



NUFFIELD CENTRE FOR EXPERIMENTAL SOCIAL SCIENCES
DISCUSSION PAPER SERIES

2011 - 003

Myopia, pension payments and retirement: An experimental approach

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March 2011

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March 19, 2011

Abstract

The behavioral economics literature on time discounting has suggested that individuals may systematically undersave when planning for retirement. Hence, pension systems have developed to enable, or indeed force, individuals to save more for retirement. Of course, the saving aspect and the timing of retirement are connected, in the sense that the expected length of retirement determines what is meant by adequate post-retirement resources, and vice versa. Despite this, the timing aspect rarely enters into policy discussions, although the same behavioural phenomena that lead to undersaving – in this paper, myopia and present bias – may also have implications for the retirement decision. Moreover, the form of pension payments may also affect the timing decision when individuals do not have time consistent preferences.

This paper presents a model of saving and retirement timing where saving rates are mandated, and pension payment may come in either a lump-sum or an annuity. It tests the model using data collected through a new experiment. The experiment presented has a particular novel feature which made it uniquely suited for testing the theoretical model. Specifically, participants in the experiment came back to the laboratory on a weekly basis over a two month period. This decision to return to the laboratory (or, to leave the experiment and collect a pension) became in itself the main variable of interest. The experiment therefore exploited the effort it takes for participants to come to the laboratory to capture preferences over time-use and leisure.

The results shown that plans over leaving the experiment tend not to reflect preferences, whilst actual leaving times were lower for more impulsive individuals and those who gave up more time to participate. This suggests a tradeoff between increasing saving through pension systems and earlier retirement. Payment group had no effect on retirement timing, most likely because the small rewards meant participants were indifferent between the two forms of payment. The results suggest individuals may have time-inconsistent preferences over leisure choices, leading to the incidences of unplanned early retirement.

1 Introduction

The decision about when to retire is influenced by a number of factors, including both personal factors such as health, which affects the expected length of retirement and the relative utility from leisure or the cost of work, and family arrangements, and financial factors such as pension wealth, entitlement to state benefits and personal savings. Hence, the design of pension schemes is obviously crucial. There are issues for policymakers thinking about pensions and retirement in both the accumulation and decumulation phase. For example, it is a well known result that many defined benefit schemes alter incentives to retire by increasing entitlements for each additional year worked above the actuarially fair rate. However, academic and policy discussion relating to the design of pension schemes often focus heavily on the saving aspect retirement planning. The behavioral economics literature on time discounting has suggested that individuals may systematically undersave when planning for retirement. Hence, pension systems have developed to enable, or indeed force, individuals to save more for retirement¹.

Of course, the saving aspect and the timing of retirement are connected, in the sense that the expected length of retirement determines what is meant by adequate post-retirement resources, and vice versa. Despite this, the timing aspect rarely enters into policy discussions, although the same behavioural phenomena that lead to undersaving may also have implications for the retirement decision. For example, the tendency of individuals to overvalue immediate consumption relative to later consumption is referred to as present bias – such individuals are referred to in this paper as myopic. It is captured in this paper by a specific form of present-biased time preferences known as hyperbolic discounting (Laibson, 1997). In terms of saving, this re-evaluation of immediate utility leads to higher consumption (and lower saving) than planned in pre-

¹There are a number of other reasons for the participation of the state in providing for retirement, set out in Diamond (1977) such as market failures in certain insurance markets, redistribution within and across generations and administrative cost efficiencies. However, the paternalism argument is a key feature of any policy discussion (see DWP, 2006, on reforms for encouraging individuals to save more)

vious periods. Some authors (e.g. Diamond and Koszegi, 2003; Bassi, 2008; Frogneux, 2009) have introduced these preference into consumption of leisure, leading to overconsumption of leisure which may result in unplanned early retirement. Holmes (2011) observed that policies designed to overcome undersaving (due to hyperbolic discounting) make unplanned earlier retirement more affordable, leading to a situation where attempting to resolve on set of time-inconsistent choices may cause other undesirable inconsistencies in a different area.

On the decumulation side of pension design, it is the size of a pension payout, rather than the form it takes which is seen as important within the existing literature. Under certain conventional assumptions about individual preferences, the choice between lump-sum or annuity, in an actuarially fair system, should have no effect on the retirement decision. Such analysis usually considers individuals with standard, time-consistent preference, operating in perfect capital markets. However, as the model developed in this paper will show, myopic individuals who receive their pensions lump-sum experience much greater incentives to take unplanned early retirement. The payoff to doing this is the extra utility from additional periods of leisure. A lump-sum pension payment reduces the costs of lower retirement consumption by allowing the retiree the possibility of much larger consumption in the immediate period, whereas an annuity receiver is limited to just the fraction of total wealth he or she receives in that period (assuming there are some form of credit constraints, so that individuals can not costlessly borrow against their annuity stream). Generally speaking, very little attention has been placed on the decumulation phase of the saving process in either academic or policy work, aside from papers which emphasize the utility costs of increased exposure to longevity risk arising from a shortage of actuarially fairly priced annuities. Evidence that annuities reduce incentives for unplanned early retirement would demonstrate another potential cost of thin annuity markets both to the individual – unplanned early retirement tends to lower some measure of overall lifecycle utility relative to

time-consistent plans, leading to regret – and the state and taxpayers, due to increased incidence of inadequate saving and the need for additional financial support to retirees.

This paper tests a model of retirement and saving using data collected through a new experiment. The experiment presented has a particular novel feature which made it uniquely suited for testing the theoretical model. Specifically, participants in the experiment came back to the laboratory on a weekly basis over a two month period. This decision to return to the laboratory (or, to leave the experiment) became in itself the main variable of interest. The experiment therefore exploited the effort it takes for participants to come to the laboratory to capture preferences over time-use and leisure.

The design of the experiment looked at two issues. Firstly, it looks at how individuals may be time-inconsistent in making plans and choices about leisure. Individuals were asked at the beginning of the experiment which future week they would like to leave the experiment in. The participants were not held to this choice, and were free to leave in whichever week they wanted. Within experimental approaches to time-inconsistency, the overwhelming focus is on choices over money or consumption, although there are a few other novel examples – for example, time-inconsistent preferences over long-run projects (Akin and Yavas, 2008) or environmental policies (Viscusi *et al.*, 2008). This experiment is, to my knowledge, the first designed specifically to capture time inconsistency in leisure choices. Secondly, the experiment tests the role of annuity pension payment in the context of the retirement decision. Contrary to the theoretical model set out in this paper, there is a view in the literature that lump-sum payments should increase the retirement age (Orzag, 2001; Fatas *et al.*, 2007), and so such payments may help deal with problems relating to the ageing population. I will argue that this existing evidence comes from experiments that do not feature a time component and consequently, do not allow for preference reversal. Therefore, this experiment provides a more comprehensive test of the theory.

These hypotheses are important to future policy debates about retirement, savings

and pensions. Firstly, policy is often focused on ensuring individuals save adequately for retirement, but little attention is given to the retirement decision. The model of Diamond and Koszegi (2003) suggests that the two need to be considered in tandem. To support this claim, it is essential to demonstrate the role that discounting may have on the retirement decision. Secondly, it should refocus discussion on the payout phase of pensions and saving schemes, an area which often been neglected in favor of the accumulation phase. Thin annuity markets are considered a problem because of the utility costs they impose on risk-averse individuals looking to insure themselves against longevity risk, as discussed above. There may be another cost resulting from more unplanned early retirement if individuals find they are limited to lump-sum payments because annuities are unfairly priced and limited in supply.

This paper is set out as follows. The next section sets out the motivation for conducting this experiment and identifies a theoretical and empirical gap. The model set out in this section leads to a number of testable hypotheses. Section 4 describes the proposed experiment and the methodology that will be used to test these hypotheses. Section 5 discusses the study and the data collected. Section 6 presents the results and section 7 concludes. As with all experimental approaches, it is important to distinguish between what has been shown in a lab setting, and what can be inferred in the real world. The conclusion emphasizes what lessons can be learned from this work in policy terms, and where further investigation may be usefully directed.

2 A theory of saving and retirement

In this section, a theory of retirement is presented where individuals have time-inconsistent preferences and payments from savings may come in different forms. In doing so, it provides a critique of existing evidence about the relationship between retirement and pension payments, and sets out a model which leads to a number of testable hypotheses which existing evidence is unable to provide any insight into, pointing towards the

need for a new approach.

2.1 Quasi-hyperbolic discounting, retirement and pension payments

Decision-making over time depends on the way individuals value immediate and future payoffs (where payoffs can be consumption, leisure or some other activity which gives affects their utility). There is no *a priori* reason to suppose that individuals discount future utility in such a way as to lead to time consistent plans (Strotz, 1956), and as a result, there is a large literature on the consequences of individuals who are myopic, impulsive and struggle with self-control.

There are numerous approaches to capturing myopic choice. Perhaps the most prominent are models with hyperbolic discounting. The hyperbolic discount function has the property of discounting utility more heavily in between two periods near to the present than between two identically-spaced periods further away in the future. If $D(t)$ is the discount function, with t being the time until receiving utility, then $D(t) = \frac{1}{\xi + \Gamma t}$ is a common specification for hyperbolic discounting, where ξ and Γ are constants.

I use the analytically convenient variant of hyperbolic discounting model: quasi-hyperbolic discounting. Specifically, if $D(t)$ is the discounting function, then:

$$D(t) = \begin{cases} 1, & t = 1 \\ \beta\delta^t, & t > 1 \end{cases} \quad (2.1)$$

In this formulation, δ is the conventional exponential discount factor, while β captures the extent to which individuals have a bias for utility today and are impulsive in their choices. A non-myopic individual is defined as one with $\beta = 1$, whilst a myopic quasi-hyperbolic discounter has $\beta < 1$. The quasi-hyperbolic discounting model maintains the property that delaying immediate consumption is more costly than delaying later consumption, but keeps some of the analytical simplicity of exponential

discounting. It is especially useful in discrete time models (Laibson, 1997).

The work of Diamond and Koszegi (2003) was the first to show an application of the quasi-hyperbolic discounting model to choices over retirement timing, where plans over when to take retirement may be time-inconsistent in the sense that individuals take unplanned early retirement. Holmes (2010) demonstrate that in some circumstances, the same myopic preferences which drive the possibility of time-inconsistent retirement timing keep savings low enough so that this is avoided. Building on that, Holmes (2011) argues that any mechanism which is designed to overcome inconsistent saving plans by committing the individual to higher saving rates may, at the same time, lead to unplanned early retirement. This may be conditional on the retiree having access to enough of his savings at the earlier retirement date. These elements are introduced in the following section.

2.2 Model

Consider an individual who lives for three periods, where they supply a unit of labour in each period prior to the retirement period, R . If l_t is the labour supply in each period, then $l_t = 1$ if $t < R$, and $l_t = 0$ otherwise. In each period that they work, they receive a wage w . In each period that they are retired, they receive leisure utility e . Utility from leisure is assumed separable from consumption utility. Individuals may retire in the second or third period: $R = \{2, 3\}$. There is a survival probability in each period, so $Pr(\text{alive in period 2—alive in period 1}) = p$ and $Pr(\text{alive in period 3—alive in period 2}) = q$. Therefore, $Pr(\text{alive in period 3}) = pq$

They are members of an actuarially fair defined benefit scheme, so there is an initial wealth, W_0 , a contribution rate, s , and a series of known pay-outs upon retirement. Specifically, if they receive a lump-sum payment and the individual retires in period 2, then they receive a pension payment of $\frac{W_0+s}{p}$. If they delay retirement to period 3, they receive a pension payment of $\frac{W_0+2s}{pq}$. Furthermore, if they receive these assets as

an annuity, they receive $\frac{W_0+s}{p(1+q)}$ in each period if they retire in period 2. Obviously, if they delay until period 3, their payment is identical regardless of their group.

Individuals have quasi-hyperbolic discount functions and constant relative risk aversion utility functions. Assume for simplicity that saving interest and exponential discount rates are zero, that borrowing is not possible, and that all individuals are characterized by the three preference parameters e , β and γ , so utility is expressed:

$$U_t = \frac{c_t^{1-\gamma}}{1-\gamma} + e(1-l_t) + \beta \left(\sum_{\tau=t+1}^3 \rho_\tau \frac{c_\tau^{1-\gamma}}{1-\gamma} + e(1-l_\tau) \right) \quad (2.2)$$

Finally, an individual in a lump-sum scheme who retires in the second period can allocate their lump-sum over the two remaining periods. Maximization of the utility function gives:

$$c_2 = \frac{W_0 + s}{p} \frac{(\beta q)^{-\frac{1}{\gamma}}}{1 + (\beta q)^{-\frac{1}{\gamma}}} \quad (2.3)$$

$$c_3 = \frac{W_0 + s}{p} \frac{1}{1 + (\beta q)^{-\frac{1}{\gamma}}} \quad (2.4)$$

2.2.1 Retirement plans

The decision over the optimal planned retirement period is found by a comparison of utility from $R = 2$ with utility for $R = 3$, assessed from the perspective of period 1.

Under the lump-sum scheme, an individual would plan to retire in period 2 if:

$$\frac{(w-s)^{1-\gamma}}{1-\gamma} + \beta \left(p \frac{\left(\frac{W_0+s}{p} \frac{(\beta q)^{-\frac{1}{\gamma}}}{1+(\beta q)^{-\frac{1}{\gamma}}} \right)^{1-\gamma}}{1-\gamma} + pq \frac{\left(\frac{W_0+s}{p} \frac{1}{1+(\beta q)^{-\frac{1}{\gamma}}} \right)^{1-\gamma}}{1-\gamma} + p(1+q)e \right) >$$

$$\frac{(w-s)^{1-\gamma}}{1-\gamma} + \beta \left(p \frac{(w-s)^{1-\gamma}}{1-\gamma} + pq \frac{\left(\frac{W_0+2s}{pq} \right)^{1-\gamma}}{1-\gamma} + pqe \right)$$

This can be solved to give a condition on e :

$$\begin{aligned} \Rightarrow (1-\gamma)e &> (w-s)^{1-\gamma} + q \left(\frac{W_0+2s}{pq} \right)^{1-\gamma} \\ &- \left(\frac{W_0+s}{p} \frac{(\beta q)^{-\frac{1}{\gamma}}}{1+(\beta q)^{-\frac{1}{\gamma}}} \right)^{1-\gamma} - q \left(\frac{W_0+s}{p} \frac{1}{1+(\beta q)^{-\frac{1}{\gamma}}} \right)^{1-\gamma} \end{aligned} \quad (2.5)$$

where $1 > \gamma \geq 0$. Following a similar calculation for an annuity scheme member, an individual would plan to retire in period 2 if:

$$(1-\gamma)e > (w-s)^{1-\gamma} + q \left(\frac{W_0+2s}{pq} \right)^{1-\gamma} - \left(\frac{W_0+s}{p(1+q)} \right)^{1-\gamma} - q \left(\frac{W_0+s}{p(1+q)} \right)^{1-\gamma} \quad (2.6)$$

From these two conditions it is easy that the value of e is an important determining factor. This leads to the following prediction:

Hypothesis 1: Individuals with a higher utility of leisure should plan to retire earlier.

The effect of the lump-sum (relative to the annuity) is seen by comparing the right hand side of equations (2.5) and (2.6). A larger right hand side value for the lump-sum equation implies that there will be some individuals who would retire earlier if they

received an annuity, but later if not. This is true if:

$$-\left(\frac{W_0 + s}{p} \frac{(\beta q)^{-\frac{1}{\gamma}}}{1 + (\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma} - q \left(\frac{W_0 + s}{p} \frac{1}{1 + (\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma} > -\left(\frac{W_0 + s}{p(1+q)}\right)^{1-\gamma} - q \left(\frac{W_0 + s}{p(1+q)}\right)^{1-\gamma}$$

which can be rearranged to give a final condition that lump-sum pensions encourage some individuals to retire later if:

$$\left(\frac{(\beta q)^{-\frac{1}{\gamma}}}{1 + (\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma} + q \left(\frac{1}{1 + (\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma} < \left(\frac{1}{1+q}\right)^{1-\gamma} + q \left(\frac{1}{1+q}\right)^{1-\gamma} \quad (2.7)$$

It can be shown that this is satisfied if γ is greater than zero and either β or q are less than one (if one of these conditions is not true, then the two sides are equal and payment forms have no effect). Hence:

Hypothesis 2: Lump sum payment saving schemes will cause a higher incidence of later planned retirement than annuity payment schemes.

Moreover, the gap between the left-hand and right-hand sides of equation (2.7) reflects the larger proportion of early retirees under the annuity scheme i.e. the wider the gap in equation (2.7), the wider the range of values of e which might only be satisfied in equation (2.6) but not in equation (2.5). Equation (2.7) shows that the more impulsive the individual is (the lower β is), the wider the gap will be. This is because an decrease in the β parameter lowers only the left hand side of this condition, reflecting the lower utility (from the point of view of period 1) of taking a lump-sum and overconsuming in the second period. From the point of view of the period 1 planner, annuities have a

commitment value, which means they could take earlier retirement without being concerned that they will have limited remaining resources in the final period. Thus, the measure of impulsiveness has some role in determining the retirement plans of the two payment groups. This gives:

Hypothesis 3: Impulsiveness increases the incidence of later retirement in the lump-sum group, relative to the annuity group.

In addition to Hypothesis 3, impulsiveness alone should not have a partial effect on retirement timing, only an effect through the interaction with group membership.

On the other hand, increasing γ (increasing risk aversion) at first widens the size of this gap, but after a certain point, begins to decrease it. Therefore, the measure of risk aversion has an ambiguous effect on the retirement plans of the two groups. The preference for delaying retirement in the lump-sum group is driven by the utility loss (from the period one perspective) from either too high period 2 consumption (due to the quasi-hyperbolic discounting) or greater exposure to longevity risk under the lump-sum scheme (due to $q < 1$ and risk aversion).

2.2.2 Actual retirement

The actual retirement decision takes place in period 2 – either the individual takes immediate retirement or delays it until the final period. The individual in a lump sum scheme would take immediate retirement if:

$$\frac{\left(\frac{W_0+s}{p} \frac{(\beta q)^{-\frac{1}{\gamma}}}{1+(\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma}}{1-\gamma} + e + \beta q \left(\frac{\left(\frac{W_0+s}{p} \frac{1}{1+(\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma}}{1-\gamma} + e \right) >$$

$$\frac{(w-s)^{1-\gamma}}{1-\gamma} + \beta q \left(\frac{\left(\frac{W_0+2s}{pq}\right)^{1-\gamma}}{1-\gamma} + e \right)$$

As before, this can be rearranged to give a condition for early retirement on e :

$$\begin{aligned} \Rightarrow (1-\gamma)e &> (w-s)^{1-\gamma} + \beta q \left(\frac{W_0+2s}{pq}\right)^{1-\gamma} \\ &- \left(\frac{W_0+s}{p} \frac{(\beta q)^{-\frac{1}{\gamma}}}{1+(\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma} - \beta q \left(\frac{W_0+s}{p} \frac{1}{1+(\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma} \end{aligned} \quad (2.8)$$

By a similar process, the individual in an annuity scheme will retire in period 2 if:

$$(1-\gamma)e > (w-s)^{1-\gamma} + \beta q \left(\frac{W_0+2s}{pq}\right)^{1-\gamma} - \left(\frac{W_0+s}{p(1+q)}\right)^{1-\gamma} - \beta q \left(\frac{W_0+s}{p(1+q)}\right)^{1-\gamma} \quad (2.9)$$

This leads to:

Hypothesis 4: Individuals with higher utility of leisure will retire earlier.

Lowering β increases early retirement across both groups by reducing the threshold from the term $\beta q \left(\frac{W_0+2s}{pq}\right)^{1-\gamma}$, which appears in both of the above conditions.

Hence:

Hypothesis 5: More impulsive individuals will retire earlier.

In addition, the lump sum would lead to more people taking early retirement than the annuity scheme if:

$$\left(\frac{(\beta q)^{-\frac{1}{\gamma}}}{1 + (\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma} + q\beta \left(\frac{1}{1 + (\beta q)^{-\frac{1}{\gamma}}}\right)^{1-\gamma} > \left(\frac{1}{1+q}\right)^{1-\gamma} + \beta q \left(\frac{1}{1+q}\right)^{1-\gamma} \quad (2.10)$$

This is satisfied if risk aversion is not too high and that q is not too low. As the value of γ increases and q decreases, the immediate utility gain to a myopic individuals of early retirement is outweighed by the exposure to longevity risk. Tables 2.1 and 2.2 show this.

Table 2.1: Payment system causing higher incidence of early retirement, $q = 0.9$

	β		
γ	0.5	0.7	0.9
0.2	Lump-sum	Lump-sum	Annuity
0.5	Lump-sum	Annuity	Annuity
0.8	Lump-sum	Annuity	Annuity

Table 2.2: Payment system higher incidence of early retirement, $q = 0.5$

	β		
γ	0.5	0.7	0.9
0.2	Lump-sum	Lump-sum	Annuity
0.5	Annuity	Annuity	Annuity
0.8	Annuity	Annuity	Annuity

The effect of being in the lump-sum group is therefore ambiguous on the final distribution of retirement decisions. When $q < 1$, it depends on the relative number of low- β individuals relative to high- γ households, with the former more likely to retire early under the lump-sum scheme and the latter more likely to retire early under the annuity scheme. However, in the case where $q = 1$, there is no longevity risk, so annuities act as a commitment mechanism over consumption, lowering utility to the period 2 individual by not allowing for a free choice over consumption. In this case, the

lump-sum always leads to more earlier retirement than the annuity scheme, as equation (2.10) is always satisfied for any combination of β and γ . Hence:

Hypothesis 6: Lump sum payment saving schemes lead to a higher incidence of early retirement than annuity payment schemes (if q is sufficiently high)

2.2.3 Inconsistencies

There is a welfare cost from unplanned early retirement. The scale of this potential inconsistency can be expressed by subtracting the threshold for leisure utility in condition (2.8) from that in condition (2.5) for the lump-sum group, and the threshold for leisure utility in condition (2.9) from condition (2.6) for the annuity group. If the former is smaller than the later, then there is unplanned early retirement, with the magnitude of the different indicating the range of individuals that would be affected by it. If this gap is labeled G_{ls} and G_a for lump-sum and annuities respectively then:

$$G_{ls} = q(1 - \beta) \left(\left(\frac{W_0 + 2s}{pq} \right)^{1-\gamma} - \left(\frac{W_0 + s}{p(1 + (\beta q)^{-\frac{1}{\gamma}})} \right)^{1-\gamma} \right) \quad (2.11)$$

$$G_a = q(1 - \beta) \left(\left(\frac{W_0 + 2s}{pq} \right)^{1-\gamma} - \left(\frac{W_0 + s}{p(1 + q)} \right)^{1-\gamma} \right) \quad (2.12)$$

As the term in brackets is positive – the positive item is larger than the negative item in both cases, as the numerator is larger and the denominator is smaller) then this leads to:

Hypothesis 7: Impulsiveness drives unplanned early retirement.

Finally, G_{ls} and G_a differ by the negative final term. By observation, the term in G_{ls} will be smaller than in G_a , when $\beta < 1$ and $\frac{1}{\gamma} < -1$. Therefore:

Hypothesis 8: Lump sum payment saving schemes lead to a higher incidence of unplanned early retirement than annuity payment schemes

3 Testing the model

This paper looks to test these hypotheses using a laboratory experiment. The only existing experiment which has looked at retirement and pension payouts is by Fatas *et al.* (2007). This looks at ways to encourage later retirement through the design on pension payouts, which would help ease the financing pressures currently faced on pension schemes worldwide by reducing the dependency ratio (the number of retirees to employees in an economy). The paper argues that whilst much of the existing literature has focused on the way that pension schemes may encourage earlier retirement because after a certain age the accumulation of further pension rights is not actuarially fair (leading to an implicit tax on labour force participation), there may be distortions even within an actuarially fair system arising through the timing of pension payments. They propose a number of behavioral reasons for this, such as greater patience for larger rewards, hyperbolic discounting, and an inability to compute complicated payments².

They tested this hypothesis using a laboratory experiment. The experiment had fifteen rounds, each with a given conditional probability of surviving, and participants

²As will be discussed later in this section, the explanation relating to hyperbolic discounting is not convincing for two reasons. Firstly, it fails to take into account the potential time inconsistency in the leisure choice – annuities limit immediate consumption, which make unplanned early retirement less affordable. Secondly, hyperbolic discounting causes impulsiveness. It implies high discount rates for immediate pay-offs, which would have a larger negative effect on delaying lump-sum payments, rather than annuities. Part of an annuity's value is received much later on, when discount rates are much lower and individuals are more patient, implying they would, in part, be more willing to delay retirement to receive higher payments.

were asked to choose a round to determine their payoffs. This is the equivalent of a retirement age, where individuals receive their pension once they have left. Participants received their pension as either a lump-sum or an annuity, which they knew about in advance. The two schemes are actuarially fair - regardless of retirement timing, the expected payment is equal to 100.

The authors found that the retirement age was significantly higher for those in the lump-sum group than in the annuity group. However, there are several important problems with this approach that casts doubt over this conclusion. First of all, this experiment does not consider time – the experiment is played within a single session, so regardless of the choice of round, payment was made at essentially the same time. Essentially, then, this experiment offered a choice between lotteries with equal expected values, rather than choices over time. Secondly, as a consequence of not looking at the time dimension, the experiment has no role for the utility of leisure (or the disutility of work) and the effect this may have on the retirement decision. Individuals are maximizing their monetary payoff alone, given their attitudes towards risk and their perception about rewards (the experiment does not explain how actuarially fair pension work, so participants are left to make their own evaluation about their expected payments). Finally, and most importantly, the reported retirement ages are planned, rather than actual. By the design of the experiment, there is no scope for changing plans, whereas the contention of this paper is that lump-sum pensions are more likely to lead to unplanned earlier retirement. In contrast, the experiment presented in this paper captures all of these elements.

4 Experimental design

This section sets out the design of the experiment. Participants were allocated to either the lump sum group or the annuity group upon arrival in the first week. They were informed of their group, and given a reminder card to take away. In the first experimental

session, they completed three games: the Delayed Reward game, the Preferred Lottery game and the Retirement game.

4.1 Delayed Reward game

All participants, regardless of their group, completed a money pairs exercise. This is called the Delayed Reward Game. This is designed to time preferences by fitting a quasi-hyperbolic discount function. Each question in this exercise had the same form:

- Respondents are asked to state their preference between $\pounds x$ today and $\pounds y$ after a delay of t , where $x = \{1, \dots, 15\}$, $y = 15$ and $t = \{1 \text{ week}, 2 \text{ weeks}, 3 \text{ weeks}, 1 \text{ month}, 2 \text{ months six months}\}$
- The choice pairs start with smallest delay ($t = 1 \text{ week}$) and the smallest immediate reward ($x = \pounds 1$)
- x is increased by $\pounds 1$ increments. At some point, the individual will shift to preferring the immediate reward. The indifference point lies between those two reward-pairs.
- Once x reaches its maximum value, the delay move to next smallest ($t = 2 \text{ days}$). Process repeats for all t .
- Three choices were chosen at random to receive payment based on reported preference.

4.2 Preferred Lottery game

Secondly, the individuals completed an exercise to measure their risk preferences. This game again asks participants to choose between two possible rewards, however instead of an immediate and a delayed reward, the choices are between a certain payment and a lottery, which only pays out a certain amount with a given probability (otherwise it pays nothing). The procedure is as follows:

- Respondents are asked to report preference between $\pounds x$ for certain and $\pounds y$ paid with a probability of z , where $x = 0.50, \dots, 10$, $y = 10$ and $z = \{0.2, 0.5, 0.8\}$
- Probability is explained as a random draw from a bag of ten balls, where $10z$ of the balls are red, and the remainder are black. The lottery pays out if the participant draws a red ball.
- The choice pairs start with smallest certain payment ($x = 0.50$) and the simplest lottery ($z = 0.5$).
- x is increased until individual prefers certain payment. This is the certainty equivalent of the lottery.
- Repeat for other two lotteries.
- Two choices are chosen at random to receive payment based on reported preference.

4.3 Retirement game

Finally, the individuals were shown the Retirement game, which is the main part of the experiment, as it collects the dependent variables in this analysis: planned and actual weeks for leaving the game, and hence the inconsistencies between the two. The rules, which were explained to the participants, were as follows:

- This game is conducted over eight weeks. Every week participants are asked to come back to the lab. These sessions last approximately ten minutes. The sessions were at the same time each week.
- The experiment pays participants based on their choices, as follows. Each week that a participant comes to the lab, they receive a wage of $\pounds 4$. Half of that wage – $\pounds 2$ – can be taken away at the end of the session. The remaining half is saved.

- Participants are told that they can stop coming to the lab any week. When they do they will begin to receive their savings. Depending on which group they have been allocated to, they either receive all of their savings as one lump-sum on the week when they stopped coming to the lab, or they receive the pot as regular equal payments over the remaining weeks of the experiment.
- The saving pot earns a 0% interest rate.
- Participants are told that they will not have to come to the lab to receive their savings. The savings are paid directly to the participants at their postal address³.
- Participants are told that as they only get the savings after they leave the game and that the game only lasts for eight weeks, then, no-one is expected to come to the lab in week eight.

The retirement payments are summarized in Table 4.1.

Table 4.1: Retirement game payouts

Period, t	Lump-sum	Annuity
1	–	–
2	2.00	0.29
3	4.00	0.67
4	6.00	1.20
5	8.00	2.00
6	10.00	3.33
7	12.00	6.00
8	14.00	14.00

Participants were then shown a card which describes the payments they will receive in each week, given a particular leaving week. They were only shown the payments for the group they are in – either annuity or lump sum. They could read off, for a given a week of leaving the experiment the exact amount that they would be paid each week. The participants were given the opportunity to ask questions about the instructions,

³As all the participants were students, payments were made to their university pigeon holes

after which, participants are asked to report in which week they would most prefer to leave the game and not return to the lab.

On the basis of a experimental trial, survival probabilities were not included in the final design, as they appeared to confuse participants.

4.3.1 Individual information

At the end of the experiment, individuals complete a short questionnaire to collect basic data on age, gender and status (as all participants were students, this distinguishes between undergraduates and postgraduates). It also includes two measures of how arduous participating in the experiment is. Firstly, it asks how much time the individual has to give up to come to the laboratory, excluding time spent in the laboratory – essentially, this captured traveling time to the laboratory from the participants' home or place of work. Secondly, it asks whether any monetary costs were incurred by the individual in coming to the lab. Examples include bus fare (or similar) and any lost earnings.

4.3.2 Follow-up experiments

All the sessions after week one are linked to the Retirement game. In all these sessions, participants completed some variation of one of the games played in the first week. This simulates work in the experiment, so that not returning to the lab in a week is taken as retirement. The table 4.2 below summarizes the games played.

The week where the participant did not return to the laboratory was recorded. All the data collected in the follow-up sessions was only of secondary importance to the main retirement experiment. The main purpose of these tasks was to give participants a mundane and predictable task to complete whilst in the laboratory. Responses to these tasks are not analysed in this paper.

Table 4.2: Follow-up experiments

Week	Game	Variation
2	Delayed Reward	Larger rewards
3	Delayed Reward	Rewards were a 'holiday' from a hypothetical time commitment
4	Delayed Reward	Larger rewards
5	Retirement Game	Hypothetical, shorter periods
6	Delayed Reward	None
7	No game	Individuals were told they had no tasks upon arrival

5 Data

The experiment was conducted using 30 University of Oxford student volunteers, both undergraduate and postgraduate, who were contacted to participate by the Centre of Experimental Social Sciences at Nuffield College, University of Oxford. As the experiment was conducted over eight weeks, a judgement was made that non-student volunteers would be less likely to be able to commit to a certain time and more likely to experience unexpected changes in their schedule that would prevent them from returning. Moreover, focusing on student volunteers allowed payment of their post-retirement earnings to be completed without the individual needing to give up any more of their time, which was important in distinguishing between the 'work' phase and the 'retirement' phase of the experiment, but without having to use the postal service. All post-retirement savings were left at the students' pigeon holes in their respective colleges, which are conveniently central for delivery.

The experiment was conducted in two waves, the first of 15 students between January and March 2010, and the second of 15 students between April and June 2010. Each participant was informed in advance of the time requirements that would be asked of them, and asked to volunteer only if they believed the time of each session was available. The first session lasted 90 minutes, and participants were paid £8 for showing up, comprising a £6 participation payment and a further £2 which was their weekly wage for the first week. In addition £2 was placed in each individuals saving account. In the

first session, individuals played the Delayed Rewards Game, the Retirement Game and the Preferred Lottery Game. In addition to their show-up fee, five of the choices from the Delayed Rewards Game and the Preferred Lottery Game were selected at random and payment was made based on those choices. Individuals were randomly allocated into one of the two groups (Annuity and Lump-Sum) by drawing a number which corresponded to a computer terminal in the lab. The first half of the terminals were in the Lump-Sum group and the remainder in the Annuity group.

Each following session lasted approximately fifteen minutes. Remaining participants were emailed two days before the experiment to remind them of the time of the next session, and were told how much they had currently accumulated, how much they would receive if they left the game that week, dependent on which group they were in, and how much they would receive if they came to the lab that week. They were asked to email the CESS lab if they could not attend a session for some exogenous reason (such as illness or an appointment), rather than because they did not want to return anymore. These individuals were treated as if they had retired from the game and so did not return in future weeks, however, their data is essentially incomplete. Three participants data was removed from the experiment because they were unable to attend a session due to external commitments.

The experiment was programmed and conducted using the software z-Tree (Fischbacher, 2007).

5.1 Discount functions

Discount functions are identified from the indifference points between immediate and delayed choices. The aim is to produce a measure of an individual's impulsiveness. For a quasi-hyperbolic discounter, this is the variable β in the discount function:

$$D(t) = \beta\delta^t \tag{5.1}$$

Utility is assumed to be linear in the reward. Let X_{it} be the immediate reward where participants switch from delayed reward to immediate reward (when the immediate reward option is ascending) and the final immediate reward prior to the point where individuals switch from delayed reward to immediate reward (when the immediate reward is descending). This is the point that will be used as the indifference point between the immediate and delayed rewards. This point was chosen rather than the mid-point of the two rewards where preferences change from delayed reward to immediate reward because there are a number of individuals who always choose the delayed reward of £15 except when the immediate reward is also the same. If the midpoint between the switching pairs was used, this would be at 14.5 for all values, implying $\beta < 1$ and $\delta = 1$. It seems much more probable that these participants' discount functions have $\beta = 1$ and $\delta = 1$.

It would be possible to construct a complicated model to estimate using maximum likelihood. However, for simplicity, it is possible to get a reasonable first approximation of the discount function, and crucially the measure of impulsiveness by estimating the two preference parameters via ordinary least squares (OLS) estimation of the following:

$$\ln X_{it} = \ln(15\beta_{it}) + t \ln \delta_{it} + e_{it} \quad (5.2)$$

where e_{it} is distributed normally with a mean of zero.

By doing both ascending and descending rounds for each delay, some errors in reporting are mitigated. The Delayed Reward data was cleaned where one indifference point is missing because the participants report preferring delayed rewards for all immediate rewards, with the response for the alternative question used in its place. One participant's data was dropped because their reported time preferences seemed to be

far outside of the quasi-hyperbolic discounting framework ⁴.

As there may be some error in estimating the preference parameter β , I create a dummy variable for being impulsive (or being a quasi-hyperbolic discounter rather than an exponential discounter), which takes a value of 1 if $\beta < 0.94$. This cut-off point was conveniently suggested by the data, as there are two clear groups observable with the estimation: $\beta < 0.94$ and $\beta > 0.98$.

Table 5.1 below summarizes the estimation of the discount functions for participants.

5.2 Risk preferences

Risk preferences were identified using reported certainty equivalents. I assume a constant absolute risk aversion functional form for the individuals preferences, because estimating this did not require knowledge of the participants total wealth. Hence, we have a series of observations.

$$u_i(x_p) = pu_i(10) + (1 - p)u_i(0) \quad (5.3)$$

where x_p is the amount the individual receive for certain that make him or her indifferent to a lottery which £10 with probability p and zero with probability $1 - p$, and $u_i(x) = -\exp -\gamma x$. Following a similar method to the estimation of the discount function, I derive a second order approximation of the utility function: $-\exp -\gamma x \approx 1 + \gamma x - \frac{\gamma^2}{2}x^2$.

To get a measure of risk, the following equation is estimated using ordinary least squares and the indifference points $\{X_p\}_{p=0.2,0.5,0.8}$.

⁴They reported a preference for the immediate reward only if it was £15 in all cases, except for the longest delay, when they preferred any immediate payoff to the delayed £15

$$(X_p - 10p) = \frac{\gamma}{2} (X_p^2 - 100p) + e_p$$

where e_p is error term which is assumed to be normally distributed with a zero mean. Again, this method does not accurately derive risk preferences particularly as there is only three observations in the Lottery game. However, it does give a measure of the risk preferences and the curvature of the individual's utility function. As with the time preferences, I add a variable for the individual being risk averse (over small rewards) which takes the value of 1 if $\gamma > 0.03$. Again, this cut-off point was suggested by the data, as almost all the observations fall into one of two groups: $\gamma > 0.03$ and $\gamma < 0.00$, with the latter also including apparently risk-loving individuals. Two participants did not give indifference points for one or more of the lotteries (stating that they preferred all lotteries to the for-certain amount), so their risk preference parameter is missing.

5.3 Leisure utility

The final preference parameter captured by the experiment is the the value the individual places on the time they give up to participate each week. After each week's experiment, participants were asked how much time and money they had given up to participate in the experiment. No participants reported a monetary cost of participating, so the measure of leisure utility will focus on the time cost. For consistency, they were asked not to include time actually spent in the laboratory.

Initially, the measure of the leisure utility was going to be the first week's response, which everyone gave answers to. However, the data revealed two possible problems with answers to this question. One respondent reported giving up 105 minutes to come to the laboratory on the first week, and 5 minutes in the subsequent week, before leaving the experiment. A second participant reported giving up 120 minutes for the first

week experiment, and did not return in following weeks to validate this. One explanation of this is that they had included the length of the experiment in their answer for the first week. Including such high value outliers, especially for early leavers, might bias the results.

To deal with this problem, two measures of time cost were derived, both of which are tested in the statistical analysis as they each have potential problems. The first used the first week's reported time but omitted any response above 90 minutes, which was the length of the experiment that week. The second was the mean reported amount of time given up to participate across all weeks where individuals returned to the laboratory, up to the fifth week. Again, the two participants reporting above 90 minutes in the first week were omitted. This has the advantage of smoothing out any erroneous responses to this question over the course of the experiment. However, it has a number of disadvantages as well. Firstly, participants may learn to incorporate the trip to the lab into their schedule in less costly ways. This information is not useful for planned retirement, which should be based on anticipated costs of coming to the lab in week 1, not any subsequent adaptation. Secondly, this is a methodologically inconsistent measure, because for some participants it takes just one observation, whereas for others it takes five. These observations are noisy measures of time cost. For example, participants may conveniently find themselves nearer the lab one week, or have further to travel to their next appointment the following week. This may mean that the measurement errors of this variable are correlated with the actual retirement decision.

Using this time as a measure of the disutility of coming to the lab assumes that all participants have equal utility values for time. The participants were selected from undergraduate and postgraduate students at Oxford University, which is a relatively homogeneous group, particularly in terms of demands on their time. There may be some variation between postgraduate and undergraduate valuations of time – due to different workloads, responsibilities and employment.

Table 5.1: Estimates of preference parameter for experiment participants

Subject no	BETA	DELTA	IMPULSIVE	GAMMA	RISK AVERSE	TIME1	TIME2
1	1.000	1.000	No	0.044	Yes	20.00	1.003
2	0.983	0.997	No	0.056	Yes	20.00	0.00
3	1.104	0.917	No	-	-	20.00	13.33
4	1.063	0.960	No	0.007	No	5.00	2.00
5	0.917	0.977	Yes	0.025	No	20.00	15.00
6	0.896	0.987	Yes	0.031	Yes	40.00	27.00
7	0.807	0.961	Yes	0.032	Yes	30.00	30.00
8	0.884	0.954	Yes	-0.009	No	20.00	20.00
9	0.898	0.972	Yes	0.0000	No	20.00	20.00
10	1.000	1.000	No	-	-	30.00	30.00
11	1.043	0.896	No	0.027	No	1.00	4.20
13	0.880	0.958	Yes	0.000	No	20.00	17.50
14	1.008	0.982	No	0.031	Yes	30.00	33.00
15	0.850	0.960	Yes	-0.002	No	-	-
16	1.046	0.982	No	0.032	Yes	0.00	23.00
17	0.986	0.994	No	-0.006	No	10.00	7.50
18	0.936	0.981	Yes	0.016	No	-	-
20	0.986	0.984	No	0.062	Yes	0.00	0.00
21	0.919	0.984	Yes	-0.047	No	60.00	60.00
22	1.141	0.892	No	0.035	Yes	40.00	41.25
23	0.939	0.998	Yes	0.000	No	60.00	60.00
25	0.960	0.992	No	0.014	No	2.00	21.40
26	1.000	1.000	No	0.061	Yes	0.00	0.00
27	1.014	0.985	No	0.062	Yes	2.00	3.50
29	1.001	0.981	No	0.053	Yes	10.00	10.00
30	1.017	0.990	No	0.000	No	10.00	10.00

Table 5.1 gives the estimated preference parameters for the 26 participants used in the subsequent analysis.

6 Results

Figures 6.1 and 6.2 show the actual retirement decisions of participants in each group, and the gap between this and their planned retirement.

The statistical analysis looks at planned and actual retirement and the retirement gap in turn.

Figure 6.1: Leaving weeks and gaps between planned and actual weeks, lump sum group

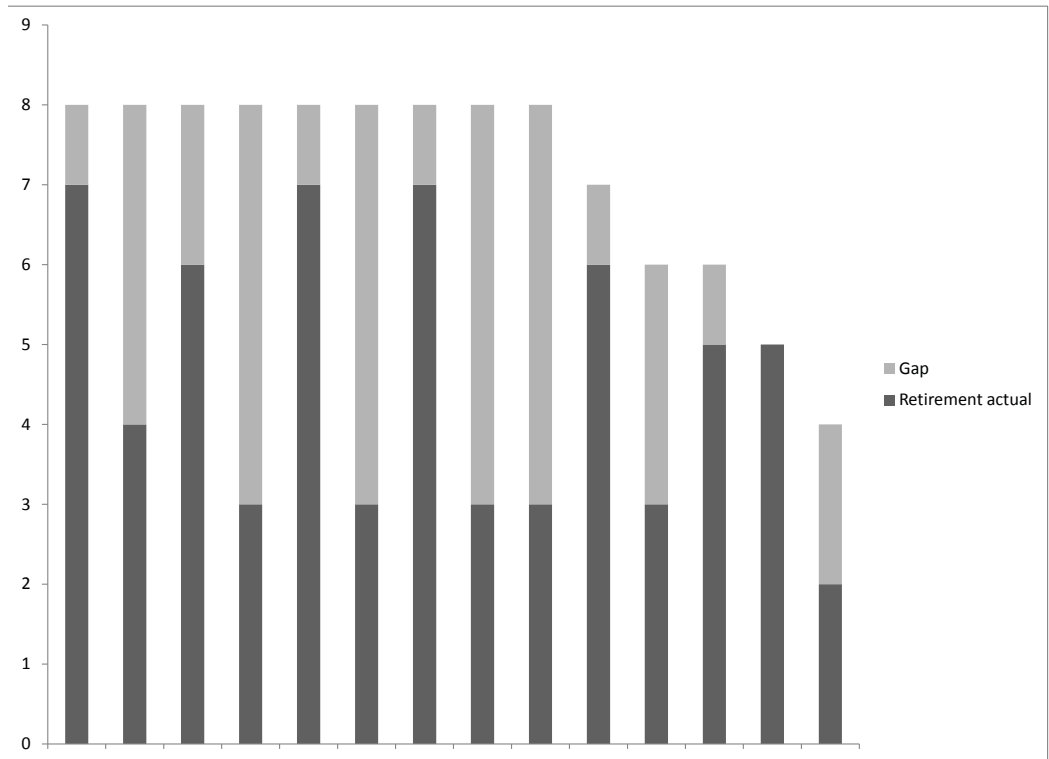
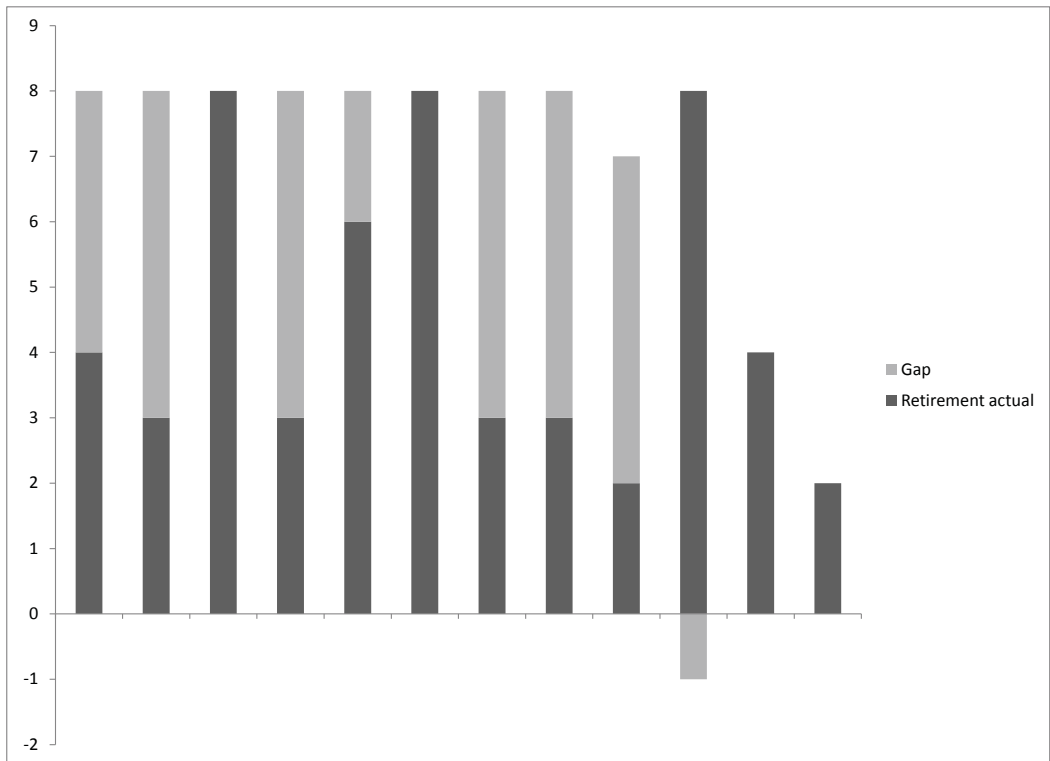


Figure 6.2: Leaving weeks and gaps between planned and actual weeks, lump sum group



6.1 Planned retirement

Firstly, consider the planned leaving week reported in the first week experiment. The most striking observation is that a large majority – around 65% of participants – reported that they would remain in the experiment until the final week. There is much more variation in the actual week of leaving. Moreover, there is very limited correlation between plans and actual leaving week - a simple correlation calculation estimates $r = 0.32$, while the p-value of a Kendall's τ test of the hypothesis that the two variables are independent is 0.208. This suggests that many participants did not necessarily make their decision in the way that reflected their actual preferences. One possibility is that some participants fixated on the eighth week because they were told in advance that this was an eight-week experiment and that to participate, they needed to be available at the same time over that period. Alternatively, they may have fixated on the largest total payoff, and disregarded other information (for example, how costly it was, in terms of time and effort, to come to the lab).

It is interesting to compare the mean characteristics of the two types of participants – those that reported a plan to remain in the experiment until the final week, and those who reported a plan to leave at some point prior to that – to see whether there are any significant differences between their respective members. These data shows that there are no significant differences by either measure of leisure utility e , impulsiveness (either the raw measure β , or the dummy variable), impatience (from the estimated parameter δ), risk aversion (either the raw measure γ or the dummy variable) or payment group. However, there does appear to be differences between the two groups of individuals in terms of the time consistency of the plans they made, captured by the gap between planned and actual retirement. This is true for both the raw gap, and for a dummy variable which takes a value of one if the magnitude of the gap is no more than one. Table 6.1 shows the differences between the mean values of all these variables across the two groups. Differences are tested using a one-side Student's t-test of the

Table 6.1: Average characteristics of planners and non-planners

	Mean			p-values	
	Non-planner	Planner	Difference	Student's t-test	Mann-Whitney U-test
DELTA	0.9750	0.9677	0.0073	0.720	0.553
BETA	0.9662	0.9836	-0.0173	0.314	0.627
IMPULSIVE	0.4118	0.3333	0.0784	0.355	0.701
CARA	0.0228	0.0198	0.0030	0.391	0.830
RISK AVERSE	0.5000	0.3750	0.1250	0.293	0.571
TIME COST1	16.813	25.125	-8.313	0.141	0.237
TIME COST2	17.420	23.494	-6.073	0.207	0.500
LUMPSUM	0.5294	0.5556	-0.0261	0.453	0.901
GAP	3.2353	1.2222	2.0131	0.010***	0.025**
INCONSISTENT	0.7059	0.3333	0.3725	0.042**	0.073*
<i>N</i>	<i>17</i>	<i>9</i>			

Significance: * = 10% level or less, ** = 5% level or less, *** = 1% level or less

means (where the inequality is determined by common sense, so, for example, a test whether planners are less impulsive or impatient, or by the actual sign of the difference if no common sense prediction exists) and the Mann-Whitney U-test. It shows the the individuals who planned to retire earlier than week eight actually left the experiment more than two weeks closer to their plan than the other group. To an extent, this supports the interpretation of some of this latter group as non-planners in the sense that their response did not represent their actual preferences over these choices over time but instead reflected some other motivation.

Given that, it is unsurprising that planned retirement is hard to predict. In terms of the predictions of the theory, payment type should delay planned retirement. Planned retirement weeks are compared between the two payment groups. using both Student t-tests and Mann-Whitney U-tests. The same tests are computed for the subsample classed here as planners for comparison. The results are shown in Table 6.2. The table also compares the difference in planned retirement between the two groups distinguished by impulsiveness and risk aversion, for completeness.

Payment group has no effect on the planned retirement age for either the full sample or the smaller subsample of planners. There is also little evidence that impulsiveness

Table 6.2: Planned retirement tests

	Mean retirement			p-values	
	Annuity	Lump-sum	Difference	Student's t-test	Mann-Whitney U-test
All	7.00	7.14	-0.14	0.414	0.928
<i>N</i>	12	14			
Planner	5.00	5.60	-0.60	0.319	0.900
<i>N</i>	5	4			
	Non-impulsive	Impulsive	Difference	Student's t-test	Mann-Whitney U-test
All	7.25	6.80	0.45	0.251	1.000
<i>N</i>	16	10			
Planner	6.00	4.00	2.00	0.052*	0.112
<i>N</i>	6	3			
	Risk neutral	Risk averse	Difference	Student's t-test	Mann-Whitney U-test
All	6.62	7.75	-0.930	0.091*	0.369
<i>N</i>	13	11			
Planner	4.40	6.63	-2.23	0.066*	0.129
<i>N</i>	5	3			

Significance: * = 10% level or less, ** = 5% level or less, *** = 1% level or less

or risk aversion mattered in this decision, even for the subsample. More impulsive and less risk averse individuals plan to leave the experiment earlier on average; however, these differences are not significant (at the 10% level) when evaluated using the non-parametric Mann-Whitney test. Note, however, that impulsiveness and risk aversion are not predicted to have a standalone effect on planned retirement from the model, but through their interaction with payment group. Investigating this interaction further is not possible, given the lack of variation in the planned retirement decision. Moreover, as payment group is not an important factor in either planned or, as shown in the next section, actual retirement choices (likely because of the small-rewards nature of the experiment) then it seems unlikely such interaction effects would be found.

The other variable predicted to explain anything about planned retirement is the cost of time. Table 6.3 shows estimates of correlations between planned retirement and both of the time cost variables. Moreover, it presents the p-values of two non-parametric tests of the hypothesis that these two variables are independent.

These tests were also replicated for the planner sub-sample, and in all cases, no

Table 6.3: Correlation tests between time cost and planned retirement

	Pearson's r	Spearman's ρ	Kendall's τ
TIME1	-0.368* (0.077)	-0.268 (0.206)	-0.160 (0.193)
TIME2	-0.361* (0.083)	-0.176 (0.410)	-0.120 (0.340)

Significance: * = 10% level or less, ** = 5% level or less, *** = 1% level or less

correlation was significant at the 10% level.

In conclusion for this section, participants did not, in general, make plans over their leaving that reflected preferences over discounting, risk or the cost of their effort, nor their payment group. Participants may have fixated on week 8, having been told in advance that the experiment ran for up to eight weeks and that only people who had this time free to potentially come to the lab should apply. It is also possible that they were not able to appreciate the costs involved in making their decision. For example, they may not have had an understanding of how arduous the act of routinely coming back to the lab may have been, and, disregarding this aspect of the choice, focused purely on the potentially monetary reward, which is maximised in the final week.

Although this has proven less useful for investigating the hypotheses set out in the model, it has raised some interesting issues about the way individuals may make plans over time. Further experiments of this sort should attempt to incentivise participants to report plans which better reflect preferences. Moreover, they should take into account the possibility of learning – that is, where individuals make choices based on their preferences, but with poor information about the future costs of those plans. In this case, it may be the individuals did not really appreciate how costly or inconvenient coming to the lab would be for them.

6.2 Actual retirement

Unlike the reported planned retirement, actual retirement should reflect actual preferences. Figures 6.1 and 6.2 show that there is significantly more variation in actual

leaving weeks compared to planned leaving weeks. The theory predicts that impulsiveness, payment group and time costs should all impacted upon actual leaving week. To test the first two, I compare retirement ages across the two groups, as shown in Table 6.4 below.

Table 6.4: Actual retirement tests

Mean retirement			p-values		
	Non-impulsive	Impulsive	Difference	Student's t-test	Mann-Whitney U-test
	5.31	3.30	2.01	0.005***	0.011**
<i>N</i>	16	10			
	Annuity	Lump-sum	Difference	Student's t-test	Mann-Whitney U-test
	4.50	4.57	-0.07	0.465	0.833
<i>N</i>	12	14			

Significance: * = 10% level or less, ** = 5% level or less, *** = 1% level or less

These tests show that impulsiveness is a significant factor in predicting actual retirement timing. Impulsive participants leave the experiment approximately two weeks earlier than non-impulsive participants. Payment group, on the other hand, had no significant effect.

The role of time cost on actual retirement is again tested by looking at correlations, show in table 6.5

Table 6.5: Correlation tests between time cost and actual retirement

	Pearson's <i>r</i>	Spearman's ρ	Kendall's τ
TIME1	-0.330 (0.115)	-0.333 (0.112)	-0.243* (0.087)
TIME2	-0.288 (0.171)	-0.242 (0.254)	-0.170 (0.241)

Significance: * = 10% level or less, ** = 5% level or less, *** = 1% level or less

The first measure of time cost, which is based on week 1 reports, seems to have predictive value. The hypothesis that the two variables are uncorrelated is rejected by a Kendall's τ test at the 10% level. Moreover, the p-values on the other two coefficients are close to 0.1.

In conclusion for this section, unlike planned retirement, actual retirement seems

Table 6.6: Inconsistent retirement timing

	Planner	Non-planner	All
Impulsive	0.667	0.857	0.800
Not Impulsive	0.166	0.600	0.438
Difference	0.500*	0.257	0.363**
Student's t-test (p-value)	0.085	0.140	0.037
Mann-Whitney U test(p-value)	0.157	0.266	0.074*
N	9	17	26

Significance: * = 10% level or less, **= 5% level or less, ***= 1% level or less

to reflect preferences. Individuals with higher discount factors (through their impulsiveness) and higher costs of participation (through the time taken to come to the lab) leave the experiment earlier. This accords with the model.

6.3 Inconsistency

The gap between planned and actual retirement is caused by either genuine time-inconsistencies (potentially driven by impulsiveness) or because participants formed meaningless initial plans (in terms of their actual preferences). Table 6.6 compares means of the dummy variable for time consistent retirement between the impulsive and not impulsive members of the two subsamples, and the sample as a whole. So, for example, it shows that in the $R < 8$ group (or planner group), two-thirds of those who were impulsive had time inconsistent retirement plans, whilst on one-sixth of the non-impulsive participants in this group were time inconsistent when reporting leaving week. For each of the three samples, I test the hypothesis that the impulsive members of the group make fewer time-inconsistent choices than the non-impulsive, using a one-sided Student's t-test and the Mann Whitney U test. The p -values for these test are given in the table below.

The table shows that in the planner group, impulsive individuals are significantly more likely to make time-inconsistent choices, whilst the non-planner group does not exhibit a significant difference between the impulsive and non-impulsive members.

This is likely because, by virtue of not make accurate plans, most non-planners make inconsistent plans regardless of their time preferences.

Table 6.1 showed that those in the planner group had significantly smaller inconsistencies than the non-planner group, reflecting some attention being paid to their preferences in making a plan. This analysis has then showed that of those inconsistencies, it is the impulsive individuals who predominantly make them. If I include all participants, the difference in the means is strongly significant, even though it includes some of the non-planners who inconsistent plans do not reflect time preference. This indicates that there are some individuals in the $R = 8$ group who did make proper plans, and that their data, combined with the planner group, is sufficient to generate a difference in time-consistent behaviour across the whole sample that is significant at the 5% level.

To complete the analysis, the same statistical tests are run for the three groups (planner, non-planner, all) for the raw gap between planned and actual retirement, rather than the inconsistency dummy. The results of these are shown in the table below.

Table 6.7: Retirement plan gap

	$R < 8$	$R = 8$	All
Impulsive	1.667	4.286	3.500
Not Impulsive	1.000	2.500	1.938
Difference	0.667	1.786	1.563
Student's t-test (p-value)	0.322	0.035**	0.036**
Mann-Whitney U test(p-value)	0.429	0.077*	0.078*
N	9	17	26

Significance: * = 10% level or less, ** = 5% level or less, *** = 1% level or less

This table shows that while those in the non-planner group are not statistically more likely to make an inconsistent choice based on impulsiveness, the size of any inconsistencies is significantly larger for lower β individuals. Of course, this is explained by the results in the previous section, where actual retirement depends significantly on impulsiveness. Those in the planner group, on the other hand, are more likely to make inconsistent choices if they are impulsive. Table 6.7 shows that the size of that inconsistency is not generally large. Hence, when looking at the raw gap between

planned and actual retirement, those in the planner group do not exhibit significant differences.

6.4 Discussion of results

The lack of any real explanatory power of the payment group variable is in contrast to both the theoretical model developed at the start of this section and the existing experimental evidence. I would argue that the reason for this is because the experimental approach can only replicate some parts of the lifecycle consumption model in a small-scale laboratory setting. For example, it can create a work task by asking individuals to give up some time in exchange for a small wage and a growing saving pot. However, the model developed at the beginning of this paper suggested that annuities have a commitment value in that they limit over-consumption, which makes earlier retirement possible for impulsive individuals. Unlike in the model, the actual payout to participants is only a small part of the wealth that the person has outside of the experiment. As a result, individuals are not credit-constrained in the way imagined by the theoretical model and can transfer later annuity payments into immediate consumption. Therefore, finding a positive relationship between lump-sum payments and earlier retirement, and between these payments and the size of the timing inconsistency, was less likely, because there is no such commitment value due to the small size of the rewards paid out to participants.

These results do, however, question the idea that individuals will plan for later retirement if they receive a lump-sum payment (Orzag, 2001). This conclusion has been supported by a small-rewards experiment. However, their results related to the specific design of their experiment, which is essentially a choice between lotteries with identical expected values, and which does not allow for changing plans and time-inconsistency because there is no time element included. This is not to say that these conclusions do not reveal anything useful about the decision-making process of individuals which

could be exploited by a policymaker looking to encourage later retirement; however, it omits important elements of the retirement choice. This experiment has replaced their lottery with a set of choices over time and rejects the hypothesis that payment type . Clearly, there is need for further work here to determine whether the effect I describe in the model could be found in experimental data. One way to do this might be to run a similar experiment where the payments are non-transferable over time. There are ways to achieve this, but it would require moving away from money payments and controlling consumption choices.

This conclusion also suggests something about the role of impulsiveness in this experiment. In the model, unplanned early retirement occurred for two reasons – because immediate leisure utility became relatively more desirable, and because it permitted higher immediate consumption through the receipt of the pension. One concern I had prior to running the experiment is that discount functions were derived using choices over money, and that it was possible that an individual could be a quasi-hyperbolic discounter over money rewards, but not leisure, and vice versa. However, the lack of significance of payment group suggests that over such small rewards, individuals are not sufficiently credit-constrained that the timing of these payments matter. Consequently, it can not be the promise of immediate payments that causes earlier retirement (as participants can replicate a pension payment through transfers over time), implying that it is through the impulsive preference towards more immediate leisure utility that is driving these results.

7 Conclusion

This paper has presented a theoretical model of retirement with individuals who are quasi-hyperbolic discounters, building upon a model by Diamond and Koszegi (2003). It derived a number of hypotheses about planned and actual retirement behaviour and time-inconsistency, and attempted to test these hypotheses using a new experiment.

The results of this experiment lead to three main conclusions

1. Individuals value their time, which is associated with their decision to leave the experiment(Hypothesis 4).
2. Impulsiveness is associated with the decision to leave the experiment, but has no relationship with the reported planned retirement. Consequently, impulsiveness may explain inconsistency in the leaving decision (Hypothesis 5 and 7).
3. Contrary to the predictions of the model and existing evidence, payment type have no significant effect on any part of the leaving decision (Hypothesis 2, 3 6 and 8).

This final point follows from the lack of commitment value that annuities have over lump-sum payments, due to the small rewards nature of the experiment. This suggests that there is scope to improve on the experiment's existing design to more comprehensively test the hypothesis that payment type will affect the retirement decision.

This experiment has contributed to the literature in a number of broader ways. It extends experimental approaches looking at time inconsistency to consider leisure choices. Moreover, it adds to the small number of studies combining behavioral and labour economics. To do this, it has developed a novel design whereby the task of coming to the laboratory on a repeated basis becomes to decision variable of interest, rather than any task performed in the lab. The design of this experiment is unique to the literature. However, I would argue that it is something that could be exploited further, and in a particular, by labour economists with an interest in testing behavioural traits in relation to more traditional models. By making the decision to come to the laboratory crucial to the experiments outcome, we can potentially investigate economics choices related to participation, search, investment and exit, all of which are potentially of interest but none of which have, as yet, been investigated in a laboratory setting.

Finally, there are potentially some interesting policy implications. These results suggest that solutions to one time-consistency problem (forced saving through pensions) may cause other time-consistency problems over other choices where commitment is not possible (retirement). Secondly, there remains an open issue about the role of pension payments in retirement timing. Stronger answers on this point would also be interesting to policy makers, given the need to encourage later retirement and concerns over the thinness of annuity markets.

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