015%
Ecuador	3.8%	3.1%	1.24	17	0.020%
South Africa	3.0%	2.4%	1.24	58	0.051%
Turkey	4.8%	3.9%	1.22	82	0.116%
Sweden	2.6%	2.1%	1.22	10	0.008%
Total				**3,362**	**4.85%**

Source: World Bank Database

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