LISBON
SCHOOL OF
ECONOMICS &
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UNIVERSIDADE DE LISBOA

# MASTER OF SCIENCE IN
# FINANCE

## MASTER´S FINAL WORK
DISSERTATION

# COMPONENTS OF UK DEFINED BENEFIT OCCUPATIONAL PENSION SCHEMES WITH A GENDER ANALYSIS

ANA JEANETE SILVA FARINHA

OCTOBER-2018

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**SUPERVISION:**

PROFESSOR MARIA TERESA MEDEIROS GARCIA

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## Abstract

When we initiate our work life, the intention to do it is to guarantee our self-sustainability. As life goes by, we end our work life and start a retirement period. It is important to guarantee a self-sustainable income in this period of life and opt to subscribe a Defined Benefit (DB) Occupational Pension Scheme (OPS), is a viable way to do it.

The aim of this work is to understand which can be components that impact (DB) (OPS) in number and in value by association. This means by increasing the final amount of a particular pension plan this can increase the total number of (DB) (OPS) in the population that we decided to study.

As United Kingdom (UK) pension system has been conducted a serial Reform Acts that is gender discriminatory, we also perform the considerations that we intend as necessary on Gender Analysis.

**JEL Classification:** C22; J16; J21; J26

**Key Words:** Defined Benefit, Occupational Pension Schemes, United Kingdom Pension System, Gender Analysis

## Resumo

Quando iniciamos uma carreira profissional, a intenção é garantir autossustentabilidade. À medida que a vida vai passando terminamos esse ciclo de carreira profissional e iniciamos um período de reforma. É importante garantir um rendimento auto sustentável nesta fase de vida e optar por subscrever um regime de pensões de Benefício Definido é uma forma viável de o fazer.

O objetivo deste trabalho é entender quais poderão ser principais componentes que impactam o comportamento dos Planos Ocupacionais de Benefício Definido em número e valor. Isso significa que aumentando o valor final de um plano de pensão em particular, poderemos aumentar o número total de Planos Ocupacionais de Benefício Definido para a população que decidimos estudar.

Como o sistema de Pensões do Reino Unido foi caracterizado por uma série de reformas discriminatórias em género, decidimos incluir uma secção com os comentários que consideramos importantes em relação a Análise de Género.

**JEL Classification**: C22; J16; J21; J26

**Key Words:** Benefício Definido, Planos de Pensão Ocupacionais, Sistema de Pensões do Reino Unido, Análise de Género.

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## List of Acronyms

ARIMA – Autoregressive Integrated Moving Average

BSP – Basic State Pension

CETV – Cash Equivalent Transfer Value

CO – Cochrane-Orcutt

CPI – Consumer Price Index

DB – Defined Benefit

DC – Defined Contribution

DOB – Date of Birth

DOC – Date of Calculation

DOL – Date of Leaving

DSS – Department of Social Security

EU – European Union

GMP – Guaranteed Minimum Pension

LEL – Lower Earnings Limit

NICs – National Insurance Contributions

NRA – Normal Retirement Age

NRD- Normal Retirement Date

OECD – Organization for Economic Co-Operation and Development

OLS – Ordinary Least Squares

ONS – Office National Statistics

OPS – Occupational Pension Schemes

PW – Prais Winsten

RPI – Retail Price Index

S2P – State Second Pension

SERPS – State Earnings Related Pension Scheme

SPA – Statutory Pension Age

UEL – Upper Earnings Limit

UK – United Kingdom

XS – Excess Pension

## List of Formulas

(1) $TNRD = TDOL \times Past\ rev \times (1 + CPI)^{number\ of\ completed\ years\ from\ DOC\ to\ NRD}$

(2) $TDOC = TNRD \times Annuity \times (1 + i)^{-number\ of\ comp\ yrs\ and\ mths\ from\ NRD\ to\ DOC}$

(3) $Total\ Pension\ at\ DOL = Final\ Pensionable\ Salary \times Service \times Accrual$

(4) $Total\ DB\ OPS_t = \beta_0 + \beta_1 CPI_t + \beta_2 RPI_t + \beta_3 Gilt10_t + \beta_4 Sat_t + \beta_5 Labor_t + \beta_6 Mort_t + \varepsilon_t$

## I. Introduction

(DB) (OPS) are very particular pension instruments that need a lot of attention and work of Actuaries. In order to understand how can increase the number of (UK) (DB) (OPS),

we decided to conduct an experience by choosing some variables that we think that can influence the behaviour of the total number of (DB) (OPS) plans. So, testing some relationships we end up with some interesting conclusions that we will share on the respective section of this work.

We initially start approaching this theme with an historical background of the (UK) pension system, so we can have a sense of how long this pension reforms have been settle and implemented, so we can understand that (UK) is one of the Countries with a long History on pension plans and specific with (DB) (OPS). This can be founded on Section II. Literature Review.

After a long description of a broad of reforms, we start describing all the main components of (DB) (OPS) by state specific comments on each of the components and the respective impact of them for the total number of (DB) plans in (UK) context. This can be found on Section III. Methodology and Results.

During our research project, we discover that along the years there have been some gender discrimination treatment on the pensions, so we also state some comments about Gender Analysis that can be founded on the second part of III. Methodology and Results.

We decided to point some of the Conclusions and Limitations on this work, so we open a window for further researchers to continuously analyse some specificities that can be developed on (UK) (DB) (OPS).

## II. Literature Review

## 1) General Review

When we are analysing a particular issue it is extremely important to understand why this issue matters and what other Researchers have learn about that, so in order to have an ample view of the (UK) pension system, in this section, we will focus on how this system was being developed and essentially pointed out some of the most important Reform Acts that have been adopted by (UK) system.

The first (UK) pension schemes were for public servants. They were a reward for loyal service and were paid by the Government from its revenues. These schemes have developed into the range of public service pension schemes. Outside the public services, (OPS) based in the (UK), have historically been established under trust and that is now a legal requirement for the majority of schemes outside of the public sector. (Government, H.M., 2014)

The (UK) pension system is a mixture of insurance-based state provision in the form of a Basic State Pension (BSP) and State Second Pension (S2P), means-tested benefits in the form of 'pension credit' and other income-related benefits.

The current level of pension system complexity in the (UK) has arisen through a series of incremental reforms that have taken place since the middle of the last Century. (Price, D. 2007)

## 2) Concept of (DB) (OPS)

We first need to clarify what is (DB) (OPS)[1]. This type of pensions are pensions in which the benefit is determined as a function of the worker's past pensionable earnings. They

[1] In order analysed in more detail what are the specific rules for revaluations of deferred pensions in (DB) (OPS) this can be consult on: https://www.oldmutualwealth.co.uk/Adviser/literature-and-support/knowledge-direct/pensions/escalation-and-revaluation/defined-benefit-occupational-pensions/

are also the most generous and least costly provision from the point of view of employees. (Bridgen P. and Meyer T. 2005)

There are different ways to achieve the formula of what the beneficiary has the right to receive but the most used is based on the worker's final wage and length of service, or on wages over a longer period. A (DB) scheme fixes the benefit in advance, usually as a proportion of the member's earnings when they retire. It is not possible to know in advance how much the scheme is going to cost. The benefits are fixed and the contributions must be adjusted from time to time to make sure that the correct amount is being accumulated to provide for them. (Overy N., 2008)

A (DB) system may be fully or partially funded, or unfunded. Thus the risk of varying rates of return to pension assets falls on the Sponsor. (Barr, N. and Diamond, P. 2009)

### 3) Importance of (DB) (OPS)

The History of the (UK) pension system is characterized mainly by the non-contributory system. Recent reforms have tilted the system further in the direction of a universal flat-rate benefit. This confirms that the main objective of the (UK) state pension system is to reduce poverty at old age. (Bozio, A., Crawford, R. and Tetlow, G., 2010)

An aging population and a trend to earlier retirement imply a growing number of elderly people dependent on a shrinking labour force. The gender gap in (UK) pensioners' incomes, a legacy of past employment norms and pension policies, remains largely ignored by policymakers; their focus has been on the future pensions of working age individuals. (Ginn, J. and MacIntyre, K., 2013)

Comparisons with other European Union (EU) Countries, the (UK)'s high pensioner poverty rate and gender inequality in later life income are avoidable, mainly through

better childcare provision and/or more women-friendly and generous state pensions (Ginn, 2003). The outstanding feature of the (UK) pension system is that, under current policies, public expenditure on pension provision will remain modest, compared with other industrial Economies. (Budd, A. and Campbell N, 1998).

### 4) (UK) Position – World trend in Pension Systems

The (UK) was one of the first Countries in the world to develop formal private pension arrangements (beginning in the 18th Century) and was also one of the first to begin the process of reducing systematically unfunded state provision in favour of funded private provision (beginning in 1980).

This explains why the (UK) is one of the few Countries in Europe that is not facing a serious pension crisis. The reasons for this is that state pensions (both in terms of the replacement ratio and as a proportion of average earnings) are among the lowest in Europe, the (UK) has a long-standing funded private pension sector, its population is aging less rapidly than elsewhere in Europe and its Governments have taken measures to prevent a pension crisis developing. (Blake, D., 2016)

(DB) pension plans have been an important part of retirement income systems with widespread pension plans. In Canada, Ireland, (UK) and in United States, voluntary employer-provided pensions are widespread. In all four Countries, however, (DB) plans have declined while Defined Contribution (DC) plans have increased among private sector employees. The decline in (DB) plans has varied considerably across Countries.

(DB) plans have declined to a greater extent in (UK) and in United States than in Canada and Ireland. (DC) plans cannot be used to retain long-service workers because their account balances are fully portable once vested, so they provide workers no incentive to stay with their current employer. (OECD, Pensions Market in Focus, 2017)

### 5) Decreasing trend regarding (DB) (OPS)

Most Occupational pension plans operate on either a (DB) or a (DC) basis. In recent years there has been a significant shift in retirement income provision in the (UK) from the situation where employers typically offer (DB) plans, to a situation where (DC) plans are more common. (Byrne, A. 2007) Private (DB) pensions are in decline. (Clark, G.L and Mank A.H.B, 2006)

Reform Act of 2014 was one of the Acts that made a huge impact on this shifting move, making interesting to point that a qualitative analyse might be relevant for a more intense study on the differences between (DB) and (DC) schemes.

With this changing traditional (DB) pension plans are gradually losing their dominance in the (OPS) systems of many Countries. The transition from (DB) to (DC) plans in private sector pensions is shifting investment risk from the corporate sector to households. (Broadbent. J. Palumb M. and Woodman E., 2006)

In recent years, an increasing number of corporations have resorted to altering the structure of employee retirement plans from (DB) to (DC) in response to escalating pension costs. (DB) plan contributions are higher, on average, and less predictable than (DC) plan contributions. (Phan H.V. and Hedge S., 2013) and (Yermo. S. and Severinson C. 2010).

### 6) (UK) Pension Legislation Act – Main Important marks

Along the years many (UK) Legislation Acts have been released to accommodate what Actuaries and pension Sponsors thinks are most adequate rules for pension schemes, according to the evolution of the characteristics that these components of pensions incorporate.

### a) 1961 to 1975

Graduated retirement benefit was introduced by the National Insurance Act of 1959 and operated from 1961–62 until 1974–75. The amount of pension earned depends on the number of units of graduated contributions the insured person paid between April 1961 and April 1975 and the value of a unit at the time the insured individual comes to claim their pension.

### b) 1978 to 2002

In the 1970s, there was considerable growth at (OPS). This created a division between those who had access to an Occupational scheme and those who had to rely on the state pension. The State Earnings-Related Pension Scheme (SERPS) was introduced by the Social Security Pensions Act 1975 and came into force in April 1978. This was a (UK) Government pension arrangement, to which employees and employers contributed between 6 April 1978 and 5 April 2002. Benefits are based on earnings between the Lower Earning Limit (LEL) and the Upper Earnings Limit (UEL). It provides a second-tier [2]pension for its members, and it establishes the minimum for those who can be permitted to opt out of the state's second-tier system and to use Occupational or Personal pension schemes instead. (Budd, A. and Campbell N, 1998)

(S2P) was introduced by the Child Support, Pensions and Social Security Act 2000 and came into force in April 2002. After Act 2000 this previous pension arrangement was replaced by The (S2P), or Additional State Pension, so this was introduced in the (UK) by the Labour Government on 6 April 2002. This new Reform includes an Additional

[2] A flat-rate first-tier pension is provided by the state and is known as the (BSP). Second-tier or supplementary pensions are provided by the state, employers and private sector financial institutions, the so-called three pillars of support in old age.
The main choices are between a state system that offers a relatively low level of pension that is fully indexed to prices after retirement and an occupational system that offers a relatively high level of pension only to workers who spend most of their working lives with the same Company. (Blake, D. 2000)

Pension benefits in favour of people with long-term illness or disability. (Bozio, A., Crawford, R. and Tetlow, G., 2010)

These pensions are paid by the Department of Social Security (DSS) from state pension age, which is 65 for men and 60 for women. (Blake, D. 2000)

### c) 2005 to 2016

In the old days, the nature of pension coverage in the public and private sectors was quite similar. In both sectors, the overwhelming majority of those with pensions were covered by a (DB) plan. (Mundell A.H, Haverstick K and Soto M.,2007)

The Pensions Act 2007 put into law the Reforms to the state pension system set out in the White Paper, 'Security in retirement: towards a new pension system', published in May 2006. This included linking annual cost of living increases in (BSP) to earnings and changes to the state pension age that took effect from 2010. The Pensions Act 2011 put into law changes to state pension age. The Pensions Act 2014 brings changes to reform the state pension system and implement the single-tier pension.

### d) After 2016

After 06 April 2016, (UK) Pensions also suffers a new revised and the additional state pension and part of pension credit are being abolished, to be replaced with a single-tier state pension. The so-called: state pension top up. To be able to qualify for the full pension, a beneficiary will now need 35 years of National Insurance Contributions (NICc), instead of 30 previously.

These pension systems set for an earlier era needs to be reformulated in order to account for longer retirement periods implied by increasing life expectancy, earlier average

retirement age and the additional rise in dependency rates implied by declining fertility. (Barr, N. and Diamond, P. 2009)

## III. Methodology and Results

### 1. General Components on (DB) (OPS)

#### a) Objective problem

One of the major problems that people face after they leave the labour force is precisely how can they have an income to enjoy their lives. Subscribe a pension plan can be a solution. A pension plan is a program that defines the conditions to receive a pension. (Instituto de Seguros de Portugal, 2011)

As (DB) are the types of plans that Actuaries have a huge impact on their formulation it seems a natural path to choose as a study object. A (DB) (OPS) can constitute an alternative solution for retiree people to enjoy their time. So, what we found interesting to study was precisely the behaviour of what we pick as major components of (DB) (OPS). We also find interesting not only have a general view on this theme, but also point the main differences among genders. As (UK) pensions have a unique set of rules it becomes one of the most attractive Countries to be studied.

#### b) Which data Choose

In order to conduct a report on components of (DB) (OPS) in (UK), it is necessary to collect some related data. So we start searching for some variables that can potentially impact the behaviour of total (DB) (OPS) subscribes.

We found interesting to define as independent variables the following ones: Consumer Price Index (CPI), Retail Price Index (RPI), 10 year Gilt, Total Annual Average Salary,

Total Labour Force, Total Mortality Rate. We collect (UK) annual data from 2007 to 2016 and end up with 10 years to analyse.

For the purpose of having more data analyse, reach a reasonable sample to perform regression analysis and minimize the errors on estimation models, we have ended up working with the equivalent monthly data to the range already mentioned. This gives us a collection of 120 values for each variable already stated. So, in order to improve the efficiency of this work, we have made the necessary changes to work with monthly data in this study.

To get the values of our Time Series, we went to different sources that we show on Appendix I. The purpose of this exercise is to analyse if the chosen variables can impact the total number of (DB) (OPS). It is necessary to consider the impact of the chosen variables testing if each of them are positively/negatively related to the dependent variable and finally assess some considerations on Statistic significance.

### c) Econometric Notes

We collect monthly data on the variables and length of time already defined and by doing so, we are dealing with what we call Time Series. So, before we proceed with further explanations is very important to consider some notes about Time Series analysis according to the literature.

To perform an econometric analysis using Time Series is important to consider some components that can distort our analysis like trends or seasonality. This will not allow the Time Series to behave as stationary and by consequence, it forbid us to perform the accurate analysis as possible. So the first thing that literature advises us to do is look at the data before we establish some specifying model. (Granger, C.W.J, 1981).

We notice that one of the components that can distort Time Series analysis is seasonality. So by performing the moving average filter we have adjust for seasonality. So we correct this source of distort on our data. (Cogley, T. and Nason, J.M., 1995)

There is also other features that can cause distorts on data, trends. According to Kao, C., 1999, it is known that some Macroeconomic variables, could be described with drift, which is the sum of an integrated process and a linear trend. The majority of the Macroeconomic Time Series often have an upward drift or trend which makes them non-stationary. (Cogley, T and Nason, J. M., 1995).

The procedure to start our analysis is doing a visual inspection of the time plot, and by checking the autocorrelation function or run a unit root test. If the Time Series end up with a unit root this means that the Time Series is non stationary and need the appropriate transformation to be run.

The Augmented Dickey-Fuller test allows us to understand how should be the transformation process to be performed on a Time Series in order to be regressed. In this test is possible to include an intercept and include or exclude a trend. If we see a trend on the plot, we should include it on the test and if we don't see it on the plot we should exclude the trend from the test.

Box and Jenkins, 1970 defends that while an original serie may be non-stationary, it can often become stationary by differencing a sufficient number of times. There is also strong evidence that suggested that on the majority of the Economic variables the appropriate differenced is one. (Granger. C.W.J and Newbold P.,1974)

We also performed the first difference for all the variables that we have in this study and we were able to see that they become stationary and ready to be used for regression purposes.

### d) Dependent Variable

As previously stated, in order to study (DB) (OPS), we have the intention to study components that affect this. To do so, we will run regression models and so a dependent variable and some explanatory variables are needed. To be able to build a model we need to have a variable that we want to be explain by other variables behaviour. That's essentially the concept of a dependent variable on a regression model. It makes sense that as we want to analyse the (UK) (DB) (OPS) we chose it as dependent variable.

Appendix II show us the evolution of the total members on (UK) (DB) (OPS). It is possible to see that this variable seems to have a positive trend along the length of time of our sample. As we are dealing with Macroeconomic Time Series it is very important that we acknowledge the fact that (UK) Economic events impact the way our variable behaves without the impact of other exogenous variables of the model. Looking at the (UK) Economic Timeline there are a few events from 2007 to 2016 that we can highlight and present on Appendix III with a brief (UK) Economic Timeline and related reasons for the increase or decrease of the total number of (UK) (DB) (OPS) plans.

### e) Explanatory Variables

Every regression model have to choose some independent variables that will help to explain part of the behaviour of the dependent variable. So, we can define an explanatory as a variable that is related to the dependent variable and can impact the behaviour of that. This means that each change on the explanatory variable can have an impact on the dependent. A possible solution for us to understand if the chosen independent variable

can strongly or weakly support the behaviour of the dependent variable is testing each of them. Doing this, we will be on the position to say if they have Statistic significance to explain part of the behaviour of the total number of (UK) (DB) (OPS) subscribes.

What is needed is to understand how a (DB) pension plan can be calculated for a single individual and absorb the variables that are needed to compute it, use them as independent variables for the study that we want to perform. It was exactly what we do and so we end up choosing the following variables to study as independent variables for our model. (CPI), (RPI), **10 year Gilt, Total Average Annual Salary, Total Labour Force and Total Mortality Rate**[3]. For each single variable chosen we will test the relationship with the dependent variable and see if each of them have Statistic significance.

### *e.1) Consumer Price Index*

(CPI) is defined as the Consumer Price Index. It is the closest measure of periods of inflation or deflation, a weighted average of prices of a basket of consumer goods. Fluctuations in (CPI) are used to assess fluctuations in the cost of living. This represents an important measure on (DB) (OPS) because changes in (CPI) will affect the way we revaluate tranches of pensions.

When a beneficiary on a (DB) plan requests the correspondent amount of money that he/she has the right to receive at the present value, we say that we compute his/her Cash Equivalent Transfer Value (CETV). For those people with a (DB) pension, a (CETV) is the lump sum the pension scheme will offer in exchange for giving up any future claims to a pension from the scheme.

[3] For the bolded variables there was made the necessary transformations in order to analyse the correspondent monthly date regarding the same range of study. For further explanations please read the section conclusions and further research.

In the context of (UK) (DB) (OPS), (CPI) is one of the most chosen indexes to compute revaluation from Date of Leaving (DOL) of the beneficiary to Normal Retirement Date (NRD) on non - Guaranteed Minimum Pension (GMP) tranches.

To do so, we usually apply the following formula:

$$TNRD = TDOL \times Past\ rev \times (1 + CPI)^{number\ of\ completed\ years\ from\ DOC\ to\ NRD} (1)$$

Where T represent the respective Tranche, $(NRD)$ is the Normal Retirement Date and (DOL) is the Date of Leaving. From the previous equation, we can see that (CPI) is important to obtain an estimate of future revaluation, this means that it takes into account fluctuations on Inflation. The value of a pension tranche tomorrow will need to take into account that over time, events tends to be different, prices fluctuates, so at (NRD), this will be reflected by the behaviour of (CPI) until that date.

### *e.2) Retail Price Index*

(RPI), like (CPI), reflects changes in the cost of a fixed basket of goods over time. Both are calculated under similar data, however, usually, 12-months inflation gets a higher valued when this is measured by (RPI) by almost 1%.

The (UK) Government still uses (RPI) for some purposes however, the Office of National Statistics (ONS) and (UK) National Statisticians believes that comparing with other international inflation index (RPI) becomes obsolete. (UK) (DB) (OPS) plans still uses (RPI) on a broad of (CETV) purposes specially to access the impact of the increase on annuities over time.

As similar to (CPI), (RPI) represents fluctuations of the cost of living but in this case, we will apply this impact to annuity tranches that need to be considered for (CETV) purposes. As already mentioned we expect that over time, prices increases and this will lead us to

higher values on the annuities computed. This increase represents the expected growth on the annuity over the years the beneficiary is entitled to receive the pension.

### *e.3) (UK) 10 year Gilt*

Gilts are bonds that have low investment risk, issued by the British Government. Essentially this represents a nominal bond that promise to pay a fixed coupon rate. On exercises like (CETV) we use zero coupon Gilts derived from a zero coupon Gilt yield curve. As we are analysing the perspective of a beneficiary in the context of these (DB) pension plans it is worthwhile to know how Gilts can impact the final transfer value.

There are mainly two different uses of this measure on the computation of a (CETV). The first main use is to compute pre - retirement rates and the second is to compute post - retirement rates. A more detailed and visual approach of it is described in Appendix IV.

On the case of pre - retirement rates, this acts like an interest discount risk free rate. To be able to use it, we need to compute every tranche of the respective beneficiary transfer value at (NRD). After this step, to know the amount of money that a beneficiary has the right to receive at the Date of Calculation (DOC), we then apply a discount factor using pre- retirement rate as our discount rate. So on a mathematical point of view, we can use the following formula:

$$TDOC = TNRD \times Annuity \times (1+i)^{-number\ of\ comp\ yrs\ and\ mths\ from\ NRD\ to\ DOC} \quad (2)$$

Where T is the respective tranche, (DOC) stands for Date of Calculation, (NRD) is the Normal Retirement Date and $i$ is our pre-retirement rate.

In essence, what we are computing is a present value of cash flow, using an interest rate that tells us the market price today of future cash flow.

### *e.4) Total Annual Average Salary*

A salary represents a fixed regular payment made by an entity to the respective employee. Typically this is made on a monthly basis but can also be expressed on annual terms. [4]

As the objective of our analysis is to understand (UK) context we used the Total Annual Average Salaries to study as one explanatory variable to our model. With the necessary changes to know the correspondent monthly values.

For retirement context and in particular for (DB) (OPS), when a beneficiary of a (DB) plan requests is present value pension, we first have to access what that person has the right to receive at (DOL). On a simplistic way to compute the total pension at (DOL), we can use the following formula:

$$Total\ Pension\ at\ DOL = Final\ Pensionable\ Salary^{5} \times Service \times Accrual^{6} \quad (3)$$

Changes on the amount of salary will affect the total amount earned by a beneficiary.

### *e.5) Total Labour Force*

According to the Cambridge dictionary, labour force represents all the people that actually work for a particular Entity and all the people that are on the right age to work, this includes all the individuals that at the short run will become employees of an Entity.

From a Macroeconomic perspective, lower employability will directly affect structural unemployment. Remembering the life-cycle hypothesis, an individual will plan his/her

[4] Notice that for Portuguese Legislation all the Gross Annual Salaries should be divided by 14 according to the supplement retributions see Portuguese Work Code articles 263º and 264º. The main difference for British Legislation is that the Annual Gross Salary should be divided by 12, please consult the British Government website to check this information https://www.gov.uk/minimum-wage-different-types-work/paid-an-annual-salary So if a regular British employee want to check his/her correspondent monthly salary can check it using the following calculator: http://www.salaryconverter.co.uk/

[5] The Final Pensionable Salary refers to the amount on which the final benefits are calculated in a (DB) scheme and it can be calculated using a broad variety of methods. To see more detailed information regarding this please consult https://www.barnett-waddingham.co.uk/comment-insight/briefings/2013/12/10/pensionable-salary-vs-final-pensionable-salary-vs-/

[6] The accrual is a financial measure that can be seen as an adjustment the adding together of interest of different investments over a period of time or the excess of the present value of a pension fund's total of future benefits. Usually, in the retirement plans, we use accruals of 1/45; 1/60; 1/80; 1/100.

consumption and savings paths throw life, trying to balance them smoothly during all the time. The savings are assumed to be enough to spend until the person die. So in order to show the importance of the labour force as a variable to take into consideration and break this life cycle theory, we present two situations that incorporate real economic changes on Appendix V.

By the analyse of both graphs is possible to see that Labour Force is a huge measure to consider in our analyses because we cannot guarantee consumption or our savings if we do not have the source to provide it and this source comes in the form of salary for all the employees on the labour force.

### *e.6) Total Mortality Rate*

Once we are studying retirement a natural concern is to be aware of the (UK) life expectancy and by opposite the mortality rate.

This represents the number of deaths in a certain group of people in a certain period of time. For the context of this study every time that we refer to Mortality Rate, we do it as an aggregate measure of deaths in the (UK) for the period that we already mentioned. For the purpose of this work, study the distribution of the (UK) population and be aware of the respective Mortality Rate is important to know if it is worthwhile to support (DB) (OPS) plans in the Country and if there is enough target population to subscribe them.

## f) Testing Hypothesis

Once our first focus is to study the general components of (UK) (DB) (OPS) it is natural to test these components with what we introduced as dependent variable. On the previous section of this text, we describe what we percept as the main components of (UK) (DB) (OPS) and use them as independent variables to be tested on regression models that we intend to build.

For each of these components, we gave an explanation why these variables were chosen.

In this section our pretend is to forecast the possible relationship that each independent variable have, giving reasonable explanations why we thought that the outcome will be that.

We have 6 Hypothesis that we want to test:

$H_1$: (CPI) is positively related with the total number of (DB) (OPS)

$H_2$: (RPI) is positively related with the total number of (DB) (OPS)

$H_3$: (UK) 10 years Gilt is positively related with the total number of (DB) (OPS)

$H_4$: Total Annual Average Salary is positively related with the total number of (DB) (OPS)

$H_5$: Total Labor Force is positively related with the total number of (DB) (OPS)

$H_6$: Total Mortality Rate is negatively related with the total number of (DB) (OPS)

The first variable being tested is (CPI) .As previously stated (CPI) is important to obtain an estimate of future revaluations on the context of computing a (CETV). A subscriber that knows precisely that, will want to have higher income for his/her subscribed pension. The increase of (CPI) will lead to higher outcomes on pensions, so this will lead as to expect that testing this component with the dependent variable will get a positive relationship.

The Second variable is (RPI). For this variable we expect a positive relationship using the same arguments as the previous. As the (RPI) represents what is expected to increase on an annuity, as higher the value of this rate, the higher will be the final amount of the pension.

The third variable is the 10 years Gilt. As previously stated on the context of a (CETV) exercise this component works as an interest rate, to know the present value of an amount of money that we already know at the retirement date. As higher the rate, the higher will be the present value. So, we expect that the relationship will be positive.

The fourth variable is the Average Salary. Salaries represent a huge variable to study and is natural to think that as higher the salary the higher will be an outcome of a pension. So, we expect a positive relationship.

The fifth variable is the Labour Force. For this particular variable, we also expect a positive relationship because as higher the Labour Force, the higher will be the target population that could be interested in subscribing a (DB) (OPS) plan.

The sixth variable is the Total Mortality Rate. For this particular hypothesis, we expect to have a negative relation when testing with the dependent variable because as higher the (UK) Mortality Rate is, the higher the probability to lose target population that is interested in subscribe a (DB) (OPS) plan.

We would like to emphasize that we will come back to analyse each of these hypotheses after getting the results. Then we will see if there are enough Statistical significance in each hypothesis.

### g) Regression Models

Previously we discuss the importance of having the necessary correction on the data to start performing econometric regressions. Our intent on this section is to access the importance of regression models to analyse Time Series.

Before we explore the importance of regression models there is Feature that we are concern about, correlation matrix.

A correlation matrix is a table that set the correlation coefficient between a set of variables. If on a regression model a set of variables are correlated to each other this will lead to inconsistent parameter and serial correlation of the residuals. (Egger P., 2002)

Correlation matrix are powerful Statistical tools to be used in order to guarantee that on a specific multiple linear regression, the chosen explanatory variables are independent to each other and therefore can be used to setup a proper regression model. (Slinker B. K. and Glantz S.A.,1985)

On Appendix VI, we show a complete analysis of our explanatory variables by extracting a table with descriptive statistics. The variables have been adjusted to reflect the correct transformation. We also show the respective correlation matrix. In this experience, we were able to spot several pairs of variables highly correlated and highlighted them on the Appendix VII. So we easily could spot which pairs of variables cannot be tested together using the same regression model.

As a result we decided to use two different types of regression models, Ordinary Least Squares (OLS) and Prais Winster (PW) and Cochrane-Orcutt (CO) as we will further detailed. We have ran six different tests per type of regression, with three explanatory variables per regression. Showing the respective results on Appendix VIII.

### *g.1) Correlated Coefficient*

From the correlation matrix we get four pairs of variables that on modular analysis have a coefficient superior to 0.5. This is the type of relationship more closely to what is known as a perfect relationship (-1 /+1).

The respective pairs of variables that we identify as having potential problems of being tested together are (CPI) and (RPI), 10 years Gilt and Total Annual Salary, 10 years Gilt and Total Labour Force, Total Annual Salary and Total Labour Force.

(CPI) and (RPI) have a correlation coefficient of 0.6053, so, on regression models that we used (CPI) we decided to exclude (RPI) on the regression and vice versa.

10 years Gilt and Total Annual Salary shows a coefficient of -0.5563. This two variables are related to each other in the sense that as Gilts are bonds issued by the British Government they represent a powerful income to the ones who buy this products.

10 years Gilt and the Total Labour work force have a coefficient of -0.5802. This two measures similar to the previous pair are related to the sense of being a tool for income.

The Total Annual Average Salary and the Total Labour Force have a coefficient of 0.8959. These two measures are directly related to each other because one stand for the amount of money earned and the other stands for the proportion of the same group of people.

As the previous mention for each pair that we identify as having high correlation coefficients we mutually exclude them on the same regression analysis in order to have the most accurate as a possible sample of regressions to study.

### *g.2) Need for Regression Models*

On essence a Regression Model is the use of a set organized and preselected data that will help understand the behaviour of the defined dependent variable on particular model. Regression based analysis remain one of the most widely Statistical approaches throughout research work. (Hayes A. F., 2013) For our specific exercise of analysing the

total number of (DB) (OPS) in (UK) we have use a regression model for help us to predict what should be expected for the next years on the behaviour of this variable.

### *g.3) Decision of using two different models*

For the purpose of getting more analytical and varied work, we decided to incorporate more than one type of regression model. So, we decided to run two sets of regression models. One using (OLS) regressions and the other using (PW) and (CO) method.

#### g.3.1) Ordinary Least Square

(OLS) regression is a generalized linear modelling technique. Represents, one of the most common techniques used in multivariate analysis. Using this method we choose a set of explanatory variables to be tested. (Moutinho L. and Hutcheson G., 2011)

#### g.3.2) Prais-Winster (PW) and Cochrane-Orcutt (CO)

The (CO) transformation has been accepted by Economists as a standard procedure for the purpose of improving the efficiency of estimators of linear regression models. (Maeshiro A., 1976) After some while, Sigber Prais and Christopher Winsten developed the (PW) estimation to deal with serial correlation in linear models. That represents in essence a modification of the initial (CO) estimation Method.

The (PW) and (CO) methods are essentially equivalent except for the treatment of the first observation in the data set. The (CO) method simply omits the first observation, while the (PW) method transforms the observation and retains it. Asymptotically, there is no difference in the efficiency of estimators produced by the two methods. (Dielman T. E. 2009)

### h) Generic model to be used

As we already present the types of estimations that we are putting our study through it is time to present what is our generic model in this study. Considering $Y_t$ the dependent variable and $X_{ti}$ the different explanatory variables on the study, the generic representative regression model is the following:

$$Total\ DB\ OPS_t = \beta_0 + \beta_1 CPI_t + \beta_2 RPI_t + \beta_3 Gilt10_t + \beta_4 Sat_t + \beta_5 Labor_t + \beta_6 Mort_t + \varepsilon_t \text{ ; (4)}$$

Where the $Total\ DB\ OPS_t$ is the first difference of the total number of DB OPS. $CPI_t$, $RPI_t, Gilt10_t,\ Sat_t, Labor_t, Mort_t$ are the first difference of each respective variables.

As already said, Appendix VIII shows the results using (OLS) method and (PW) and (CO) method respectively.

### i) Analysis of the results

Through the entire study, our intent is to answer the question of what are the main determinants of (UK) (DB) (OPS). The results of our experience can be consulted on Appendix VIII of this work. The reason to use two different types of regression to build our tests is to have more accurate and diverse results that can help us to achieve more accurate conclusions.

On this appendix we present the results of the regressions that we have run with the appropriate changes to ensure that the regressions passed the autocorrelation test and that the residuals follow a white-noise process. All of them have passed Durbin- Watson test for (OLS) regressions and Portmanteau test at a 5% significance level. It is worthwhile to state that the reason why we do not perform the Durbin-Watson test to the (PW) regression is that it cannot be applied, once the regression itself ensures no

autocorrelation. Having no evidence of autocorrelation and having the residuals follow a white noise process, we are on the position to say that we have followed the main important conditions of the Guass-Markov theorem. For each of the hypothesis that we have tested we would like to share the conclusions.

### *i.1) H1- Is (CPI) positively related with the total number of (DB) (OPS)?*

Our intent with this hypothesis is to show that (CPI) is important and have a positive impact on the dependent variable. So we test this, using a total of six tests from two different regression models, using tests 1, 2, 3, 7, 8 and 9. After analysing the results, we cannot assume a positive relationship with the dependent but we can see that (CPI) is statistically significant to explain the behaviour of the dependent.

### *i.2) H2- Is (RPI) positively related with the total number of (DB) (OPS)?*

As on the previous hypothesis, the intent is also to show that (RPI) is important and have a positive impact on the dependent variable. So we test it, using tests 4,5,6,10,11 and 12.

After performing the tests that support hypothesis 2, we can see that even we don't manage to have a positive relationship, this variable is still statistically significant to study the dependent.

### *i.3) H3- Is the 10 years Gilt positively related with the total number of (DB) (OPS)?*

With this third hypothesis the intent continuous to be the search for a positive relationship. So for 10 years Gilt we were able to perform tests 1, 4, 7 and 12. Running all the four tests we get surprised. All of them reveals a negative sign, so we cannot use any of the tests to show evidence of a positive relationship. At least using these two types of regression models with the timeline that we chose to study. In what concerns the significance level all of them reveals to be statistically significant.

### *i.4) H4- Is the Total Annual Average Salary positively related with the total number of (DB) (OPS)?*

The intent with this hypothesis is show evidence of a positive and significant relationship with the dependent variable on the study. To test it we perform tests 2, 5, 8 and 11. It was not possible to perform more than that, once the variable Total annual average salary is relatively related to other variables.

The results reveal that, as we expect the total Annual Average Salary have a positive relationship on the four tests and also have statistical significance. So we have strong evidence to confirm this hypothesis.

### *i.5) H5- Is the Total Labour Force positively related with the total number of (DB) (OPS)?*

As all of the previous hypothesis we also want to show evidence of positively and significant relationship with the total number of (UK) (DB) (OPS) plans. In order to test this hypothesis, we have run tests 3, 6, 9 and 12. It is possible to see that we get a positive relationship with the dependent on all the tests. On the statistical significance, we also achieved Statistical significance. There is strong evidence that can confirm this hypothesis.

### *i.6) H6-Is the Total Mortality rate negatively related with the total number of (DB) (OPS)?*

In opposite of all of the previous hypothesis that we want to test, we want to show evidence of a negative relationship between the Total Mortality Rate and the dependent. To do so, we also have performed all the 12 tests, using two different regression models as the previous hypothesis. Moving to the analysis of this results we say that on all the tests performed there is no evidence in neither one of the tests of the negative relationship that we are expecting on. Also, about significance, there strong evidence that all the tests

performed are Statistically significant to study the dependent variable. It seems that we do not have evidence, at least using these types of regression models with this particular time scale, that the hypothesis can be totally confirmed.

#### *i.7) Evidence of the proposed hypothesis*

We finished the detailed analysis of each hypothesis that we found interesting to explore in this experience and know we are on position to say that we strongly can confirmed our initial prepositions about hypothesis 4 and 5. With a 95% confidence level, we can say that Total Annual Average Salary and the Total Labour Force are strong variables to study our dependent and both are confirmed to have a positive impact on the total number of (UK) (DB) (OPS).

In this study, we do not have enough evidence to be able to strongly confirm hypothesis 1, 3 and 6. Even we do not reach the results that we are expecting to, this are valuable data to this study. We can say that (CPI), 10 years Gilt and the Total Mortality Rate are important variables. As these three variables show evidence of being statistically significant besides the opposite relationship that we want to test it, we decided to partially confirm these three hypotheses.

Finally, in what concerns hypothesis 2, we can show that only 2 of the six tests show evidence of being significant to describe the dependent variable behaviour. Once we do not have enough evidence either the relationship or the statistical significance of (RPI) in this study, we decided that we do not have enough evidence to confirm the hypothesis.

### 2) Gender Analysis

The previous section of this study was dedicated to the general components of (UK) (DB) (OPS). What is also interesting to be analysed is if there are differences in the treatment of these pensions between genders. So, we have also incorporated a brief gender analysis

on this study to be able to approach some important concept that we need to bear in mind when we are analysing (UK) (DB) (OPS) between genders.

We have been revised the information provided in order to state the most recent changed in terms of equalising [7]pensions among the gender.

### a) What is a Gender Analysis

A gender analysis is an analysis that recognizes the existence of differences among genders. In the past decade gender inequality in pensions has been increasingly recognized as unacceptable. Women's lower average pension income makes them more likely than men to depend on means-tested benefits or on family members in later life, but neither of these is an attractive option. (Ginn, J. and MacIntyre, K., 2013)

### b) Importance of performing a Gender Analysis

We are concerned with the underlying causes of these inequities and focused to achieve positive change for the gender that has not been favoured. This was one theme that has been concerned researchers as we will state further. More than biological differences between men and women, the ways in which those differences have been valued is one of the most concerning issues on (UK) (DB) pensions among years.

### c) What Researchers have said

Along the years, women has risen their participation on the (UK) workforce. However, despite an escalation in the number of women found on the employment ladder, they are still yet to gain earnings parity with men even after the Equal Pay Act (1970) (Furnham, A. and Wilson, E., 2011)

[7] On 26th October 2018, the High Court issued its long-awaited judgment in the Lloyds case. The case needed clarification on how the (GMP) in order to avoid the unequal effect of (GMPs). So, since that day we have new methods to valued (GMP) pensions in respect of the period that goes from 17/05/1990 to 05/04/1997.

Due to (UK) men and women acting to confirm a stereotypical gender role within partnerships and welfare policies, women earn much less than their partners. This reflects and reinforce the gender division. (Price, D. 2006)

Gender inequality in pensions has been increasingly recognized as unacceptable. According to the Department of Work and Pensions, women's lower average pension income makes them more likely than men to depend on means-tested benefits or on family members in later life. (Ginn, J. and Macintyre, K., 2013)

### d) Equalisation

Along the time the state pensions have been changed according to the different acting pension reforms. Most private-sector (DB) schemes in the (UK) contracted out the earnings-related part of the state pension system before April 2016. In place of this, for the period between 1978 and 1997, the benefit such schemes provided often had to include within it a (GMP) element. This (GMP) is gender discriminatory, following the pattern of the state pension. Thanks to other requirements imposed by the Government on private schemes, this has probably made the overall scheme benefit gender discriminatory. (Everett D. and Matteucci D., 2017)

#### *d.1) Guaranteed Minimum Pension*

(GMP[8]) is the minimum pension that an employer had to provide through a private pension scheme if they wanted to contract out the additional state pension before 6 April 1997.

[8] In order to check the rates that need to be used in the case of applying a Fixed (GMP) rate, please consult https://adviser.royallondon.com/technical-central/rates-and-factors/fixed-rate-gmp-revaluation/ and be aware that the range intervals date is related to the (DOL).

The (GMP) [9]rules were abolished from 6 April 1997. However, past accruals remain and a scheme that was contracted-out must still provide a pension at least as good as the (GMP) in respect of contracted-out service for any time a person was a member of that scheme, up to and including 5 April 1997.

Once (GMP) has specific rules to be accounted, even when the scheme provides a higher benefit overall than the (GMP), the (GMP) must be accounted for separately from the rest of the private pension. Please see Appendix IX to have a visual sense at one example of how to separate tranches of computation when we analyse the data of a particular beneficiary that have (GMP) to be accounted.

### *d.2) Statutory Pension Age[10] (SPA)*

According to the (UK) Government, this represents the earliest age that a beneficiary can start receiving the state pension. This is based on the gender of the person, as well as the birth date.

### *d.3) Normal Retirement Age (NRA)*

This concept of Normal Retirement Age (NRA) is similar to the previous concept of (SPA) but acknowledge the fact that this is scheme specific, so in the simplest way this represents the age at we should consider age retirement for calculation purposes, even if this does not correspond to the date at which the person retired in fact.

[9] Notice that there are different methods to revaluations of (GMP). It can be by fixed rates, using tables of Section 148 at the respective April year or by Limited revaluations up to 5%.

[10] In order to check how the Law have been changed in terms of (SPA) we can check https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/310231/spa-timetable.pdf and to be able to know a specific (SPA) we can use (UK) Government calculator by following the necessary steps at https://www.gov.uk/state-pension-age

In order to compute Protected Rights[11], we use (NRA) of 65 for male and (NRA) of 60 for female. This procedure is standard across all scheme rules. Essentially, besides the age effect, what causes the main differences in the calculations of Protected Rights for both genders is the specific rules that we should obey computing the respective annuities. So, to be more conscientious about the gender impact on annuities, we present on Appendix X.

### e) Important High Court Events – Gender Discrimination decisions

Two of the most important events in terms of efforts to end gender inequalities are being cited below.

#### *e.1) Barber Vs Guardian Royal Exchange (European Court of Justice) – 17 May 1990[12]*

In 17 of May 1990, Mr Barber wins a court case, claiming that he has been discriminated by his gender in what concerns his right to receive his retirement pension benefits. The European Court agreed and since that date by retrospective application of the barber decision all pension benefits were subject to Article 119 (141) that institutes the barber period. This result conflict with previous European Commissions Directives and therefore is not operate prior to 17 May 1990.

In practical terms the barber period constitutes an interval of time were all pensions were revaluated using an (NRA) of 60, despite the gender of the beneficiary. This constitutes one of the most important resolutions on (UK) pensions at the time and has caused

[11] According to the (UK) Law, Protected Rights represents the part a member's pension rights in a contracted-out money purchase scheme or an appropriate personal pension scheme that derived from rebates the member's employer and the member received on their (NICs).

[12] The description of Mr. Barber' employee history facts that lead him to the court can be seen in https://www.sackers.com/pension/barber-v-guardian-royal-exchange-european-court-of-justice-17-may-1990/

Actuaries to rewrite the scheme rules of different pension schemes. In order to show this impact see Appendix XI with a setup rules [13]of a generic pension scheme.

### *e.2) Lloyds Banking Group Pensions Trustees Limited Vs Lloyds Bank PLC and others – 26 October 2018[14]*

On October 26 of 2018, Andrew Short QC and Nicholas Hill acted for the Representative beneficiaries of this case. They addresses the long-standing question whether contracted-out members' benefits must be adjusted to reflect inequalities in their (GMP)s.

As have been proved that there is an objective difference between the position of males and females arising from the (GMP) legislation, the Trustee needs to repay the correspondent amount of monetary difference resultant of the excess of what the opposite gender have the right to receive in the same conditions.

So from that date forward, Actuaries and Trustees have been made an effort to amend the (GMP) inequalities by using different methods to equalise (GMP)s. Essentially what is needed to be done is correct the value that is given in excess to the opposite gender by finding a correspondent uplift on the same conditions to the gender that is being performed the analysis. One method of doing that is shown on Appendix XII.

Notice that this (GMP) equalisation is only applicable to the period that goes from 17 of May 1990 to 05 of April of 1997.

## f) Other Important Considerations

In order to have a large view about gender analysis is important to state a few considerations about the gender differences that are demographic and economic as well.

[13] This setup rules is an output of an Actuarial application used by Mercer
[14] Other descriptive facts about this case can be analysed be consult https://www.outertemple.com/2018/10/judgment-in-the-lloyds-gmp-equalisation-case/

### *f.1) Demographic Considerations*

To be able to state differences among males and females is highly important to analyse how they are structured on the population of this study. Increases in pensionable age, are one policy response to the fact that people are living longer. Around half of Organization for Economic Co-Operation and Development (OECD) Countries have elements in their mandatory retirement-income provision that provide an automatic link between pension and a change in life expectancy. These changes have important implications for the way the cost are providing for pensions as life expectancy increases. In order to have a clear idea of the (UK) life expectancy reality is shown on Appendix XIII the evolution of the (UK) population from 2007 to 2016.

As well as the life expectancy, National life tables [15]are important features to be considered because they contain important elements of what is expected to be the average number of additional years a person can be expected to live.

### *f.2) Economic Considerations*

There is also a few economic differences that should be stated among the genders. As we had the possibility to collect the Labour Force date and Average Salary by gender we have performed the correspondent graph of these measures. Please see Appendix XIV to see the gender differences of the two economic measures on the same period that have been objective of study.

## g) (CETV) Gender Exercise

As we already state in the beginning of this gender analysis section, we believed that (UK) actuarial rules tend to benefit males among females rights so we have performed a

[15] Once the (ONS) releases an annual updated of National life table for the (UK) we can consult this tables at https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/datasets/nationallifetablesenglandreferencetables

cash equivalent exercise using Ceteris Paribus the same inputs applying the correspondent actuarial rules for the specific gender. The simulation exercise was performed using monthly basis from January 2016 to December 2017. The entire exercise can be shown on Appendix XV.

## IV. Conclusion and Further Research

Choosing to study a theme on retirement pensions is generally is not easy, because there is a lot of particularities to be said. We start this study by giving a general overview of what have being done on Reform Acts to update pension Laws and particularly in the (DB) (OPS) (UK) plans.

The exercise of think on variables that can impact and make a decision on whether the possible subscribers should apply for a (DB) plan implies a lot of effort in us to understand the components that normally impact the value that contributes to increase or decrease the final amount of these individual plans at the end of the day. We then moved to study the general components of (DB) (OPS) plans by testing the relationship of our chosen explanatory variables with the dependent variable and become aware that only Hypothesis 2 hasn´t shown evidence of being significant. This result confirms the idea that (RPI) has become an index obsolete.

The third part of this study was to show that along the years there have been conducted some gender discrimination on the treatment of pension plans but the constant law review is precise to reduce these discrepancies by correcting as much as possible beneficiaries that might feel discriminated.

As we already expect during this project we have faced some limitations that we found a way to fill. Initially, we start collecting annual data for our Time Series analysis but as

we realize that wasn't enough to conduct accurate regression analysis we decided to step back and collect monthly data for the same range of time that have been selected. Unfortunately, we weren´t able to find monthly data for 10 year gilt, Total Average Annual Salary, Total Labour Force and Total Mortality Rate. So, we have perform the necessary adjustments I order to have monthly data for each study variable.

For further research, there is an open window to continue studying (DB) (OPS). An interesting suggestion is to segregate the number of males and females of the total (DB) (OPS) and try to analyse which gender has been more likely to submit a (DB) pension plan.

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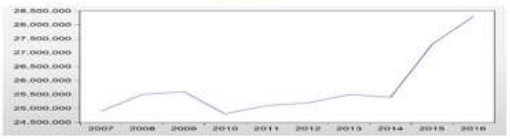
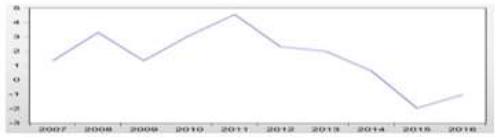
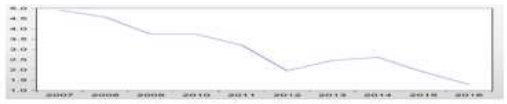
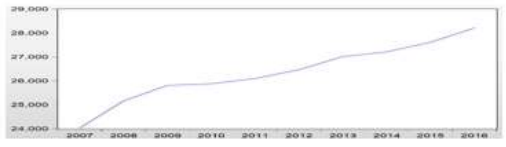
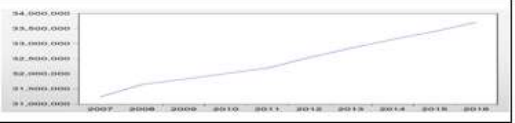
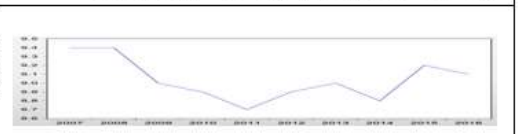
# Appendix

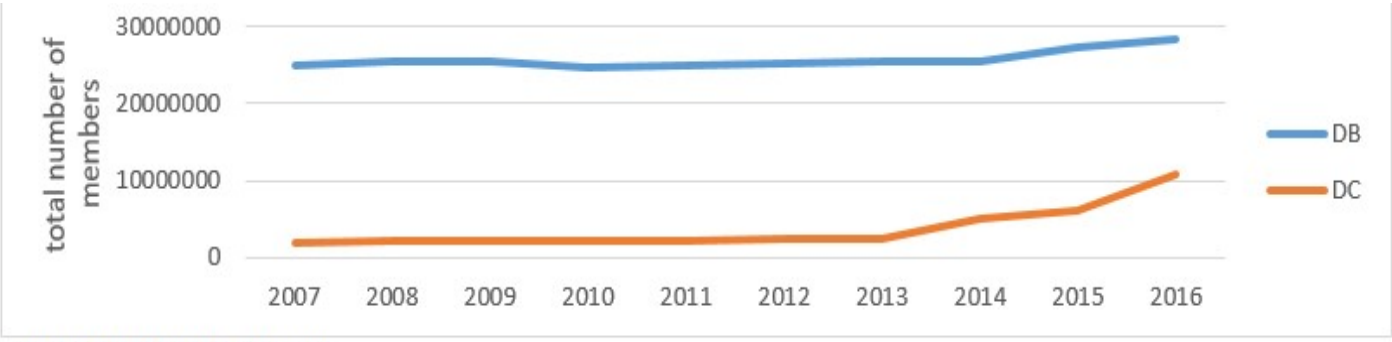
## Appendix I - Data Sources

| Data from 2007 to 2016 | | |
|---|---|---|
| *Collecting Data* | *Description* | *Graphic* |
| *Dependent Variable: Total Number of DB OPS* | In order to collect, we went to the website of UK Office for National Statistics, searched for statistical bulletin on OPS in UK, found an Excel file with an overview of the study performed and picked table 3 to analyse. Table 3 on this study, give us the Number of OPS by sector, membership type and benefit structure. As our cluster is DB plans, we focused on the total DB plans in this table and collect the annual data that belong to the range already mentioned. |  |
| Explanatory Variables | | |
| *CPI, Consumer Price Index* | To get the UK CPI we went to the website of UK Office for National Statistics, searched for CPI Annual Rate and get a graph that show us the value from January 1989 to June 2018, select the sample that we need for this study and save the necessary data. Doing that we have the variables at the same timeline as the dependent variable and are in the position to assess the relationship with it. After that we found the correspondent monthly values in http://www.wolfbane.com/cpi.htm |  |
| *RPI, Retail Price Index* | To collect RPI Data we went to the website of UK Office for National Statistics, searched for RPI annual rate and find a graph that give us the UK annual RPI from June 1948 to June 2016 and pick the values that are interesting for our analysis. Afterr that we also find the correspondent Monthly data at http://www.wolfbane.com/rpi.htm |  |
| *10 Year Gilt** | To collect Gilts-10 Years government bonds we went to the Bank of England website and search for Annual Yield from British Government securities, then search for 10 years Nominal Zero Coupon and select the range that we want to study, collect the data in order to performed the necessary analyse. |  |
| *Total Annual Average Salary** | To collect total average salaries, we went to the website of UK Office for National Statistics, searched for annual survey of hours and earnings we get the 2016 provisional results. Search in this webpage we found Figure 3 with the Median Full-time gross Annual earnings by sex, from UK from 1999 to 2016, so this will be the representative of the numbers for the Total Annual Average Salary earned by the UK Population on the period of our study. |  |
| *Total Labor Force** | To find this variable we went to the World Bank website, search for the total UK Labor force and find a graph with this information from 1990 to 2017 and so we collect the data that are relevant for our years sample. |  |
| *Total Mortality Rate** | To get the information about the uk mortality rate we went to PortData webpage, select the information needed on the boxes and find UK mortality rate between 2007 and 2016. So we collect this information and treat it accordingly. |  |

**For the variables with this symbol we wasn't able to find Monthly date, so we have adjust the annual data in order to deal with the correspondend monthly data of each variable*

Source: Self Elaboration

## Appendix II - Evolution of Total Number of (DB) and (DC) (OPS)




Source: Office National Statistics

## Appendix III -Economic events that can impact the self -behaviour of (DB) (OPS)

UK Economic Timeline

| I | | II | III | | | IV | V | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| **Global Credit Crunch**: Fall in bank lending; result of sub-prime mortgages. Big effect on all economies over the world. | **Financial Crisis:** UK government nationalises tree leading banks as a respond to the global credit crunch. | **UK economic Recession ends**: after six quarters on recession the economy start to grow again. | **Collision Government**: General Ellection. Large Scales public spending cuts to reduced UK deficit. | UK blocks proposed changes to the EU's Lisbon Treaty aimed at addressing the crisis in the eurozone. | British and Scottish governments agrees on referendum for Scottish Independece in 2014. | **New Royal member**: The Duchess of Cambridge gives birth to a son George. | Scothland remains part of UK with 55% in favor of the United Kingdom. | UK Independence Party wins nearly four million votes on elections. | **Political crisis**: David Cameron resigns and Theresa May suceed as Prime Minister. Referendum for Brexit on 23th June, 2016, decides to leave EU with 51.9% | **Brexit:** Early Elections and Formal Negociations begin to end British's membership of the EU. |

**Source**: https://www.bbc.co.uk/news/world-europe-18028620

How Total members on UK DB OPS reacts on Economic events

| I | II | III | IV | V |
|---|---|---|---|---|
| Increasing ↗ | Decreasing ↘ | Increasing ↗ | Decreasing ↘ | Increasing ↗ |
| The Country is facing a Financial Crisis and this makes people more conscientious about how they should protect their future, so is natural to think that they become more open to subscribe pension plans. | The Country start recover the recession, people tend to adopt their normal behaviour, so they do not feel pression to subscribe a pension plan. | New period of political instability. People are afraid and scared about what will happen on the future. Potential subscribers on pension plans are now more motivated to apply for it, so the increasing number of subscribers in this period reflect the incremental effect of protect future savings. | Good news for British people, new member on Royalty will distract them to though on economic problems and they will return to the normal behaviour without any extra motivation to protect | Once again the country face a new political instability and just in two years face two referendums. For the percentage of each one it is possible to see that the country is divided one it comes to big and important decisions. Actually during this period we can percept the highest increase on subscribe DB OPS plans, reflecting precisly the extra motivation reason to increase protection on future savings. Fom 2014 to 2015 their is an increase of 1.9 Millions and 2015 to 2016 an increase of 1.0 Million. |

**Source**: Self Elaboration

## Appendix IV - Uses of Fixed Yield

**Monthly Assumptions**

**Yield Curve Rates**

The gilt implied inflation rates below are based on the implied inflation curve for the appropriate duration. They will differ slightly from the inflation figure calculated by comparing nominal and real gilt yields.

| Scheme profile | Young | Young Intermediate | Non-pensioner | Intermediate | Mature | Very Mature | Retiree |
|---|---|---|---|---|---|---|---|
| **Government bonds** | | | | | | | |
| Macaulay duration (years) | 33.4 | 31.3 | 29.5 | 28.1 | 24.6 | 20.3 | 15.5 |
| Modified duration (years) | 32.8 | 30.7 | 28.9 | 27.7 | 24.2 | 20.0 | 15.2 |
| Fixed yield | 1.75% | 1.76% | 1.76% | 1.75% | 1.75% | 1.73% | 1.71% |
| Implied inflation | 3.39% | 3.40% | 3.42% | 3.41% | 3.43% | 3.45% | 3.50% |
| Real yield | -1.56% | -1.56% | -1.57% | -1.58% | -1.60% | -1.64% | -1.71% |
| **Corporate bonds** | | | | | | | |
| Macaulay duration (years) | 31.3 | 29.2 | 27.7 | 25.9 | 22.5 | 18.6 | 14.5 |
| Modified duration (years) | 30.4 | 28.4 | 26.9 | 25.2 | 21.9 | 18.1 | 14.1 |
| Discount rate | 2.83% | 2.82% | 2.82% | 2.80% | 2.78% | 2.74% | 2.67% |
| **Swaps:** | | | | | | | |
| Macaulay duration (years) | 33.7 | 31.5 | 29.7 | 28.4 | 24.9 | 20.5 | 15.6 |
| Modified duration (years) | 33.1 | 31.0 | 29.2 | 28.0 | 24.5 | 20.2 | 15.4 |
| Discount rate | 1.62% | 1.62% | 1.62% | 1.62% | 1.62% | 1.61% | 1.60% |
| Implied inflation | 3.40% | 3.40% | 3.42% | 3.41% | 3.43% | 3.44% | 3.47% |

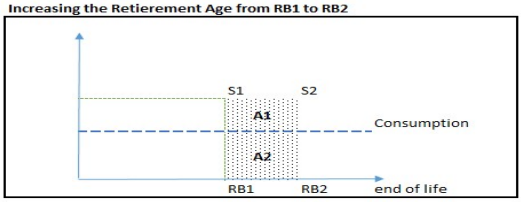
If the scheme rules sais:
**Pre Ret** = Fixed Yield + 2% --> 3.76%
**Post Ret** = Fixed Yield + 1.75% --> 2.51%

Source: Internal Actuarial Tools from Mercer

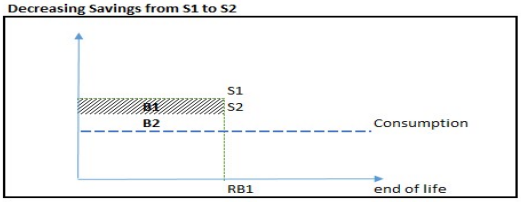
**Fixed Yield** = This represents the earning generated on an investment, The closest financial instrument adapted to **UK Market are UK Gilts**
**Pre Ret** =These rates acts as interest discount risk free rates
**Post Ret** = These rates are used to generate the amount of the correspondent annuities of the calculations in order to forecast what should be the additional cost of an increase in market conditions to generating pensioners annual payments

## Appendix V - Life Cycle Theory

**Increasing the Retierement Age from RB1 to RB2**




**Decreasing Savings from S1 to S2**




Labels:

| | |
|---|---|
| **RB1** | **Retirement Beginning 1** |
| **RB2** | **Retirement Beginning 2** |
| **S1** | **Savings 1** |
| **S2** | **Savings 2** |

On both graph we have described the life cycle theory and a variation given real economic changes that can desagree with that theory.
If we only consider the Life Cycle theory, we will get the all white area.
The Life cycle theory says that individuals tends to consume smothly constant through life and save enough money that allows them to start spending when Retirement comes at **RB1.**

If we increase the retirement age from RB1 to RB2, the individuals can accumulate more savings during their work time in order to spend later when **RB2** starts. This will lead us to an increase of people on labor force because now we have increased the age of retirement and more people are included on labor force.

If Ceteris paribus the only change was the age of retirement, our consumption will not be a linear constant function and the individual have the opportunity to expande his/her consumption area while he/she is on the labor market, shown in **A2** and as is still on market have the abbility to keep saving to retirement fase, represented by **A1**. Now the Interval of time until the end of life is smaller to distribute the all savings, because the individual remains on the labor market until reach **RB2.** This supports the fact that consumption cannot be seen as a constant linear function as the changed on Retirement age change the initial forecast and the structure of labor force.

If Ceteris Paribus, consumption patterns increase before the individual reach the Retirement age, the original Saving **S1** of the life cycle theory will decrease and become **S2.**
On the above graph this is represented by the decrease of **B1** area.
Until the individual reach the retirement age, we only can save what is on **B2** area.

So, as similar to the previous situation, here the life cycle theory also cannot be hold, because the decrease of savings will lead to a situation of lack of resources to consume after **RB1** period starts.

In this graph what happens was a decrease of the individual savings.
This situation can compromize the equilibrium of the Life cycle model, because what is suppose to happen is that each individual know their own consumption behaviour that can predict how much money they need to save in order to be independent when retirement comes.

From both graphs, we can affer that is better to increase the age of retirement, to prevent increase of consumption behaviours and to be able to keep increasing saving for the retirement period. This is the same as increase the labor force by keeping in the market the employees for longer periods.

**Source:** Self Elaboration

## Appendix VI – Table with descriptive Statistics

| Variable | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|
| 1st Dif Members DB _OPS | 2380.952 | 18352.03 | -66666.66 | 158333.3 |
| 1st Dif CPI | -.0016632 | .0402939 | -.2166667 | .1638889 |
| 1st Dif RPI | -.0017507 | .059988 | -.375 | .425 |
| 1st Dif Gilt10y | -.0025371 | .0147578 | -.1044917 | .0418667 |
| 1st Dif Sal | 2.920168 | 12.29027 | 0 | 93.5 |
| 1st Dif LaborF | 1732.597 | 6329.52 | 0 | 33915.67 |
| 1st Dif Mort | -.0002101 | .0052551 | -.0333333 | .0333333 |

Source: Output from Stata 13

## Appendix VII - Table with Correlation Matrix

| | 1st Dif M_DB | 1st Dif CPI | 1st Dif RPI | 1st Dif G10y | 1st Dif Sal | 1st Dif LF | 1st Dif Mort |
|---|---|---|---|---|---|---|---|
| 1st Dif Members DB _OPS | 1.0000 | | | | | | |
| 1st Dif CPI | -0.3260 | 1.0000 | | | | | |
| 1st Dif RPI | -0.0944 | 0.6053 | 1.0000 | | | | |
| 1st Dif Gilt10y | -0.4970 | 0.3853 | 0.2799 | 1.0000 | | | |
| 1st Dif Sal | 0.5631 | -0.0360 | -0.2569 | -0.5563 | 1.0000 | | |
| 1st Dif LaborF | 0.5094 | -0.1372 | -0.1462 | -0.5802 | 0.8959 | 1.0000 | |
| 1st Dif Mort | 0.4385 | -0.2865 | 0.3079 | -0.0202 | -0.0979 | -0.0030 | 1.0000 |

Source: Output from Stata 13

## Appendix VIII -Main Results using Regression Model from (OLS) & (PW)and (CO)

| | Test 1 | Test 2 | Test 3 | Test 4 | Test 5 | Test 6 |
|---|---|---|---|---|---|---|
| Hypothesis 1: **(CPI+)** | 0.809 | 0.006 | 0.046 | | | |
| Hypothesis 2: **(RPI+)** | | | | 0.159 | 0.110 | 0.016 |
| Hypothesis 3: **(Gilt+)** | 0.000 | | | 0.000 | | |
| Hypothesis 4: **(Sal+)** | | 0.000 | | | 0.000 | |
| Hypothesis 5: **(Labor+)** | | | 0.000 | | | 0.000 |
| Hypothesis 6: **(Mort-)** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Constant | 0.89 | 0.969 | 0.939 | 0.348 | 0.896 | 0.868 |
| Durbin Watson Test (Prob> F) | 0.4721 | 0.9722 | 0.9387 | 0.4264 | 0.9036 | 0.8649 |
| Portmanteau Test (Prob> $X^2$) | 0.9970 | 0.9993 | 0.9980 | 0.9996 | 0.9734 | 0.9048 |
| Observations | 119 | 119 | 119 | 119 | 119 | 119 |

*the values represented on the table are p-values, subjected to a p<0.05

| Significance and Signal | Test 1 | Test 2 | Test 3 | Test 4 | Test 5 | Test 6 |
|---|---|---|---|---|---|---|
| Hypothesis 1: **(CPI+)** | - | - | - | | | |
| Hypothesis 2: **(RPI+)** | | | | - | - | - |
| Hypothesis 3: **(Gilt+)** | - | | | - | | |
| Hypothesis 4: **(Sal+)** | | + | | | + | |
| Hypothesis 5: **(Labor+)** | | | + | | | + |
| Hypothesis 6: **(Mort-)** | + | + | + | + | + | + |

Source: Output from Stata 13

| | Test 7 | Test 8 | Test 9 | Test 10 | Test 11 | Test 12 |
|---|---|---|---|---|---|---|
| Hypothesis 1: **(CPI+)** | 0.809 | 0.006 | 0.047 | | | |
| Hypothesis 2: **(RPI+)** | | | | 0.160 | 0.112 | 0.016 |
| Hypothesis 3: **(Gilt+)** | 0.000 | | | 0.000 | | |
| Hypothesis 4: **(Sal+)** | | 0.000 | | | 0.000 | |
| Hypothesis 5: **(Labor+)** | | | 0.000 | | | 0.000 |
| Hypothesis 6: **(Mort-)** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Constant | 0.373 | 0.969 | 0.939 | 0.344 | 0.896 | 0.868 |
| Portmanteau Test (Prob> $X^2$) | 0.9970 | 0.9993 | 0.9980 | 0.9996 | 0.9734 | 0.9049 |
| Observations | 118 | 118 | 118 | 118 | 118 | 118 |

*the values represented on the table are p-values, subjected to a p<0.05

| Significance and Signal | Test 7 | Test 8 | Test 9 | Test 10 | Test 11 | Test 12 |
|---|---|---|---|---|---|---|
| Hypothesis 1: **(CPI+)** | - | - | - | | | |
| Hypothesis 2: **(RPI+)** | | | | - | - | - |
| Hypothesis 3: **(Gilt+)** | - | | | - | | |
| Hypothesis 4: **(Sal+)** | | + | | | + | |
| Hypothesis 5: **(Labor+)** | | | + | | | + |
| Hypothesis 6: **(Mort-)** | + | + | + | + | + | + |

Source: Output from Stata 13

Subtitle:

No Evidence of statistic significance

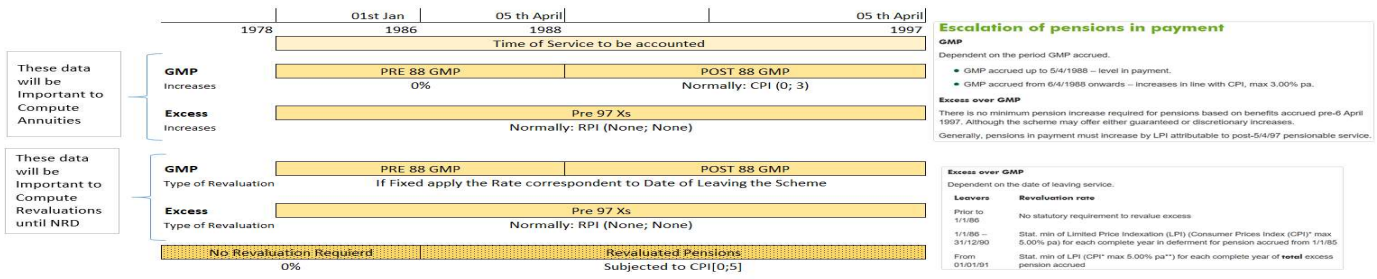
statistic Significance

\- Negative

\+ Positive

## Appendix IX - Separation of Tranches in analysis

If the Beneficiary member have Service between 1978 and 1997




**Escalation of pensions in payment**

**GMP**

Dependent on the period GMP accrued.

- GMP accrued up to 5/4/1988 – level in payment.
- GMP accrued from 6/4/1988 onwards – increases in line with CPI, max 3.00% pa.

**Excess over GMP**

There is no minimum pension increase required for pensions based on benefits accrued pre-6 April 1997. Although the scheme may offer either guaranteed or discretionary increases.

Generally, pensions in payment must increase by LPI attributable to post-5/4/97 pensionable service.

**Excess over GMP**

Dependent on the date of leaving service.

| Leavers | Revaluation rate |
|---|---|
| Prior to 1/1/86 | No statutory requirement to revalue excess |
| 1/1/86 – 31/12/90 | Stat. min of Limited Price Indexation (LPI) (Consumer Prices Index (CPI))* max 5.00% pa) for each complete year in deferment for pension accrued from 1/1/85 |
| From 01/01/91 | Stat. min of LPI (CPI* max 5.00% pa**) for each complete year of **total** excess pension accrued |

Source: https://www.oldmutualwealth.co.uk/Adviser/literature-and-support/knowledge-direct/pensions/escalation-and-revaluation/defined-benefit-occupational-pensions/ and self elaboration

## Appendix X - Annuity Calculator for Protected Rights

| Annuities | Pre 88 GMP PR | Post 88 GMP PR |
|---|---|---|
| Post Retirement | 2.66% | 2.66% |
| NRA | 65 | 65 |
| Pension Increase | 0.00% | 2.05% |
| Mortality | | |
| YOB | 1959 | 1959 |
| Male | 97% #SPA07M_CMI_2013_1.5% B=1959 +0 yrs | 97% #SPA07M_CMI_2013_1.5% B=1959 +0 yrs |
| Female | 92% #SPA07F_CMI_2013_1.5% B=1959 +0 yrs | 92% #SPA07F_CMI_2013_1.5% B=1959 +0 yrs |
| Male - Rating | 0 | 0 |
| Female - Rating | 0 | 0 |
| Percentage Married | | |
| Male | 80% | 80% |
| Female | 70% | 70% |
| Age Difference | | |
| Male | 3 | 3 |
| Female | -3 | -3 |
| G'tee | 0 | 0 |
| Spouses Pension proportion | 50% | 50% |
| 5 yrs temp | 4.68574436 | 4.926238623 |
| Male Annuity | 18.95402 | 25.10743 |
| Female Annuity | 19.06719 | 25.19166 |

Source: Internal Actuarial Tools from Mercer and Self Elaboration

**Statutory Rules for Protectet Rights**
**Pre 88 GMP = Fixed 0%**
**Post 88 GMP = CPI (0%; 3%)**

Source: http://www.legislation.gov.uk/uksi/1996/1461/made
https://www.oldmutualwealth.co.uk/Adviser/literature-and-support/knowledge-direct/pensions/escalation-and-revaluation/defined-benefit-occupational-pensions/

**How we get this values?**
Formula = ASL + Percentage Married x Spouse Pension Proportion x AREV

**ASL = Annuity Single Life**
ASL ( Age Retirement; Post Retirement Rate; Mortality Spouse%; guarantee; Pension Increase; Rating spouse; Weighthing Spouse; Year of Birth; GMType)
ASL( 65; 2.66%; 92%; 0; 0%; 0; 70%; 1959; "B")

**Percentage Married** 80%

**Spouses Pension Proportion** 50%

**AREV = Joint Life Annuity**
AREV ( Age Retirement; Post Ret.Rate; Age Dif; Mortalaty table of Sp; Pension Inc; MRating ; MWeigh; rating sp; Weight Sp; Year of Birth; GMType)
ASL( 65; 2.66%; 3; #SPA07F_CMI2013_1.5%; 0%; 0; 80%; 0; 70%; 1959; "B")

As there are a lot of inputs to be considered when we compute an Annuity is normal to have this different amounts.
By having different Percentade Married and Percentage of Mortality
the same Pre 88 GMP Protected Right have generate a highest Annuity for a Female Member in this particular exercise

## Appendix XI - Barber Window

Tranche | Basis | Validation | Expression Builder | Notes | Output Text

**Tranches**

| Description | Pre 1990 | Barber Window | Post 1994 | Post 97 |
|---|---|---|---|---|
| Tranche Name | Pre 1990 | Barber Window | Post 1994 | Post 97 |
| Short ID | T1 | T2 | T3 | T4 |
| Administration Code | | | | |
| Start Date | 01/04/1950 | 17/05/1990 | 10/05/1994 | 06/04/1997 |
| End Date | 16/05/1990 | 10/05/1994 | 06/04/1997 | 01/04/2050 |
| Male Revaluation Age | 65 | 60 | 65 | 65 |
| Female Revaluation Age | 60 | 60 | 65 | 65 |

Source: Mercer Actuarial Application to Write Scheme Rules

In This Scheme it was included the berber Period, so as it is possible to see in this specific tranche both genders are having the benefits revalued at the same age (NRA60).

## Appendix XII - One Equalisation Method

**1) We will collect the necessary basic date like Date of Birth and Total Pre 97 Benefits at Date of Leaving**

**GMP Equalisation**

DOB: 31/08/1960 Total Post 90 - Pre 97 £3,193.93
Sex: M Weeks over 60:

**2) We have a Male calculation to perform, so what we going to do is find the correct amount for the opposite Sex in order to instigate which have the highest outcome and apply it to the member in case the opposite sex have the right to receive more**

Member's Data at Date of Leaving (DOL):

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Male:** | | | | | | | | | | | Scheme LRF | | |
| Post 88 GMP Temporary: | £508.67 | x | 2.023 | x | 1.043 | * | 2 | x | 1.0000 | = | £ | 1,119.65 | |
| Pre 97 XS: | £2,685.26 | x | 1.718 | x | 1.0251 | * | 1 | x | 1.0000 | = | £ | 4,729.07 | |
| Post 88 GMP: | £508.67 | x | 2.023 | x | 1.043 | * | 6 | x | 1.0000 | = | £ | 1,325.52 | |
| | | | | | | | | | Stat LRF | | | | |
| Post 88 GMP: | £ - | x | 2.023 | * | 5 | | | x | 1.0000 | x | £ | - | |
| Pre 97 XS: | £ 5,048.73 | - | £ - | = | £ 5,048.73 | | | | | | | | |
| Post 88 GMP Temporary: | £ 1,119.65 | x | 1.0475 | * | -1.416666667 | x | 4.945545 | | | | = | £ 5,184.97 | |
| Pre 97 XS: | £ 4,729.07 | x | 1.0475 | * | -1.416666667 | x | 29.64039 | | | | = | £131,252.78 | |
| Post 88 GMP: | £ 1,325.52 | x | 1.0475 | * | -1.416666667 | x | 24.4988 | x | 1.0275 | * | -5.00 | = | £ 26,550.45 |
| **Female:** | | | | | | | | | | | | | a.y (NRD60-DOC) |
| Post 88 GMP: | £569.20 | x | 2.023 | x | 1.0431 | * | 1 | x | 1.0000 | = | £ | 1,201.12 | 1 |
| Pre 97 XS: | £2,624.73 | x | 1.718 | x | 1.0251 | * | 1 | x | 1.0000 | = | £ | 4,622.47 | |
| Post 88 GMP: | £ 1,201.12 | x | 1.0475 | * | -1.416666667 | x | 28.11522 | | | | = | £ 31,621.17 | |
| Pre 97 XS: | £ 4,622.47 | x | 1.0475 | * | -1.416666667 | x | 29.64039 | | | | = | £ 128,294.04 | |

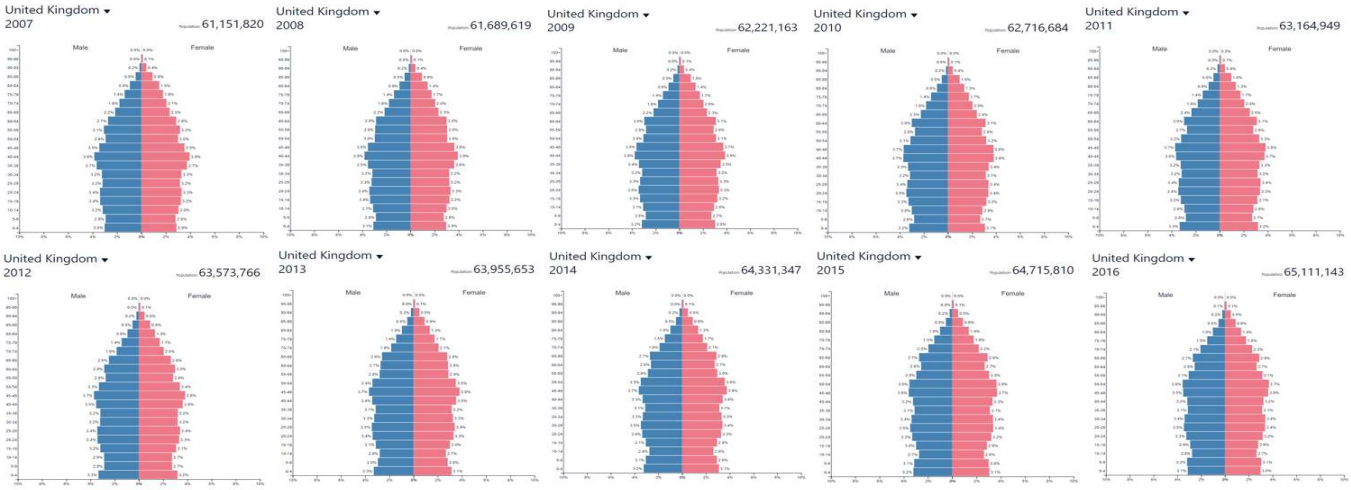
£508.67 x 1.119

Source: This was a fictionary exercise extract using na Actuarial Tool from Mercer

| Tax years | | Gender conversion factor | |
|---|---|---|---|
| Start date | End date | Male to Female | Female to Male |
| 02 January 1900 | 05 April 1934 | 1 | 1 |
| 06 April 1934 | 05 April 1935 | 1.05 | 0.9524 |
| 06 April 1935 | 05 April 1936 | 1.1 | 0.9091 |
| 06 April 1936 | 05 April 1937 | 1.15 | 0.8696 |
| 06 April 1937 | 05 April 1938 | 1.2 | 0.8333 |
| 06 April 1938 | 05 April 1939 | 1.25 | 0.8 |
| 06 April 1939 | 05 April 1940 | 1.2381 | 0.8077 |
| 06 April 1940 | 05 April 1941 | 1.2273 | 0.8148 |
| 06 April 1941 | 05 April 1942 | 1.2174 | 0.8214 |
| 06 April 1942 | 05 April 1943 | 1.2083 | 0.8276 |
| 06 April 1943 | 05 April 1944 | 1.2 | 0.8333 |
| 06 April 1944 | 05 April 1945 | 1.1923 | 0.8387 |
| 06 April 1945 | 05 April 1946 | 1.1852 | 0.8438 |
| 06 April 1946 | 05 April 1947 | 1.1786 | 0.8485 |
| 06 April 1947 | 05 April 1948 | 1.1724 | 0.8529 |
| 06 April 1948 | 05 April 1949 | 1.1667 | 0.8571 |
| 06 April 1949 | 05 April 1950 | 1.1613 | 0.8611 |
| 06 April 1950 | 05 April 1951 | 1.1563 | 0.8649 |
| 06 April 1951 | 05 April 1952 | 1.1515 | 0.8684 |
| 06 April 1952 | 05 April 1953 | 1.1471 | 0.8718 |
| 06 April 1953 | 05 April 1954 | 1.1429 | 0.875 |
| 06 April 1954 | 05 April 1955 | 1.1389 | 0.878 |
| 06 April 1955 | 05 April 1956 | 1.1351 | 0.881 |
| 06 April 1956 | 05 April 1957 | 1.1316 | 0.8837 |
| 06 April 1957 | 05 April 1958 | 1.1282 | 0.8864 |
| 06 April 1958 | 05 April 1959 | 1.125 | 0.8889 |
| 06 April 1959 | 05 April 1960 | 1.122 | 0.8913 |
| 06 April 1960 | 05 April 1961 | 1.119 | 0.8936 |
| 06 April 1961 | 05 April 1962 | 1.1163 | 0.8958 |
| 06 April 1962 | 05 April 2090 | 1.1136 | 0.898 |

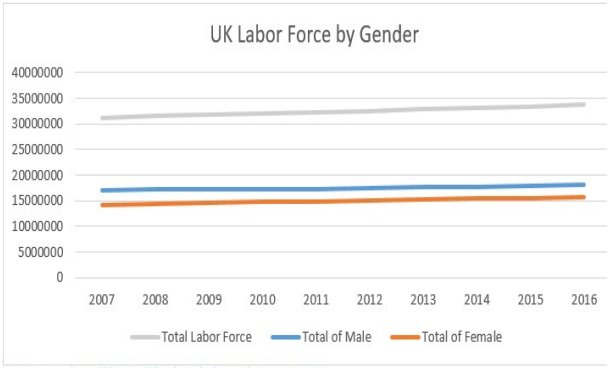
**3) In This case as the Male conditions benefit the Male there is no Uplift to be applied**

## Appendix XIII - Distribution of Population from 2007 to 2016




Source: https://www.populationpyramid.net/united-kingdom/2007/

## Appendix XIV - Graph with Labour Force and Average Salaries by Gender




Source: https://data.worldbank.org/indicator/SL.TLF.TOTL.FE.ZS


Source: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2016provisionalresults

## Appendix XV - General Report on (CETV) Exercise

The aim of this exercise is to show that even on the presence of equal salaries, years of work and equal pension at (DOL), Males transfer values continue to be bigger than females in the same conditions during each month of 2016 and 2017.

In order to percept if it exists a favorable treatment to Males Transfer Values in comparison with female ones, it is proposed to realize an Exercise of computing a (CETV) for both Male and Female conditions Ceteris Paribus, only the Life Expectancy rules will be changed according to the gender.

It was necessary a real case example which was picked from Mercer's data base on a random month. This was replicated for the months in analysis, in order to analyse the differences between genders and the evolution of financial market conditions during 2016 and 2017.

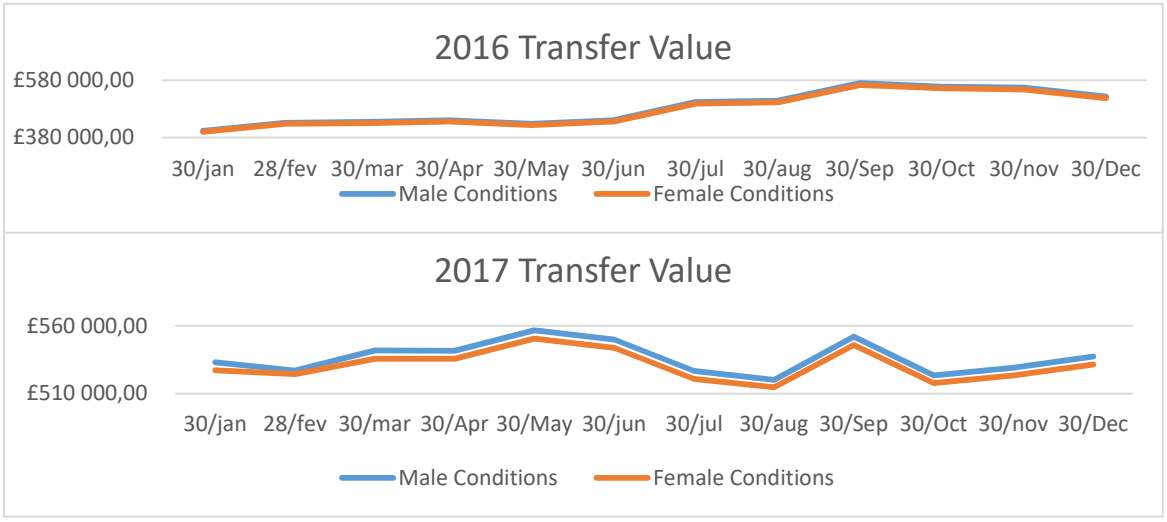
By replicate the same date for each month of 2016 and 2017, we get the following results:

| 2016 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOC | 30/jan | 28/fev | 30/mar | 30/Apr | 30/May | 30/jun | 30/jul | 30/aug | 30/Sep | 30/Oct | 30/nov | 30/Dec |
| Male Conditions | | | | | | | | | | | | |
| TV | £ 403 558,90 | £ 431 843,50 | £ 434 835,33 | £ 440 564,65 | £ 427 852,68 | £ 440 144,48 | £ 503 199,09 | £ 507 795,24 | £ 569 217,98 | £ 557 622,38 | £ 553 380,77 | £ 522 679,55 |
| Post 97 | £ 244 980,76 | £ 262 104,75 | £ 263 833,80 | £ 267 402,07 | £ 259 595,87 | £ 266 872,53 | £ 305 173,11 | £ 307 805,31 | £ 345 227,17 | £ 338 580,90 | £ 336 302,34 | £ 317 603,50 |
| PR at 65 | £ 22 023,68 | £ 23 832,62 | £ 24 316,98 | £ 24 523,45 | £ 23 888,77 | £ 25 126,85 | £ 29 185,44 | £ 30 039,16 | £ 33 272,17 | £ 31 275,37 | £ 29 379,07 | £ 28 034,17 |
| Female Conditions | | | | | | | | | | | | |
| TV | £ 399 894,17 | £ 427 708,83 | £ 430 646,68 | £ 436 308,72 | £ 423 797,61 | £ 435 873,57 | £ 497 808,58 | £ 502 289,49 | £ 562 565,45 | £ 551 277,60 | £ 547 187,73 | £ 517 073,08 |
| Post 97 | £ 243 349,11 | £ 260 228,06 | £ 261 936,41 | £ 265 468,39 | £ 257 769,82 | £ 264 944,81 | £ 302 657,60 | £ 305 236,27 | £ 342 040,15 | £ 335 538,47 | £ 333 315,42 | £ 314 937,12 |
| PR at 60 | £ 24 405,14 | £ 26 109,26 | £ 26 590,16 | £ 26 799,26 | £ 26 187,13 | £ 27 357,96 | £ 31 237,20 | £ 31 955,60 | £ 35 157,55 | £ 33 428,91 | £ 31 823,26 | £ 30 419,01 |
| Differences | | | | | | | | | | | | |
| TV | 0,9164% | 0,9667% | 0,9726% | 0,9754% | 0,9568% | 0,9799% | 1,0828% | 1,0961% | 1,1825% | 1,1509% | 1,1318% | 1,0843% |
| Post 97 | 0,6705% | 0,7212% | 0,7244% | 0,7284% | 0,7084% | 0,7276% | 0,8311% | 0,8417% | 0,9318% | 0,9067% | 0,8961% | 0,8466% |

| 2017 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOC | 30/jan | 28/fev | 30/mar | 30/Apr | 30/May | 30/jun | 30/jul | 30/aug | 30/Sep | 30/Oct | 30/nov | 30/Dec |
| Male Conditions | | | | | | | | | | | | |
| TV | £ 533 165,14 | £ 526 988,00 | £ 541 825,17 | £ 541 679,26 | £ 556 781,75 | £ 549 934,68 | £ 526 624,52 | £ 520 215,94 | £ 552 012,91 | £ 523 309,80 | £ 529 103,80 | £ 537 314,16 |
| Post 97 | £ 323 539,58 | £ 320 009,36 | £ 328 798,47 | £ 328 609,44 | £ 337 973,55 | £ 333 617,93 | £ 319 475,43 | £ 315 492,19 | £ 334 878,60 | £ 317 464,16 | £ 321 148,34 | £ 325 960,64 |
| PR at 65 | £ 29 259,52 | £ 28 247,64 | £ 29 991,52 | £ 30 186,68 | £ 30 472,57 | £ 30 667,89 | £ 29 281,10 | £ 29 265,15 | £ 30 778,49 | £ 29 071,02 | £ 29 384,66 | £ 29 831,21 |
| Female Conditions | | | | | | | | | | | | |
| TV | £ 527 255,79 | £ 524 433,24 | £ 535 779,35 | £ 535 641,53 | £ 550 476,60 | £ 543 754,88 | £ 520 907,73 | £ 514 616,54 | £ 545 822,35 | £ 517 686,48 | £ 523 380,28 | £ 531 421,88 |
| Post 97 | £ 320 721,14 | £ 319 210,59 | £ 325 914,67 | £ 325 734,66 | £ 334 943,38 | £ 330 668,55 | £ 316 774,76 | £ 312 863,14 | £ 331 925,82 | £ 314 815,86 | £ 318 443,71 | £ 323 168,63 |
| PR at 60 | £ 31 615,15 | £ 30 904,83 | £ 32 338,32 | £ 32 479,16 | £ 32 817,86 | £ 32 957,55 | £ 31 627,86 | £ 31 620,16 | £ 33 086,27 | £ 31 448,31 | £ 31 758,85 | £ 32 252,20 |
| Differences | | | | | | | | | | | | |
| TV | 1,1208% | 0,4871% | 1,1284% | 1,1272% | 1,1454% | 1,1365% | 1,0975% | 1,0881% | 1,1342% | 1,0862% | 1,0936% | 1,1088% |
| Post 97 | 0,8788% | 0,2502% | 0,8848% | 0,8826% | 0,9047% | 0,8919% | 0,8526% | 0,8403% | 0,8896% | 0,8412% | 0,8493% | 0,8639% |

Which lead to an interesting analysis that we can directly compare Benefits after 1997 and the total amount of Transfer Value because all of this is computed using the same normal retirement age at 60 but because the Protected Right have different rules to be considered ((NRA) 60 for Females and (NRA) 65 for Males), we will not be able to compare them directly.

On the General Calculation of the Transfer Value used considering the data that we have we will used T1, T2 and T3 that stands for T1 – Pensions between 17/05/1990_05/04/1997; T2 – Pensions between 06/04/1997_05/04/2006 and T3 06/04/2006_01/01/2015. All of these three tranches have a revaluation age of 60, so independently of which gender we used to compute the benefit the revaluation age will be the same. On the General Results for total transfer Values this differences in the final value will be more evident on 2017 conditions as the graphs will show.




Giving the results achieved, is it possible to see that there are bigger gaps between genders considering Protected Rights at 60 instead of 65 for both years in analysis, not having any exceptional outlier month. This means that for this exercise, if Females are entitle to received there Protected Rights at 65 instead of the Statutory 60 the difference between genders could reduce a little.

Why this difference happens if we are computing Protected Right, considering Ceteris Paribus, the same conditions for both genders? On this calculation all components are the same, except the component Annuity. The way we compute annuities will be different depending the gender that we are analysing.

We have different baseline for mortality tables: #SPA07M / ##SPA07F, mortality weightings of 110%/100%, an adjustment of +3/-3 years and different proportion Married 80%/70% if we are considering a male/female member respectively. All of this inputs will affect the final annuity that is generated at the end. State different rules according to the gender is what is causing the difference on Annuities and this affects the final Protected Right Value that a specific person have to received.