The Dutch pension system and implicit labour taxes

ERASMUS UNIVERSITY ROTTERDAM
Erasmus School of Economics
Department of Economics

Supervisor: dr. Y. Adema

Name: Jorn Mulder
Exam number: 343673
E-mail address: mulder.jorn@gmail.com

Abstract

Pensions have been one of the hottest topics of the past decade. Due to the institutional pay-as-you-go (PAYG) pension system designs a lot of OECD countries will face the imminent consequences of population ageing, leading to large future government deficits. Both popular and academic literature suggest pension system reforms in order to deal with this threat. Several academic papers suggest the reform to a more funded pension system in order to make the pension system more financially stable, such as the Dutch pension system that constitutes both unfunded and funded characteristics. However, the topic of pension systems is complex. Pension systems affect a lot of issues beside the major financial risks and government deficits, such as the labour market.

Since mandatory pension contributions are needed by the government to provide pension benefits, one could consider these mandatory pension contributions as payroll taxes on labour efforts. This will constitute an implicit tax on labour, which is larger or smaller depending on the institutional design of the pension system. The hypothesis of this thesis is that the Dutch hybrid PAYG-funded pension system is more efficient than pure PAYG pension systems.

In this thesis the reader will see how a tax-benefit link will increase labour market efficiency. Besides a tax-benefit link pension systems that are fairer in terms of pension contributions and benefits over the lifetime of the individual also tend to be more efficient in terms of labour market efficiency. After a theoretical elaboration on this topic the model will be calibrated by means of a sensitivity analysis.

Thesis outline

1. Introduction

For many years the welfare state of western economies has been one of the main topics of discussion in the academic and popular literature. Since the Second World War many welfare facilities have been introduced in Western economies in order to provide social security for all retired employees. During the design of these systems policy makers had to make a decision whether to introduce a funded pension scheme, in which the pension benefits are paid for by the accumulated pension contributions of employees, or a unfunded pay-as-you-go system, in which the pension benefits of the current retired employees are paid for by benefits of the current working employees. With the financial crisis of the 30's in mind many policy makers decided to implement a pay-as-you-go system in their countries. For several decades the pay-as-you-go pension scheme functioned well.

However, several decades after the implementation of the many pay-as-you-go (PAYG) pension systems policy makers are facing a new dilemma: population ageing. Many papers and articles appear on the subject of population ageing and the strains it puts on the existing unfunded welfare systems. The conclusion is that a pension crisis is imminent and that reforms of the pension systems are necessary in order to prevent a financial and social catastrophe. This leads to many proposals of pension reforms, such as the proposal of Feldstein to reform current PAYG systems to funded pension schemes. Miles and Timmermann (1999) illustrate such a reform in terms of risk and transition costs, but eventually conclude that a successful transition is depending on a lot of factors and assumptions, leading to the suggesting conclusion that milder reforms might be a more viable option than a full-scale reform. They suggest that the Dutch pension system is a good alternative pension system, since it has both PAYG and funded pension scheme elements. Therefore, the Dutch pension system might provide the solution to an imminent pension crisis.

The debate around pension systems is a complex one. Besides the issues of intergenerational financing risks there are also a lot of other distorting effects that have to be taken into account when proposing pension reforms. For example, Disney (2004) argues that part of the solution of financing the European public pension programs in the future (and to prevent benefit cuts) the employment rates will have to rise. At the same time many authors, such as Cigno (2008), argue that pension contributions can be seen as a tax wedge, which will therefore result in an implicit tax on labour supply. This dilemma focuses the attention of policy makers on the importance of the institutional design of pension schemes.

It also is the main topic of this bachelor thesis. If Miles and Timmermann are right about their claims about the Dutch pension system being a good solution for the long-term pension solvability for a given country, it is worth checking out if there might not be additional distorting effects present that might cast doubt on the optimism about the system. The Dutch pension system might not live up to the expectations in terms of efficiency, as the readers might conclude after reading the optimistic policy proposals done by Miles and Timmermann. The goal of this thesis is to shed more light on the efficiency of the Dutch pension system; more in particular on the aspect of labour supply distortions. My hypothesis is that the combination of both PAYG and funded elements in the Dutch pension system is favourable compared to pure PAYG pension systems on the subject of implicit labour taxes. The main research question of this thesis is therefore: *How is the Dutch labour supply side of the labour market equilibrium distorted by the hybrid Beveridgean-funded pension system of the Netherlands?*

The thesis will start with a brief introduction of the Dutch pension system and the Dutch labour market. The imminent pension crisis will be explored for the specific case of the Netherlands and several aspects of the system will be compared to other Western countries. After this introduction relevant scientific papers on the topic of labour supply and pension systems will be reviewed. The input from this literature will be used to find the answer to this research question. In order to find this answer I will design a theoretical macro-economic model using the reviewed literature in order to look at the differences between the Dutch pension system and other pension systems. After doing this I will try to measure the efficiency gain of loss by calibrating the model, using parameters that fit reality. The results of this calibration will be used to formulate policy advise for policy makers. I will conclude with some remarks on the scientific validity of this thesis and come up with possible improvements for further research.

2. The Dutch pension system and labour market

After an introduction to the Dutch economy and demography, the major characteristics of the Dutch pension system will be explored. By explaining several key definitions the reader will receive sufficient information in order to be able to comprehend the complex issue of pension systems. The second part of this chapter will focus on some empirical findings of the influence of the design of pension systems on labour supply, giving the reader insight in how pension systems can function as a payroll tax in reality.

2.1. Institutional design of the Dutch pension system

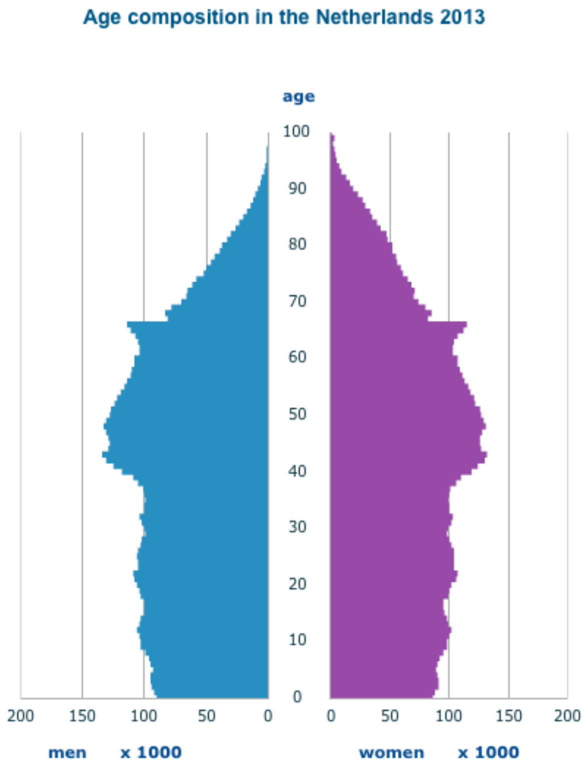
The Netherlands is a Western European country with a population of nearly 17 million people. With an estimated GNP of €953,5 billion euro's in 2012 The Netherlands is the 24th largest economy in the world and the sixth economy in the European Union. Throughout the years The Netherlands can be characterised having a stable economy with relatively low unemployment, inflation and a large trade surplus caused by being the main transportation hub in Europe (CIA, 2013).

Just like was mentioned in a previous paragraph, like many other Western countries The Netherlands is facing a potential demographic crisis due to population aging. As one can see in the ageing pyramid below (Figure 1), there will be a point at which the "baby boom-generation" will reach the pension age. Because of the institutional design of the Dutch pension system this will result in a pension crisis, since a large part of the pension system of the Netherlands is an unfunded "pay-as-you-go" (PAYG) system. Unfunded pension systems are systems in which current working generations provide the pension contributions in order to provide the pension benefits for the current retired generation. The pension crisis exists because of this feature, since a large shift in the demographic composition can result in large deficits for the coordinating government. Another possible pension system is a funded pension system, as was proposed by Feldstein in the introduction of this chapter. It is characterized by the fact that generations save for their own pension benefits. The savings are accumulated over a lifetime and are used to invest in assets in order to receive an even higher rate of return. At the same time the investment of pension assets means that policy makers in a country with a fully funded pension system have to deal with a lot more risks on an intergenerational scale. This makes the existence of fully funded pension systems politically unfeasible.

In turn PAYG pension systems can be divided in two types as well. In pension systems of the

Beveridgean type all individual pension benefits are the same for all retired people, regardless of the hours this person has worked. In this system the pension contributions can be seen as a tax on the labour effort of current generations in order to fund the benefits of the retired generation. In turn the government obliges itself to fund the benefits of current generation in the future, which will have to be paid by the next generations contributions, and so on.

Figure 1: Demographic pyramid of The Netherlands in 2013



Source: (CBS, 2013a)

The other type is the Bismarckian pension system, named after the initiator of the first German welfare system around 1880, Otto von Bismarck. This type of a PAYG pension system is characterized by a link between the pension contributions of the working individual and the benefits of this individual (Cigno, 2008). In these Bismarckian pension systems the pension contributions become a form of mandatory saving, what might cause a distortion of the labour supply equilibrium. In later parts of this thesis I will further elaborate on that topic.

When one looks at how the pension system of the Netherlands can be characterized, it will be called a Beveridgean PAYG pension system (OECD, 2011). This however is not the full story, since the Netherlands knows several pension 'pillars' (Rijksoverheid, 2013). The first pillar, the Algemene Ouderdomswet (AOW), is indeed of the Beveridgean type. Dutch citizens who reach the age of 65 (66 and 67 in the future, due to recent legislation) are eligible to these pension benefits, regardless of their work effort in the past. As of 1 July 2013 the received pension benefits from the first pension pillar is approximately €725,77 euros per person, which is 70% of the Dutch net minimum wage.

Table 1: Size of the three pension pillars for several OECD countries

%	**First pillar**	**Second pillar**	**Third pillar**
Greece	98	1.5	0.5
France	97	1.5	1.5
Spain	97	1.5	1.5
Italy	96	2	2
Austria	95	3	2
Germany	94	4	2
Denmark	76	20	4
Sweden	75	20	5
Switzerland	72	26	2
The Netherlands	56	37	7

Source: (Boeri et al., 2006)

The design of the first pillar in encountered in a lot of Western countries. What makes the pension system of the Netherlands special is the existence of a funded second pension pillar. As one can see in Table 1 the Netherlands can be distinguished from other major European countries in the sizes of the first, second and third pension pillars. One of the main features of this pillar is that it is an occupational scheme in which the employers and employees provide a part of the earned wages to one of the many pension funds that exist in the Netherlands. As of 2008 91% of the Dutch employees contribute to this funded second pillar. Participation in one of these funded pension funds is mandatory, unless the individual can present an alternative pension scheme that will be sufficient and equivalent for the individual's retirement. Only in such cases 'opting out' of the pension scheme is allowed, making the second pillar quasi-mandatory (OECD, 2011). This way the employees can build up their own eligible pension benefits up to 100% of the last earned final pay of the employee. After reaching this amount additional taxes will be levied on the contributions of the worker. Since most Dutch private pension schemes only offer up to 70% of the last earned final pay the occurrence of these extra taxes do not take place often. Because of this quasi-mandatory feature the Netherlands has the largest size of the private pension funds in the world with €831,3 billion euros worth of assets as of 2011 (138% of the Dutch GDP in 2011) (CBS, 2013b).

The third pillar consists of supplemental pension benefits in the form of savings and life insurances. It is used a lot by small entrepreneurs who do not have access to the pension funds of the second pillar. Since the third pillar is relatively small it will not be further elaborated on in this thesis. Savings of the third pillar will be regarded as savings in the macro-economic model of Chapter 4.

As was said in the introduction, the large size of the second pillar of the Dutch pension system is fairly unique compared to the world and seems to bring several benefits with it, such as a better solvency of the pension system (providing a better solution for the imminent pension crisis), higher rates of return and a stronger tax-labour link between pension benefits and delivered labour supply. The 'hybrid' Dutch pension system, with the combination of a Beveridgean PAYG type first pillar and a large funded second pillar, seems to offset the downsides of both types of pension systems. If this is the case the Dutch pension system might be a shining example for the rest of the OECD countries that are facing a potential pension crisis.

2.2. Institutional pension system design and the labour market

With the main research question in mind, it is worth looking at the factors making the Dutch pension system better than other pension schemes, in this case the labour market. As was stated in the introduction of this paragraph the Netherlands has known a relatively low unemployment rate over the years. Despite this reputation the seasonal corrected unemployment rate has reached an all-time high peak of 8,3%. This is mainly caused by various economic events in Europe, such as the economic depression and the systematic Eurocrisis that still affects consumer and investor confidence. Because of the versatile character of the labour market and the abstract influence of pension systems on labour market participation of individuals it is hard to give clear-cut answers on this subject.

Disney (2004) argued that the institutional design of public pension schemes matters in order to finance the pension deficit in the future. At this moment a lot of the literature is looking at pension contributions as a tax wedge, what causes distortions in the labour participation of women and men alike. Disney looks at the tax component of pension contributions and undertook an empirical analysis to look at the relationship of labour distortions and pension 'payroll taxes'. Disney finds in a preliminary analysis that the contribution rate has significant negative effect on the labour participation of women and no significant negative effect on the participation of men. He states that the impact of labour taxes on activity is weak, but at the same time points out that these results rely heavily on the specification of the institutional indicators.

In order to further examine in how the pension contributions can result in payroll taxes Disney spends considerable time at defining actuarial fairness and intergenerational equity and the link between these two definitions with the institutional design of pension systems. After modifying his model Disney finds by means of a time-series and cross-country analysis that the tax effect of pension contributions are still significantly negative for the labour participation of women and significantly negative for older cohorts of men. The main conclusion is that in the case of Bismarckian pension schemes it is very important for the government to function as actuarially fair as possible in order to minimize the tax effect.

Finally, in a paper that will be discussed later in this thesis, Cigno (2008) reviews a lot of the available empirical literature on the subject of implicit labour taxes himself and concludes, that despite indications that implicit labour taxes exist, one has to take care not to draw too far-reaching conclusions on the basis of these empirical analysis. The models these authors used do not include a lot of market imperfections and these empirical tests only look at individual behaviour. Since the effect of pensions and pension systems on labour supply decisions are taking place on a micro-economic level, more empirical tests should be conducted using micro-data in order to estimate the true effect of a change in policies.

3. Literature review

In the literature review several academically relevant papers on the topic of pension systems and the labour market will be reviewed. The key insights of these papers will be used to design a formal pension system model in Chapter 4.

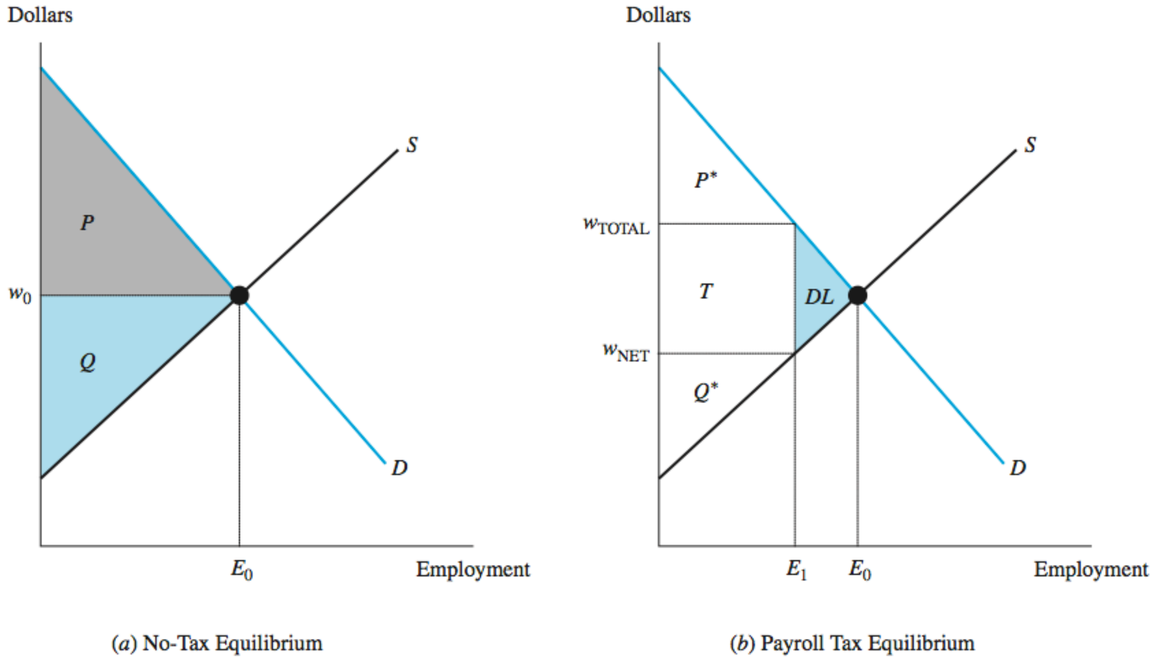
3.1. Borjas (2013)

A main topic of this thesis is the functioning of the labour market. In economics the neoclassical model of labour-leisure choice is used to analyse labour supply behaviour. With this model factors that determine whether economic agents work and if so, how much they work is determined by the factors that are isolated in this model. The most important factor of labour-leisure choice models is utility, a parameter that depicts the amount of welfare individuals derive from consumption (financed by earned wages) and leisure. Economists then typically look at the marginal utility that agents receive from labour and leisure, dependent on their budget constraints. This means that at the point where the last unit of utility from labour is equal to the last unit of utility of leisure divided by the wage rate, the economic agent will receive most utility of his intensive labour supply decision. Since labour demand is beyond the scope of this thesis I will not elaborate on that topic.

This model is then used to look at the efficient equilibrium that is reached in a fully competitive labour market. According to the invisible hand theory by Adam Smith a fully competitive labour market should reach an efficient equilibrium in which the producer and consumer surplus are maximized. This is the result of trade. Trading causes an efficient allocation of labour resources that leads to the maximization of surpluses.

Taxes can cause a distortion of the equilibrium that is found in this labour market. It is important to note that the political discussion that only firms or the employees should carry the costs of a new tax is irrelevant. It does not matter whether taxes are imposed on workers or firms. Because a tax on firms causes a shift in wages and employment, part of the tax is shifted to the employees. The size of this distortion depends on the elasticity of labour supply and demand. Taxes are not necessarily bad, since the government will use the benefits in order to execute their policies. However, the optimal point that was reached in the competitive labour market is no longer reached. The utility that is lost in the process is called deadweight loss of the tax, as can been seen in Figure 2.

Figure 2: Deadweight loss of a Payroll Tax



Source: (Borjas, 2013)

In the figure above you can see how even mandated benefits can decrease efficiency. The introduction of a payroll tax leads to a tax wedge causing the market labour equilibrium to shift left. The implementation of a payroll tax on employment leads to tax benefits *T*, which the government will use to provide benefits to its civilians. However, consumer and producer surplus have decreased as a result of the implementation of the payroll tax. (a) shows how consumers had a consumer surplus of P and P^* after the implementation of the payroll tax in (b). The producer surplus decreases from Q to Q^*. In his situation civilians cannot optimally allocate their former resources anymore, so that E_0 is not optimal anymore. This decrease in efficiency is illustrated by the triangle *DL* (deadweight loss).

Some authors are arguing that the benefits of the Dutch pension system, especially the second pension pillar, are a payroll tax on labour. The existence of the second pension pillar contributions, financed for two-thirds by employers and one-third by employees, result in an implicit tax wedge, which might cause deadweight loss because of the distortions on the labour markets. This poses the question whether the institutional design of pension systems is important for minimizing the deadweight loss for economic agents. This will receive further attention in later chapters.

3.2. Lindbeck and Persson (2003)

The goal of the paper of Lindbeck and Persson is to explore differences in efficiency between several pension systems. The authors state that a lot of the focus on the topic of pension reform has been on defined benefit and defined contribution schemes, but that the aspect of actuarial fairness and funded versus unfunded pension schemes remain unexplored. In the context of pension systems actuarial fairness can be defined as the fairness of the system in terms of pension contributions and pension benefits over the lifetime of the individual. If the individual could choose to invest his pension contributions in stocks he could receive a certain rate of return over the years. If the government takes this market interest rate into account when it provides the pension benefits to the individuals, the system is considered actuarially fair. In the case that the government does not fully return the market interest rate over the pension contributions or when the government provides lower pension benefits than individuals should receive on basis of their past contributions, the system is actuarially unfair.

In this paper Lindbeck and Persson look at how pension reform from an unfunded actuarially unfair PAYG system towards a quasi-mandatory and a fully funded pension scheme affects labour market efficiency. They disregard the aspect of risk for the main part of the paper, but conclude with some remarks on this aspect at the end of their paper. Since actuarial fairness plays a major role within the topic of implicit labour taxes, this paper offers a lot of insight in the functioning of the institutional design of pension systems.

Lindbeck and Persson start with some arguments for proposing implementation of a mandatory PAYG pension system for all civilians of this country. By making this pension system mandatory everyone will have to contribute to the pension system, which will prevent freeriding since individuals will now not be able to fully exploit the altruism of other individuals. The mandatory pension system will also provide social security for 'myopic' individuals, individuals that will not save up the necessary funds for the moment when they grow older. Furthermore a mandatory PAYG might perhaps be the only viable option since the market for annuities on a time scale this large is undeveloped. Finally a PAYG pension system makes distribution of welfare within and between generations possible.

The pension system Lindbeck and Persson design comes down to a system in which labour supply, wage growth, population growth and the mandatory contribution rates determine the rate of return between generations. In their analysis, Lindbeck and Persson find that reforming a pension system towards a more actuarially fair scheme leads to a positive labour supply substitution effect, thus increasing efficiency. The authors argue that the lower implicit tax on labour, caused by making the pension system more actuarially fair will also tend to affect the retirement rate, since individuals will now be more willing to work on for a longer period.

With that finding pension reform seems to offer a lot of efficiency gain by lowering the implicit tax on labour, but these reforms will have to be observed in comparison with other topics such as income distribution and income insurance. By making pension systems more actuarially fair the government will have less possibilities to redistribute welfare between and within generations. This induces the fear that pension reform towards a more actuarially fair system will result in more inequality between rich and poor individuals. Lindbeck and Persson find from several empirical studies that this fear is not justified, because the empirics show that reform will actually result in 'progressive' redistribution (allocation of wealthy towards poor individuals), since the current pension systems are not as 'regressive' (leading towards more inequality between wealthy and poor individuals) as the authors previously expected.

Financial stability is another issue that plays a major role in the observation of pension systems. A pension system is said to be financially stable when the capital value of expected pension payments are equal to the capital value of the revenues to the pension system. A shorter explanation for this is that the discounted sum of the total individual contributions and the benefits of the pension system have to balance each other. Actuarially fairer pension systems are thought to be more financially stable, because it mimics several characteristics from the fully funded pension schemes, that does not distort the labour supply of the market. This is because the pension benefits of individuals are based on the returns on these individuals own pension contributions. This leads to the conclusion of Lindbeck and Persson that a reform of a non-actuarial defined benefit system towards a more actuarial fair defined contribution system tends to increase efficiency of the labour market.

The conclusions of this paper seem to confirm the hypothesis of this thesis. If the Dutch pension system is more actuarially fair than other pension systems, this will probably result in more labour supply efficiency. However, it remains a question whether this pension system will also be socially superior towards actuarially unfair Beveridgean PAYG pension systems, since several major aspects of pension systems were not taken into consideration in this paper (such as financial risks). It is interesting to pay some attention to several of these aspects at the end of this thesis, like Lindbeck and Persson did at the end of their paper.

3.3. Cigno (2008)

Alessandro Cigno published a theoretical paper concerned with the labour distortion of the supply side caused by different pension systems in 2008. He starts with stating that the political discussion takes for granted that the pension contribution is automatically taken as a tax on labour, which will in turn reduce employment. The academic discussion about pension contributions being an implicit labour tax has been going on for years, which has lead to several theoretical and empirical studies on this subject.

Cigno elaborates in his paper on the topic of the distortion of labour distortion caused by two different pay-as-you-go (PAYG) pension systems. His first pension system is the Beveridgean pension system, in which individual pension benefits are not related to the individual contributions of his active working life. His alternative pension system is the Bismarckian pension system, where a link is present between the pension benefits and pension contributions of the individual. In the case of Bismarckian pension systems pension contributions can be seen as mandatory savings. The tax element that exists in the Bismarckian pension system is derived from this mandatory feature, since saving more than an individual prefers could be seen as an implicit tax on labour. Furthermore, since several authors have stated that the age of retirement would be distorted as well by different designs of pension systems, it is important to note that Cigno is assuming the age of retirement is fixed.

Cigno's model is a two-period life cycle model in which utility is derived from the consumption in the working-age period and the consumption in the retirement-age period. It is assumed that the model ends after these two periods, so that the entire budget is consumed. The consumption of period 1 consists of the hours worked multiplied by the wage per hour minus the savings made by the individual. The consumption of period 2 consists of the savings from period 1 multiplied by the market interest factor. By introducing a compulsory pension system in this life-cycle model Cigno shows how the marginal pension contribution rate lowers the disposable income, which is transformed in pension benefits in period 2. The basic differences between Beveridgean and Bismarckian pension systems appear at this moment, since with the Beveridgean pension system the pension benefits are the same for everyone and with the Bismarckian pension system the pension benefits are a function of the individual's lifetime contributions.

This brings up the topic of actuarial fairness of pension benefits. If the received pension benefits are more than the contributions multiplied by the market interest rate, he or she is receiving more money than is actuarially fair. This means that other people of generations are giving a present to this individual. The same applies for individuals who are receiving less than the actuarially fair benefits.

When the mathematical formulas and derivations are compared with each other, the conclusions are straightforward. A Beveridgean pension scheme always discourages labour under the assumptions of Cigno's model, where with a Bismarckian pension system this depends on the matter of actuarially fairness of the pension benefits. It is the difference between the capitalized value of the pension contributions and the present value of the benefits that constitutes the implicit labour tax on the individual.

Cigno concludes with comparing his theoretical findings with some empirical papers on this subject. He finds that the empirical evidence does not contradict his own conclusions, but at the same time states that the comparison of his theoretical model with reality is problematic since the labour markets are influenced by a large variety of factors. It might be the case that labour is distorted by other major factors rather than pension policy. Secondly this paper does not do justice to the macro-economic descriptive statistics, since this theoretical model looks at the possible reactions of individuals in a micro-economic environment. These points will be relevant for the rest of this paper, since I will probably encounter the same problems when designing the theoretical pension system for the Netherlands.

3.4. Fisher and Keuschnigg (2008)

A more extensive and complicated model about labour market distortions caused by pension systems and pension reforms appeared in 2008 as well. Fisher and Keuschnigg wrote an extensive paper about the theoretical implications of pension reform in light of the debate about the funding of the pension systems in the long run. They state that over the years pension reforms have been motivated by concerns about the pension systems having adverse effects on programs focused on labour market incentives. Since then policy makers have proposed initiatives to strengthen the link between benefits and contributions in order to prevent some of these adverse effects of pension reforms in a way that were illustrated in the paper by Cigno. Other proposed reforms were focused on making pension schemes more actuarially fair by providing disincentives for early retirement and less work effort.

With this academic debate on the background Fisher and Keuschnigg focus on the interactions between the incentives facing younger and older workers. To show how incentives of older and younger workers interact they come up with a formal model that clarifies how the aggregate labour supply of these groups might be offset or reinforced. In order to do this they propose looking at all forms and reforms of pension systems, so that the institutional framework of these pension systems may be observed within this formal model. This way Fisher and Keuschnigg show how the margins of labour supply are affected by the various institutional designs. They conclude their paper with an observation of the excess burden of pay-as-you-go systems, in particular at how this excess burden depends on the elasticities of labour supply for younger workers and retirement behaviour of older workers. Furthermore they also take into account how the effective tax rates of these two groups affect the excess burden of the institutional design.

The theoretical model of Fisher and Keuschnigg is based on several assumptions that are essential to simplify reality to a feasible model. In this model agents are risk-neutral and only live in two periods: a period in which the employee is young and working and a period in which the employee is old and can choose to retire. In order to keep the model simple the authors propose a Ricardian production model in which labour is the only production factor. Labour markets are fully competitive, which implies that real wages are at unity and that there is no unemployment. Finally this model considers present and future consumption as perfect substitutes, making the interest rate the only factor of time preference.

The authors state that these assumptions make the model a simple one. These assumptions are indeed strong and reality is of course not accurately represented in this model. Seeing as the goal of the model is to provide insight in how incentives are affected by particular institutional pension system designs, these strong assumptions do not pose a further problem for using them for this thesis.

The model used by Fisher and Keuschnigg begins with a simple macro-economic framework in which the agents face a decision on how much labour they will supply. This labour supply decision determines the amount of wage is earned, so that the budget constraints of the first and second period are dependent on the hours worked, wages, savings, the statutory contribution rate and the market interest rate. Using parameters the authors scale the preferences for early and late retirement, where they assume that this preference is increasingly negative for every extra hour worked.

In order to derive the implicit tax of the pension system Fisher and Keuschnigg substitute the budget restrictions in a value function (see Appendix *a*). By using this value function and a set of assumptions they come up with several derivatives that shows how the labour supply margin is affected by several factors, such as retirement age and the labour supply decision. In this section three of the major functions will be discussed that are particularly relevant for this thesis.

$$p = m(x)[\tau L * R^p + \tau x] + b \qquad (1)$$

Equation (1) is crucial in determining the several pension policies and the factors that influence the size of the pension earnings in the second period, since it shows how the several pension designs differ in the way the pension benefits are distributed to the retired employees. Adjusting and adapting this function for the Netherlands, later in this thesis, will provide an adequate tool to analyse labour supply distortions in the Dutch labour market. Within this function the variable 'b' represents flat pension payments independent of contributions, R is the interest rate of the pension system and τ is the statutory contribution rate. This means that a system where $p = b$ (because $m(x) = 0$) represents a Beveridgean pension system. $m(x)$ stands for the tax-benefit link between the past contributions and present pension benefits. It is $m(x)$ that determines whether the pension system is actuarially fair or not. This depends for a large part on the retirement age x. In the sense of this pension function a pension system is Bismarckian if $m(x) > 0, b = 0$ and $R^p = 1$, which implies that in a Bismarckian pension system the agents do not receive extra interest over a longer active working life. Finally this function also shows that a funded pension system where the contributions earn the market rate of interest, so that $R^p = R$.

Using this pension benefit function Fisher and Keuschnigg derive the implicit labour tax (see Appendix *a*), represented by the function below. This equation represents some key insights into the intensive labour supply decision of workers. It shows that a pay-as-you-go system in which agents do not receive the market interest rate for their contributions will distort the labour supply margin more than a funded system. It also shows how a delayed retirement affects the conversion of contributions into benefits and how this translates in a higher implicit labour tax.

$$\tau_L = \tau * [1 - [(1 - x)m(x)\frac{R^p}{R}] < \tau \qquad (2)$$

τ_L stands for the implicit labour tax for young workers making an intensive labour supply decision. In this system with a benefit-contributions link the pensions are observed on the basis of past earnings. It shows that not the entire contribution rate is seen as an implicit labour tax, but only the part that is seen by the young worker as a tax in his younger years. As has been explained in the literature review of Lindbeck and Persson (2003) this part is similar to the amount of the contribution rate that is not actuarially fair. As Fischer and Keuschnigg state, "greater work effort by the young raises not only current income but also leads to higher retirement income when old". This statement is particularly relevant when looking at the conclusions of the paper of Cigno, since his perception is less sophisticated than this definition of implicit labour tax. During the design of the model that measures the design of the labour supply distortion in the Dutch labour market this is something that will be taken into account.

The third major equation from Fisher and Keuschnigg's paper that is relevant for this thesis is the equation that shows the relative increase of the implicit labour tax caused by a later retirement decision, depicted by the variable x^*:

$$\tau_L^* = \frac{\tau m_0 x}{(1-\tau_L)R} x^* \quad (3)$$

The retirement age in the Netherlands is fixed at the age of 67 years old, making this formula irrelevant for a Dutch observation. However, it is interesting to see how the implicit tax rate might differ when this formula is used in a comparison between countries with differences in retirement ages. In that sense this formula is an interesting suggestion when the theoretical model will be calibrated in a later stage of this thesis.

These few formulas are the first simple building blocks for Fisher and Keuschnigg's paper and their analysis about the efficiency of several pension system reforms. Since a lot of the rest of their paper is about the effect of the implicit retirement tax, a topic that will not be further discussed in this thesis, a large part of the paper on the matter of efficiency of public pensions is not directly relevant for the analysis in Chapter 4. Nevertheless this theoretical paper by Fisher and Keuschnigg is in many ways more complete and sophisticated compared to the paper written by Cigno. Where Cigno has a relatively simple model in which the basic distortion of a Beveridgean system is compared to distortions caused by a Bismarckian system, Fisher and Keuschnigg also look at funded pension schemes and actuarially fair adjusted pay-as-you-go pension schemes besides Beveridgean and Bismarckian pay-as-you-go-systems. This is especially useful for the purpose of this thesis, since the pillars of the Dutch pension system has characteristics of all these pension systems. The extensiveness of the model designed by Fisher and Keuschnigg can therefore be used in looking at the institutional design of the Dutch pension system and be used to look at the distortion of the labour supply margin caused by the pension system in the Netherlands. To conclude on the usefulness of the paper by Fisher and Keuschnigg it can be said that it provides a lot of additional insight and that it provides suggestions for adapting this model for the particular institutional design of the Dutch pension system. This should work out fine as long as the reader takes into account that the underlying assumptions of this model are pretty strong and should be treated as such.

4. The model

In Chapter 4 will a model be designed and elaborated on in order to look at the implicit tax on labour caused by hybrid pension systems such as the Netherlands. All main elements from the papers of the literature review will be used in the design of this model. The reader will be able to identify the key factors that make a hybrid pension system better or worse compared to other pension systems.

4.1. A Diamond-Samuelson model

To look at the implicit labour tax caused by the institutional design of the Dutch pension system it is necessary to incorporate the findings of the reviewed literature into a new model, before the results can be calibrated. A simple, but useful, macro-economic model that captures time and specific life cycle behaviour of individuals is the Diamond-Samuelson model. In this intergenerational model the budget constraints of individuals are determined, which will in turn be used to determine the optimal utility. This macro-economic household of the individual exists in this setting for two periods: the period in which the individual works and the period in which the individual is retired. I assume that this individual dies after these two periods and does not have to deal with inheritance issues, since this individual fully consumes his wealth. The budget constraints of the individual are depicted by the following equations:

$$c_t = (w_t - \eta_t)L - s_t \tag{4}$$

$$c_{t+1} = (1 + r_{t+1})s_t + \theta_{t+1} \tag{5}$$

As you can see in equation (4) consumption in time period 1 is dependent on the height of the individual's wage rate w_t, the labour supply decision L, his savings decision s_t and the pension contribution η_t. Equation (5) shows how the individual is retired in time period 2 and how the individual can consume his savings and accrued interest plus the pension benefits θ_{t+1} the individual is eligible for. When these constraints are combined the following disposable income is available for the individual to consume:

$$(w_t - \eta_t)L + \frac{\theta_{t+1}}{(1+r_{t+1})} = c_t + \frac{c_{t+1}}{(1+r_{t+1})} \tag{6}$$

The consumption choice of the individual in periods 1 and 2 depend on two important factors in this model: time preference ρ and interest rate r_{t+1}. These variables play a key role in the amount of utility that the individual derives from his consumption choices. The total amount of utility is depicted by the following utility function:

$$U = U(c_t) + \frac{U(c_{t+1})}{(1+\rho)} \tag{7}$$

What follows from this utility function is that utility is derived solely from consumption. This would imply that working the maximum hours possible would be in the individual's best interest. This, of course, is not realistic. Human individuals are social creatures that derive utility from several pleasures in life, which are not all linked to consumption, for example rest or a healthy family life. Working extra hours compromises the individual in his ability to derive utility from these other pleasures. If it is assumed that the individual needs all forms of these pleasures in order to enjoy life, he will at a certain point no longer be better off with working extra hours because this individual is too much compromised in his other pleasures by working, resulting in lower utility. In the rest of this thesis I will call this phenomenon 'disutility of working'. In order to capture the disutility of working in the model I will use the mathematical definition of Fisher and Keuschnigg's model to find the individual's optimal labour supply decision. It will be assumed that the marginal disutility of providing extra labour effort is positive and increasing:

$$U(c_t^e) = c_t - \varphi_t(L) \tag{8}$$

This results in the situation that utility derived from period 1 consists of a sum of utility from consumption and disutility per extra amount of labour effort that is supplied. Like Fisher and

Keuschnigg I will take disutility of increased labour effort into account in this model. The labour disutility function will therefore be $\varphi_t(L) \equiv \gamma L^{\delta}$, with $\delta > 1$ and $\gamma > 0$, so that the marginal disutility of labour is positive and rising.

Utility from period 2 is derived from the consumption in period 2. Since the former employee is now retired, he is not facing disutility of working anymore and can fully consume his retirement savings and pension benefits.

$$U(c_{t+1}^{p}) = c_{t+1} \tag{9}$$

By inserting the budget restrictions in the utility function you can see in equation (10) how utility is derived from consumption. It should be noted that this thesis uses a linear utility function in which consumption in period 1 and 2 are perfect substitutes, which implies that there are no diminishing returns to scale. It is therefore a possibility that individuals choose to consume all of their lifetime income in period 1 and nothing in period 2. The main reason for using this simple utility function is the complexity of the more widely used Cobb-Douglas function. The linear utility function should however suffice to test the hypothesis of this thesis.

$$U = \left[\left((w_t - \eta_t)L - s_t\right) - \gamma L^{\delta}\right] + \frac{[(1+r_{t+1})s_t + \theta_{t+1}]}{(1+\rho)} \tag{10}$$

Two variables in this utility function are especially relevant for this thesis: η and θ. These variables represent the institutional design of the pension systems. It will show how the hybrid PAYG-funded Dutch pension system differs from other systems. This function reminds of the pension benefits of the Fisher and Keuschniggs model, which is partly correct. In this model we take Cigno's basic model of social tax wages and extend it with the more detailed pension function of Fisher and Keuschnigg, but this time without the possibility for the individual to choose his own retirement age. This is more realistic, since in a lot of countries the government decides what the retirement age is at which individuals become eligible for pension benefits. Furthermore this model will include the variable g_{t+1}, which will depict the return the government is withholding from the contributions of the individual (Lindbeck & Persson, 2003), so that the system will possibly be actuarially unfair through government intervention in the pension system rate of return. The first part of the equation shows the part of the pension system that has a tax-benefit link, so that the pension benefits might depict both a fully funded pension system as well as a Bismarckian PAYG pension system. Pension benefits are thereby defined as:

$$\theta_{t+1} = \alpha \underbrace{(1 + r_{t+1} - g_{t+1})}_{1-\tau_L} \eta_t L + \beta \vartheta_{t+1} \tag{11}$$

where g_{t+1} is the rate the government withholds from the pension contributions, r_{t+1} is the market interest rate accrued by the individual in time period 2 and ϑ_{t+1} is the Beveridgean PAYG pension benefit the individual receives in period 2. The parameters α and β are the relative sizes depict the relative sizes of the funded and unfunded part of the hybrid pension system.

As we have seen in Cigno's paper, actuarially unfair pension systems distort the labour market more than actuarially fair pension systems. The rate g_{t+1} is important in this model, because when this interest rate differs from the market rate of return, the individual will make either a profit or a loss from his quasi-mandatory participation in a private pension fund. This in turn will result in more or less distortion of the labour market equilibrium. To conclude there is also the Beveridgean-type benefit ϑ_{t+1}. This formula confirms the findings of Cigno (2008) in the sense that Beveridgean-type benefits result in a full distortion of the labour market equilibrium, whereas Bismarckian-type benefits only distort partially and fully funded schemes are superior in their neutrality towards the labour market equilibrium. This is caused by the tax-benefit link that is present in the first part of the equation and absent in the second part of the equation.

This model offers a good framework to calibrate later in this thesis. This is necessary, because we cannot immediately see whether the Dutch system is superior to other pension systems without defining the parameters of the model. With this model the foundations have been laid out in order to look at the effect of the institutional design of pension systems on the labour supply side of the market equilibrium.

4.2. Implicit labour tax

As we have seen in the literature review, the pension contribution rate is only an implicit tax on labour as far as it exceeds the saving and pension preferences of the individual. Besides this difference in preference implicit labour taxes may also occur when the pension benefits are not actuarially fair compared to the pension contributions of the individual. The parameters that represent these difficulties have been included in the model. Therefore it is a matter of combining all the variables in the utility function and deriving an optimal labour supply decision of the individual:

$$\frac{\partial U}{\partial L} = w_t - \eta_t - \delta\gamma L_t^{\delta-1} + \left[\frac{\theta_{t+1}}{1+\rho}\right]' = 0 \tag{12}$$

The derivation of the optimal labour supply decision seems identical to the derivation of the implicit labour tax of Fisher and Keuschnigg. This is partly true, but in this setting the retirement age is fixed at a certain age. Besides the aspect of retirement, time preference can result in an even higher implicit labour tax when it plays a role in the model. We also see what the effect of the interest rate of the pension system is, since a lower or higher pension system interest rate can cause an actuarially unfair situation in which the implicit labour tax rises. From time to time news articles report that the pension funds are cutting the pension benefits of retirees when the coverage ratios of the pension funds become too low. This then adds up to the implicit labour tax of individuals, when the individuals are discounting this kind of cuts in their utility function.

Because of the assumptions that have been made in Section 4.1 we know that the marginal disutility of labour for an individual is $\delta\gamma L^{\delta-1}$. This can be observed as the true implicit labour tax of the institutional design, as can be observed from the following derivation using the chain rule. Here it becomes clear that actuarial fairness plays a large role in what part of the pension contribution is regarded as the implicit labour tax.

$$L^* = \left(\frac{w_t - \eta_t + \left(\frac{\alpha\eta_t 1 + r_{t+1} - g_{t+1})}{1+\rho}\right)}{\delta\gamma}\right)^{\delta-1} \tag{13}$$

From this derivation (see Appendix *b*) it also becomes clear how g_{t+1} can alter the implicit labour tax, because individuals that are eligible for less than 100% of their past pension contributions leads to additional actuarial unfairness. This is relevant, since a lot of OECD countries have some sort of tax-free cap after which there will be levied additional taxes on the pension contributions. In the case of the Netherlands a lot of pension funds offer pension benefits up to only 70% of the final pay, which could be regarded as an unfair conversion factor.

In Table 2 the differences between the implicit labour taxes have been separated per major type of pension system. The differences now become very clear: the entire contribution rate is regarded as a tax within Beveridgean pension systems, while in pension systems with a stronger tax-benefit link (Bismarckian and funded) only the part that is considered actuarially unfair is considered an implicit labour tax. Fully funded pension systems do not even have an implicit tax on labour, since in this setting individuals can save as much as they want and receive full interest over their entire savings, making this system actuarially fair.

Table 2: Implicit labour taxes of various institutional pension system designs

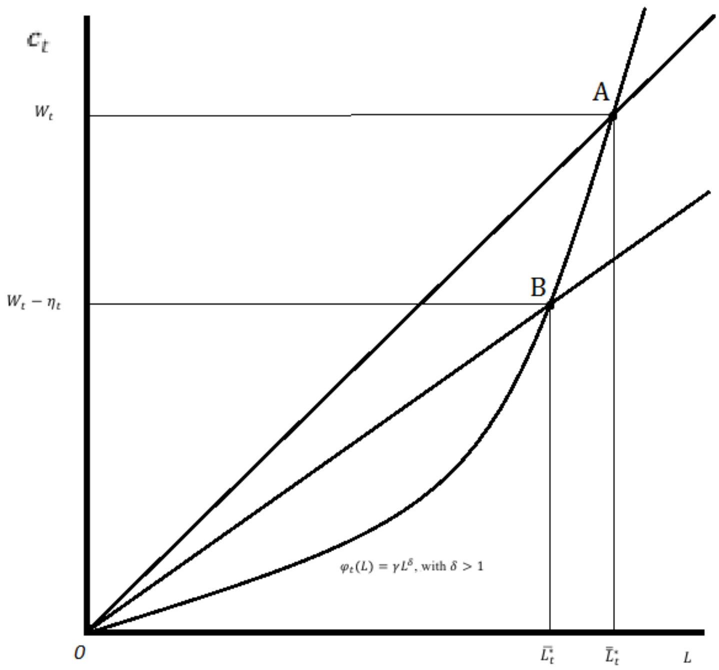
Institutional design	$\boldsymbol{\tau_L}$	**Features**
Beveridgean PAYG	η_t	$\beta = 1$ $n_{t+1} > 0$
Bismarckian PAYG	$\eta_t * (r_{t+1} - g_{t+1})$	$\alpha = 1$ $g_{t+1} \geq 0$
Funded	0	$\alpha = 1$ $g_{t+1} = 0$
Hybrid	$\alpha\eta_t * (r_{t+1} - g_{t+1}) + \beta\eta_t$	$\alpha + \beta = 1$ $[\alpha, \beta] \geq 0$ $n_{t+1} > 0$ $g_{t+1} \geq 0$

The pension system of the Netherlands, although featured as Beveridgean, is not fully PAYG and at the same time not fully funded as well. In this case the implicit tax on labour changes in the relative sizes of the PAYG and funded parts of the pension system. From this mathematical notation we can see that implicit labour taxes increase in the relative size of the PAYG part. This might suggest that aggregate utility of the society, through a sum of individual utility functions, would change with pension reforms from Beveridgean pension systems toward more funded pension systems.

4.3. Efficiency of the Dutch pension system

Section 4.2 showed how implicit labour taxes vary with institutional pension designs and how it distorts the intensive labour supply decision of the individual. In the case of Beveridgean PAYG pension systems the entire contribution rate is seen as a payroll tax on labour, causing a large distortion of the labour supply decision, while systems with a stronger tax-benefit link decrease the distortion. The hypothesis stating that the hybrid Dutch pension system is more efficient than ordinary Beveridgean PAYG pension systems seems to be affirmed. In the figure below the effect of implicit labour taxes on utility has been graphed, so that it becomes clearer how the institutional design affects total utility.

Figure 3: Consumption in period *t*

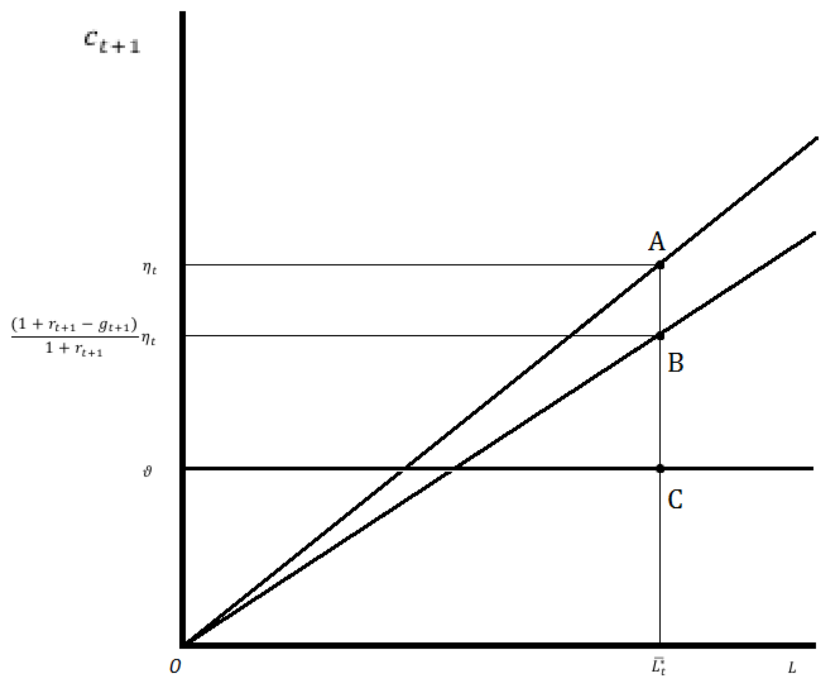


Two equilibriums A and B with varying labour supply decisions as a result of the pension payroll tax

In this figure you can see how the individual's consumption at the first time period is dependent on the amount of labour supply. At point A, where the marginal utility of wages crosses the marginal disutility of working, is the equilibrium in this model, since the individual will be maximizing his utility in this point. When the individual has to contribute a part of his wage as a pension contribution this will in first instance be observed as a payroll tax (see Borjas, 2013), causing the individual to work less because his benefits from working have dropped. The new equilibrium will be in point B.

Luckily the individual does not view the entire pension contribution as a payroll tax, if a tax-benefit link between contributions and the pension benefits exists in the pension system. As can been seen in Figure 4 the individual will receive his pension benefits in the second time period. In the case of a Beveridgean PAYG system this will mean a lump sum benefit of ϑ, that may of may not be actuarially fair, depending on factors such as the growth of the population (n_{t+1}), the market interest rate (r_{t+1}) and the part of the contributions that the government keeps (g_{t+1}). Since a tax-benefit link is not present in this situation, the supply of more or less labour by the individual in the first time period does not have an effect on the size of the pension benefits of this Beveridgean PAYG system. Figure 4 shows clearly that this results in a straight horizontal line. Individuals are not incentivized to provide more labour, because they will not enjoy more pension benefits when they are retired in the second time period.

Figure 4: Consumption in period *t + 1*



Equilibriums A (actuarial fair tax-benefit link), B (actuarial unfair tax-benefit link) and C (no tax-benefit link)

When on the contrary a tax-benefit link is present (which is the case with Bismarckian PAYG systems and funded pension systems), the labour supply decision does have an effect on the pension benefits. Working in the first time period has lead to a form of mandatory saving that results in pension benefits in the second time period that are proportionally high to the individual's labour supply decision. Figure 4 shows what happens when a tax-benefit link is introduced in a pension system. Point A and B are the result of introducing a tax-benefit link in this system, because the individual will now have an incentive to work harder. The pension contribution η_t is therefore only a payroll tax as far as it is not actuarially fair compared to the pension benefits, depending on several factors that can be seen at the vertical axis of Figure 4. An actuarially unfair pension system with a tax-benefit link will lead to an implicit tax on labour, resulting in point B, which is lower than the actuarially fair pension system of point A. Since we know from Section 4.2 that a fully funded pension system is actuarially fair, as individuals receive full interest over their contributions, there are no distortions in this system and the labour supply decision is not distorted. The fully funded pension system is therefore completely neutral when it comes to labour market distortions.

When one looks at the efficiency of the system focusing on the individual's labour supply decision it will vary with the tax-benefit link between pension contributions and pension benefits. The Netherlands has a hybrid pension system with both Beveridgean and funded characteristics. A system with a strong funded pension system in comparison with the Beveridgean features of the pension system should therefore be more efficient. By deriving the change in intensive labour supply decision in the relative size of the funded part of the pension system in comparison to the Beveridgean part of the pension system we can see that the total efficiency gain of change in α is the following (Appendix c):

$$\frac{\partial U}{\partial\left(\frac{\alpha}{(\alpha+\beta)}\right)} = \frac{\partial U}{\partial L} * \frac{\partial L}{\partial \alpha} = \left(\frac{\left(\frac{\eta_t(1+r_{t+1}-g_{t+1})}{1+\rho}\right)}{\delta\gamma}\right)^{\delta-1} \tag{14}$$

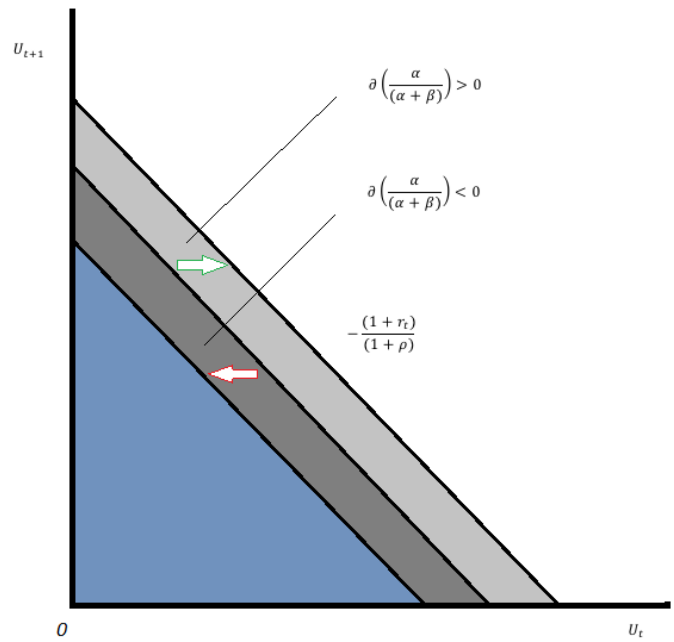
Since $\varphi'(L) > 0$ and $\varphi''(L) > 0$ the amount of efficiency gain is depending heavily on the variable δ, because this variable affects the disutility of working in an exponential rising way.

When all these steps have been summed up it is clear how systems with a stronger tax-benefit and more actuarial fairness link differ from systems that have less of these features. Because of the design of the utility function utility is derived from a simple trade-off of consumption in periods 1 and 2. The trade-off between those periods is depicted by a negative slope, derived by dividing the market interest rate by the time preference of the individual. This equation is also known as the Euler's equation (Heijdra & Van der Ploeg, 2002):

$$\frac{\partial U_t}{\partial U_{t+1}} = -\frac{(1+r_t)}{(1+\rho)} \tag{15}$$

In Figure 5 can be seen how the slope of Euler's equation influences the trade-off in consumption between the first and the second time period. This figure shows how total utility is increased or decreased by an implementation of a (stronger) tax-benefit link.

Figure 5: Change in utility as a result of reforming a hybrid pension system



Reform in the size of the funded part of the pension system will proportionally affect the total utility of the individual. When countries with a Beveridgean pension system are compared with other countries with different pension systems, a figure like Figure 5 could show how countries can benefit from reforming towards a hybrid Dutch pension system, because of the stronger tax-benefit link that will now be present in their pension system. It also shows how more utility will be derived when the pension system will become more actuarially fair.

As a final remark on the model of this chapter it should be noted that consumption in time periods 1 and 2 have been regarded as perfect substitutes, in which the time preference of consumption is the main factor influencing the consumption decisions of the individual. This is a strong assumption of reality, since a so-called 'Cobb-Douglas' function might provide a more thorough analysis of the effect of implicit labour taxes on the total utility of the individual. This might be interesting for further research on this subject.

5. Calibrating the model

The model will be calibrated in Chapter 5 through a series of sensitivity analysis. By determining the values of the model parameters the results of the calibration will illustrate how the labour supply decision is affected by labour market distortions as a result of different pension system designs. By comparing different pension systems an answer will be found to the hypothesis, whether the Dutch hybrid pension system is favourable compared to PAYG pension systems on the subject of implicit labour taxes.

5.1. Parameters of the model

The model that will be calibrated is a partial equilibrium model. There are both benefits and downsides to this approach. First of all it should be noted that the topic of pension systems is very complicated, because there are so many factors involved that may have an effect on the pension system or on the economy itself. Calibrating a partial equilibrium model is useful since it will exactly show the answer to what the hypothesis has stated, whether the Dutch hybrid pension system is favourable compared to PAYG pension systems with respect to the aspect of implicit labour taxes. Besides that it should be taken into account that the calibration of a general equilibrium model is complicated, because several additional assumptions have to be made and factors have to be added in order to calibrate such a model. The calibration of a partial equilibrium should prove to be sufficient in order to see the effects on labour supply caused by pension system designs.

Table 3 shows the chosen parameter values for the sensitivity analysis of the model. The factor prices, wage and market interest, have been set at respectively unity ($w = 1$) and the time preference rate ($r = \rho$). This will make the calibration more straightforward, since the parameter values have been simplified. The time preference rate has been set at 20%, so that the market interest rate is also 20% in this model. This seems large, but because this is only a model that observes two periods a large parameter is needed in order to illustrate the results better.
Section 4.1 made clear that the disutility of labour is one of the central variables of the model. Several conditions in this formula had been assumed, such as the exponential factor being higher than 1 ($\delta > 1$) and the total-factor rate being positive ($\gamma > 0$). Needless to say the parameters in this model will take fulfil these conditions into account. Table 3 shows the values for these parameters.

Table 3: Parameter values

w_t	Wage rate	1.00
r_{t+1}	Market interest rate	0.20
η_t	Pension system contribution rate	0.20
ρ	Time preference rate	0.20
γ	Total-factor labour disutility	0.50
δ	Exponential labour supply disutility factor	2.50
ϑ_{t+1}	Beveridgean PAYG pension benefits	0.14
g_{t+1}	Government pension contribution withholdings in Bismarckian PAYG pension systems	0.10
α	Size of tax-benefit link part of the pension system	0.398
β	Size of the Beveridgean PAYG part of the pension system	0.602

The parameters α and β determine the sizes of the tax-benefit part and the Beveridgean part of the pension system. As could be seen in Chapter 2 in Table 1 from the paper by Boeri et al. (2006) the sizes of the first, second and third pillar vary across several OECD countries. In order to let the model represent reality as much as possible these values, after a small modification (see Appendix *e*), will be used for α and β as a representation of the individual's pension benefits. Because the pension system of the Netherlands will be used as a reference point in comparison to other pension systems, the values of these parameters will therefore be 0.398 and 0.602 in the sensitivity analysis.

As can be seen in Section 2.1 the Dutch Beveridgean first pillar provides a sum of 70% of the net minimum wage. If we assume that the average individual starts working at age 18, lives 81 years and retires at the age of 67, the individual should provide enough benefits in his 49 working years in order to receive 14 years of 70% net minimum wage pension benefits. The mandatory pension contribution rate η_t should under these circumstances be set at 20% of the earned wages (see Appendix *d*). Because this is a simple two-period inter-temporal model, the received Beveridgean pension benefits ϑ_{t+1} should come down to 70% of the accumulated 20% contributions, resulting in a parameter value of 0.14.

All these parameters result in a model in which utility depends on the amount of labour supplied by the individual. As can be seen in the next section individuals can decide to supply labour at values ranging from 0 to 1.4. A nice analogy to use in this sense is to think of the labour supply in terms such as full-time equivalents (FTE).

5.2. Results

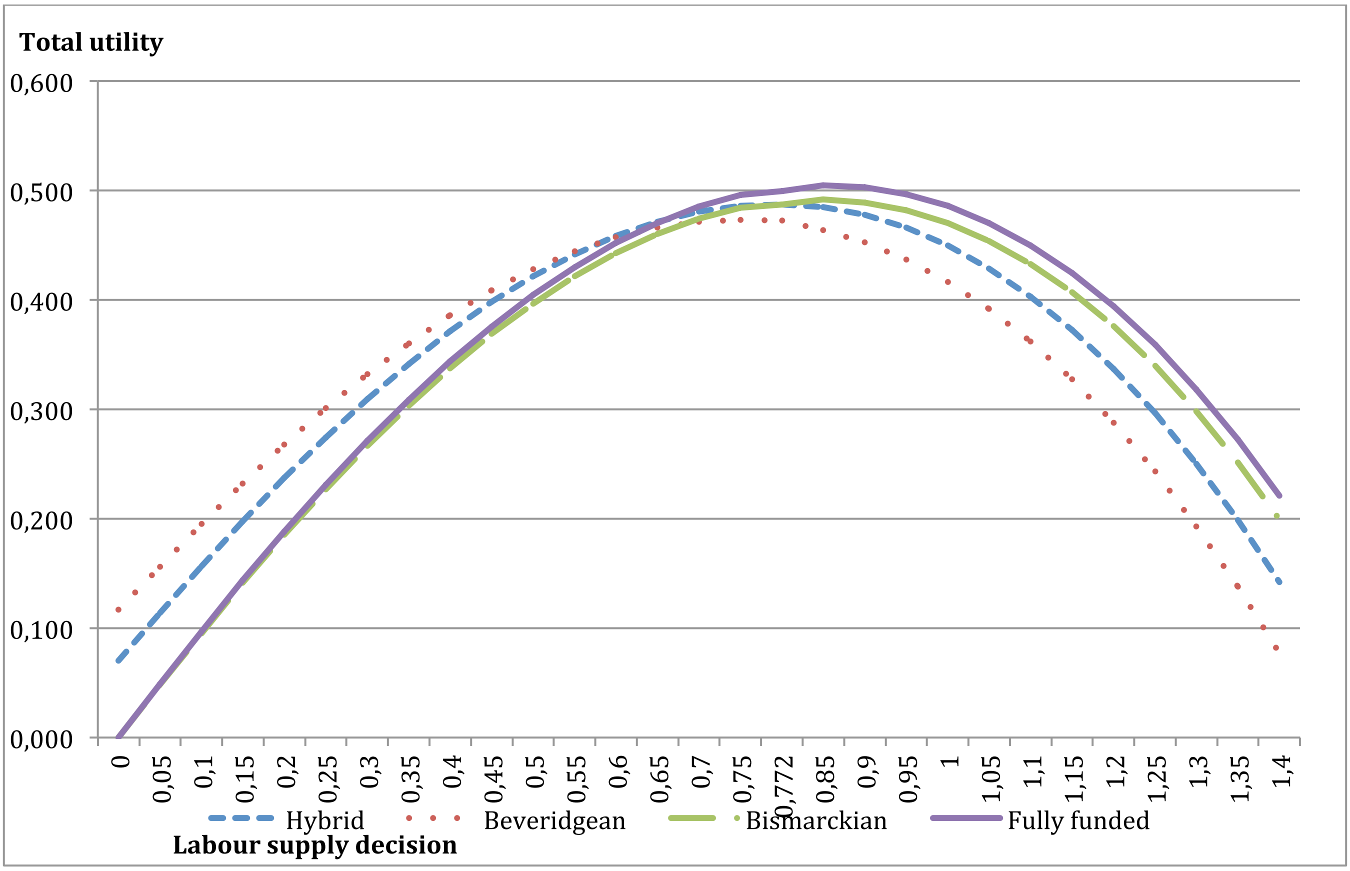
By inserting all the parameters in the model and plotting the results in a graph it becomes clear how the tax-benefit link is affecting the labour supply decision of individuals.

A quick look at Figure 5 shows how utility is derived from working more, until the disutility of working has risen too much so that an optimal point is reached. The fact that working more results in more utility is intuitive, since more work will lead to more wage earnings resulting in higher consumption in time periods 1 and 2. Table 4 shows the qualitative responses of several parameters on utility. A major factor of influence is the presence of a tax-benefit link, which makes pension systems more sensitive to changes in the size of the parameters.

Table 4: Qualitative response in utility

	w_t	r_{t+1}	g_{t+1}	α	β	ρ
Pension systems with a tax-benefit link	+	+	-	+	-	-
Beveridgean	+	.	.	+	.	-

Figure 5: Utility in relation to the labour supply decision



A relevant feature from Figure 5 and Table 4 is that it illustrates how a strong tax-benefit link between pension contributions and pension benefits can be useful. Table 5 shows that individuals in a fully funded pension scheme can obtain utility as high as 0.505, by providing an amount of labour supply of 0.85. It thereby exceeds the utility values of all the other pension systems. This seems intuitive, because the labour-neutral parameters of the fully funded pension scheme result in a minimally distorted labour supply decision of the individual. When this situation is compared to the individual in a Bismarckian PAYG pension system this becomes more clear. In the

Bismarckian PAYG pension system individuals derive a utility value of 0.492 by supplying 0.85 labour effort, the same amount as individuals in a fully funded pension system supply. The reason for this difference has been thoroughly discussed throughout this paper: actuarial fairness. In this model the Bismarckian PAYG pension system and the fully funded pension system are almost identical, but for a single parameter: g_{t+1}. As has been discussed in Section 4.2, mandatory savings within a Bismarckian PAYG system might not accrue the market interest rate of return, because the government might withhold some of these returns for other use. As a result of this implicit labour tax caused by actuarial unfairness the individual receives 0.013 less utility, a percentage change in utility of -2.6%.

Besides the pension systems with strong tax-benefit links there are other pension systems left to consider. A Beveridgean PAYG pension system results in a total labour supply of 0.75, considerably lower than the labour supply decisions in Bismarckian PAYG and fully funded pension systems. The utility count of 0.473 means a drop in efficiency of 6.3% compared to fully funded pension systems and a drop of 3.9% compared to Bismarckian PAYG pension systems. From a labour efficiency point of view it seems to be in the interest of individuals, employers and the government alike to implement a fully funded pension scheme, since it seems to result in both more labour market efficiency as well as more utility for individuals. These first results seem to affirm the hypothesis of this thesis.

Table 5: Optimal points (see Appendix *f*)

	Beveridgean	*Dutch hybrid*	*Bismarckian*	*Fully funded*
Optimal points				
U	0.473	0.488	0.492	0.505
L	0.75	0.80	0.85	0.85
Parameters				
α	0.000	0.398	1.000	1.000
β	1.000	0.602	0.000	0.000
g_{t+1}	0.000	0.000	0.100	0.000

However, the most important pension system of this paper has not been reviewed yet: the Dutch hybrid Beveridgean-funded pension system. Dutch individuals reach their optimal point of utility (0.488) with supplying a work effort of 0.80. This means that the Dutch pension system is better than a pure Beveridgean PAYG pension system, but worse compared to pension systems with a strong tax-benefit link. These results suggest that the Dutch hybrid pension system is indeed superior towards pure Beveridgean PAYG pension systems, but could achieve even better results if an even stronger tax-benefit link would be implemented. In any case, the hypothesis that the Dutch hybrid pension system performs better than pure Beveridgean PAYG pension systems has been confirmed, since both utility and labour supply are higher in the Dutch system than the utility and labour supply of Beveridgean pension systems.

The conclusions from these results are straightforward: a stronger tax-benefit link results in both more labour market efficiency and more utility. However, the question remains under which conditions Beveridgean and Dutch pension systems might be favourable compared to Bismarckian and fully funded pension systems. It is therefore worth it to look at the interception points of the labour supply decisions and the derived utility of the various pension systems.

Table 6: Comparative equilibria $\bar{L}$ and $\bar{U}$

	Beveridgean	*Dutch hybrid*	*Bismarckian*	*Fully funded*
$\bar{L}$	0.575	-	0.772	0.653
$\bar{U}$	0.451	-	0.487	0.472

Table 6 shows the equilibria between the Dutch hybrid pension system and the other pension systems by giving the values for which the lines of Figure 5 intercept each other. Until 0.575 labour effort has been supplied individuals derive most utility from the Beveridgean pension system. After this point the Dutch hybrid pension system and the fully funded pension systems are the best pension systems for individuals. The reason behind this is the absent tax-benefit link in the Beveridgean pension system, because the mandatory contribution rate of 20% is seen as a complete tax on labour. In pension systems with a stronger tax-benefit link the marginal utility per labour effort point is higher than in the Beveridgean pension system, resulting in an interception at the coordinates (0.575, 0.451). This results in another interesting equilibrium: the interception between the Dutch hybrid pension system and the Bismarckian PAYG pension system. At the coordinates (0.772, 0.487) the utility and labour supply from individuals are the same for these systems. Because of the stronger tax-benefit link in Bismarckian PAYG pension systems the marginal utility per labour effort unit is exceeding the same marginal utility from Dutch hybrid pension systems in this equilibrium, resulting in the situation in which Bismarckian PAYG pension systems are more efficient than the Dutch hybrid pension system for all values $\bar{L} > 0.772$. In turn the non-distorted the fully funded pension system is superior to Bismarckian PAYG pension systems for all values $\bar{L} > 0$ and to the Dutch hybrid pension system for all values $\bar{L} > 0.653$. It might be suspected that Bismarckian and fully funded pension systems have the same equilibrium in the interception point with Dutch hybrid pension systems, but this is not the case, since that the mandatory savings of the fully funded pension systems are not distorted by the governmental withholdings. The difference in this equilibrium is thus caused by actuarial unfairness.

6. Conclusions, policy recommendations and improvements

The results of the calibration confirm the hypothesis that the Dutch hybrid pension system is favourable compared to pure Beveridgean PAYG pension systems. As we have seen throughout this thesis the main cause of this superiority is the present tax-benefit link in the pension system. The results even suggest that implementation of stronger tax-benefit links will result in even higher labour market efficiency and more utility for individuals. Since the implicit labour tax is a product of actuarial unfairness, the government can also achieve more efficiency by making pension systems more actuarially fair.

If one were to formulate policy advise from the findings of this thesis for policy makers in foreign countries with Beveridgean PAYG pension systems, it would be to advise these foreign countries to implement a stronger tax-benefit link in the pension system. Seeing as most efficiency and utility is obtained in a fully funded pension system, one might even advise a full-scale reform to this labour market-neutral pension system. However, as we have seen in the paper by Miles & Timmermann (1999) the transition costs might be too high or too difficult to pay, making a full-scale reform impossible. A less rigorous reform could be the implementation of a Bismarckian PAYG pension system or the Dutch hybrid pension system. In both systems both utility and efficiency are higher than in Beveridgean PAYG pension systems. However, seeing as the ageing of the population is a major problem for PAYG pension systems one could wonder whether this reform would result in a real improvement. A hybrid pension system, with both PAYG and funded elements, might therefore be the most feasible reform for countries with Beveridgean PAYG pension systems.

The conclusions of this thesis are not very robust. The model that was calibrated in this thesis was a partial equilibrium model, which had the sole purpose to look at how labour supply decision are affected by the institutional designs of various pension systems, all other factors considered right (ceteris paribus). The model included a lot of relevant factors, but even more factors have not been included in the model. The topic of pensions is relatively complex, since there are so many aspects involved that can influence the economy and the pension systems alike. Conclusions from a paper with a small research horizon, such as this thesis, should therefore be taken with a grain of salt. This is especially the case when one considers that the results are based on relatively strong assumptions. Besides that the model is not that sophisticated and the parameters could be better defined. A way to solve this in further research might be to investigate the same topic within a general equilibrium model in order to better grasp the complexity of the entire economy.

In any case one should therefore carefully consider the conclusions of this thesis. An example of how bad policy could be made is by observing one of the main conclusions of this thesis that fully funded pension systems are the superior pension systems when it comes to labour market efficiency. It should be considered that in reality there are practically no *fully* funded pension systems present in the world, because policy makers have not yet found a way to deal with the large risks that are accompanying fully funded pension systems. Besides that there are many uncertainties and imperfections in the economy that simple models such as in this thesis cannot comprehend. Because of these factors policy makers decide to implement safer, fairer and more socially preferable options, such as the straightforward Beveridgean PAYG pension system.

At the same time this thesis does make clear that there a lot of efficiency can be gained by reforming towards a Dutch hybrid pension system. Even when one considers that this thesis is built on strong assumptions and is imperfect in many ways, this thesis does in fact show that the Dutch hybrid pension system offers a lot of opportunities and efficiency gain for countries with a Beveridgean PAYG pension systems. Because of that conclusion policy makers should consider mimicking the Dutch by implementing a hybrid Beveridgean-funded pension system. This will make the pension systems more financially sustainable in the future and will result in more labour market efficiency, while at the same time the retired employees of this nation have sufficient social security to enjoy their old days.

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8. Appendix

a. Derivation implicit labour tax Fisher and Keuschnigg

$$V = (1-\tau)L - \varphi(L) + \frac{1}{R}[x(1-\tau) + (1-x)p - \gamma\phi(x)] \tag{16}$$

$$\varphi'(L) \equiv (1-\tau_L) \tag{17}$$

$$\frac{dV}{dL} = 0 \tag{18}$$

$$(1-\tau)\cancel{L} - (1-\tau_L) + [\frac{1}{R} * [\cancel{x(1-\tau)} + (1-x)p - \cancel{\gamma\phi(x)}]] = 0 \tag{19}$$

$$(1-\tau) - (1-\tau_L) + [\frac{1}{R} * [(1-x)[(m(x)(\tau\cancel{L}R^p + \cancel{\tau x}) + \cancel{b}]] = 0 \tag{20}$$

$$-\tau_L = -\tau + [\frac{(1-x)(m(x)\tau R^p)}{R}] \tag{21}$$

$$\tau_L = \tau * [1 - [(1-x)m(x)\frac{R^p}{R}] \tag{22}$$

b. Derivation of the optimal labour supply decision

$$\frac{\partial U}{\partial L} = W_t - \eta_t - \delta\gamma L_t^{\delta-1} + \left[\frac{\theta_{t+1}}{1+\rho}\right]' = 0 \tag{23}$$

$$\theta_{t+1} = \alpha\eta_t(1 + r_{t+1} - g_{t+1})L + \beta\vartheta_{t+1} \tag{24}$$

$$\theta_{t+1}'(L) = \alpha\eta_t(1 + r_{+1} - g_{t+1}) \tag{25}$$

$$\frac{\partial U}{\partial L} = W_t - \eta_t - \delta\gamma L_t^{\delta-1} + \left(\frac{\alpha\eta_t(1+r_{t+1}-g_{t+1})}{1+\rho}\right) = 0 \tag{26}$$

$$\delta\gamma L_t^{\delta-1} = W_t - \eta_t + \left(\frac{\alpha\eta_t(1+r_{t+1}-g_{t+1})}{1+\rho}\right) \tag{27}$$

$$L^* = \left(\frac{W_t - \eta_t + \left(\frac{\alpha\eta_t(1+r_{t+1}-g_{t+1})}{1+\rho}\right)}{\delta\gamma}\right)^{\delta-1} \tag{28}$$

c. Derivation of the efficiency gain for changes in α

$$\frac{\partial U}{\partial\left(\frac{\alpha}{(\alpha+\beta)}\right)} = \frac{\partial U}{\partial L} * \frac{\partial L}{\partial\left(\frac{\alpha}{(\alpha+\beta)}\right)} \tag{29}$$

$$\alpha + \beta = 1 \tag{30}$$

$$\frac{\partial U}{\partial\left(\frac{\alpha}{(\alpha+\beta)}\right)} = \frac{\partial U}{\partial L} * \frac{\partial L}{\partial\alpha} \tag{31}$$

$$= \left(\frac{\cancel{W_t - \eta_t} + \left(\frac{\cancel{\alpha}\eta_t(1+r_{t+1}-g_{t+1})}{1+\rho} \right)}{\delta\gamma} \right)^{\delta-1} \quad (32)$$

$$= \left(\frac{\left(\frac{\eta_t(1+r_{t+1}-g_{t+1})}{1+\rho} \right)}{\delta\gamma} \right)^{\delta-1} \quad (33)$$

d. Necessary pension contributions in a PAYG pension system

$$\sum_{t=18}^{67} \eta = \sum_{t=67}^{81} 0{,}7 \quad (34)$$

$$\eta = 0{,}2 \quad (35)$$

e. Relative sizes of the Dutch first and second pension pillar

Second pension pillar: $\frac{0.37}{0.37+0.56} = 0.398$ (36)

First pension pillar: $\frac{0.56}{0.37+0.56} = 0.602$ (37)

f. Total utility for various labour supply values

Labour supply	*Dutch hybrid*	*Beveridgean*	*Bismarckian*	*Fully funded*
0	0,070	0,117	0,000	0,000
0,05	0,114	0,156	0,048	0,049
0,1	0,157	0,195	0,095	0,097
0,15	0,198	0,232	0,141	0,144
0,2	0,237	0,268	0,185	0,188
0,25	0,275	0,301	0,227	0,231
0,3	0,309	0,332	0,267	0,271
0,35	0,342	0,360	0,303	0,309
0,4	0,371	0,386	0,338	0,344
0,45	0,398	0,409	0,369	0,376
0,5	0,422	0,428	0,397	0,405
0,55	0,442	0,444	0,422	0,430
0,6	0,459	0,457	0,443	0,452
0,65	0,472	0,466	0,461	0,471
0,7	0,481	0,472	0,474	0,485
0,75	0,486	**0,473**	0,484	0,496
0,772	**0,487**	0,472	0,487	0,499

f. Total utility for various labour supply values

Labour supply	*Dutch hybrid*	*Beveridgean*	*Bismarckian*	*Fully funded*
0,85	0,485	0,464	**0,492**	**0,505**
0,9	0,478	0,452	0,489	0,503
0,95	0,466	0,437	0,482	0,497
1	0,450	0,417	0,471	0,486
1,05	0,429	0,392	0,454	0,470
1,1	0,403	0,362	0,433	0,450
1,15	0,373	0,328	0,407	0,425
1,2	0,337	0,288	0,376	0,394
1,25	0,296	0,243	0,340	0,359
1,3	0,250	0,193	0,298	0,318
1,35	0,199	0,138	0,251	0,272
1,4	0,142	0,077	0,199	0,221