MPhil in Economic Research

Retirement Consumption: Evidence from UK Pension Reform

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[1] This is an estimate that my LaTeXeditor gave me.

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Abstract

Countries around the world are reforming the way individuals contribute to and withdraw from retirement savings accounts. I evaluate the effect that the United Kingdom's 'Pensions Freedom Act'—a landmark law change that meant defined contribution pension holders were no longer forced to annuitise their funds—had on consumption in retirement. I use a regression discontinuity specification using the year an individual turns 65 as the running variable. I complement this with a difference-in-difference setup, harnessing those who were unaffected by the policy reform as a natural control group. I find that the rates of annuitisation drop to almost zero after the reform—this is consistent with the literature on the annuity puzzle. I find some evidence that individuals increase consumption in early retirement as a result of the policy change—in particular spending on food outside the house increases. Two features of lifecycle models can explain the annuity puzzle. A lifecycle model with a bequest motive would predict a rise in consumption when individuals no longer annuitise their pensions, whereas a lifecycle model with pessimistic life expectancy would predict a fall in consumption. I show this by solving the consumption paths in retirement with and without annuities, mimicking the policy reform. I then apply the empirical models to this simulated data and measure the consumption change in early retirement that results from annuitisation. I find that a lifecycle model with a bequest motive best fits the identified consumption response—a result that could inform policymakers in designing optimal pension policies for an ageing population.

1 Introduction

The importance of retirement policy to the UK, and across the developed world, is growing. The number of individuals of pensionable age is expected to increase from 11.9 million in 2020 to 15.2 million in 2045 according to the latest projections from the Office for National Statistics (ONS), and for every 1,000 people of working age there will be 341 of pensionable age in 2045 compared to 280 in 2020 (ONS 2020). The increase in absolute and relative numbers of elderly people makes retirement policy more consequential. Moreover, private DC pensions are becoming increasingly common and are predicted to grow as current cohorts age (Cribb and Karjalainen 2023). Therefore, policies regarding how private pensions can be accessed will have a larger impact on the overall welfare of retirees.

Moreover, understanding how retirees spend their money over retirement is an important micro and macroeconomic policy question of its own. If retirees spend too much in early retirement, the state may need to provide for them towards the end of their lives. This has implications for government budgets, especially since population aging means more individuals may require expensive end of life care. On the other hand, if retirees over-save and do not spend, perhaps in order to bequest wealth or because of expectations around life expectancy and medical expenditures, the economy may be dynamically inefficient—a state in which the capital stock is too high. In this case consumption, per capita could be increased if savings were decreased.

In the UK, adults have three methods of funding retirement: the state pension; defined benefit (DB) employee pension schemes, which provide an income in retirement based on some function of tenure and wages; and defined contribution (DC) pensions, under which individuals save and invest in a tax-advantaged account that is usually supplemented with employer contributions. Under the 2010–2015 coalition government in the UK, the law regarding the use of private DC pensions at retirement changed. Individuals were no longer forced to buy annuities, which provide a guaranteed income stream until the end of life, with their pension pots and could access them in a variety of ways, such as a lump sum withdrawal or income drawdown, involving a steady withdrawal of assets from the pension pot—common advice is to take 4% a year—whilst the rest remains invested. Subsequently, the number of annuities sold in the UK dropped precipitously.

In this paper, I first use the policy reform as a discontinuity to measure the impact of forced annuitisation on the consumption levels of individuals in the first few years of retirement. And then I simulate consumption responses to annuities using three different lifecycle models, and compare the predicted effect of forced annuitisation on consumption to the effect observed in the data.

Given that the reform was implemented suddenly and without advanced notice before the Spring 2014 budget, my primary regression discontinuity specification uses the year an individual turns 65, the state pension age in the UK in 2014, as the running variable—if individuals turn 65 after 2014 they are considered treated. This rests on the assumption that individuals who retired in 2015, 2016 and 2017 are otherwise similar to those who retired in 2011, 2012 and 2013 except for the fact that the later retirees do not need to annuitise their DC pension pots. I also run a difference in difference estimator, comparing the change in consumption at retirement for individuals who retired before the reform to those who retired after the reform. I find some evidence that individuals increase consumption in early retirement as a result of the policy change, in particular I find a slight increase in consumption of food away from the home.

Classical economic theory suggests that these retirement annuities should be highly valued by individuals as a way to insure against late death (Yaari 1965). However, in developed countries, rates of annuitisation are far below the levels that theory predicts—this phenomenon has been termed the "annuity puzzle". The literature has suggested several reasons for this, but there is no consensus about which mechanism is dominant. I exploit early retirees' consumption responses to the change in policy in the UK to add to this literature.

I test two competing hypotheses for the annuity puzzle: bequests and pessimistic life expectancy. A bequest motive means that individuals want to leave an estate for their heirs to inherit—which they cannot do if they annuitise their wealth. On the other hand, individuals may believe that they will not live as long as annuity providers think they will, and therefore annuities that are on the market do not appear to be good value. Depending on the reason for the lack of annuitisation in the UK, the consumption response of retirees to the pension reform will differ. If individuals do not annuitise because of pessimistic life expectancy, their consumption should increase after the reform. If, on the other hand, individuals do not annuitise because of a bequest motive, consumption should not change as much as a result of the reform.

I solve lifecycle models for both of these cases and simulate consumption decisions with and without annuitisation. I then apply the empirical models to this simulated data and measure the consumption change in early retirement that results from annuitisation. The sign and magnitude of these coefficients relative to the coefficients from the real data will be indicative of the mechanism causing the annuitisation puzzle. I find that the lifecycle model with bequests best matches the coefficients from the regression discontinuity models, and interpret this as evidence that bequests are the dominant reason for the annuity puzzle.

1.1 Literature review

My paper draws on three main strands of literature: that of the annuity puzzle, exploring reasons why retirees choose not to annuitise; the retirement saving puzzle, which seeks to explain why retirees drawdown assets slowly; and the lifecycle model, the predictions of which generate the above puzzles.

Yaari 1965 showed that under standard assumptions with risk averse agents we would expect individuals to annuitise all of their wealth at retirement, so that they are insured against the risk of long life. More recently, Davidoff, Brown, and Diamond 2005 show that complete annuitisation is optimal under a broader range of assumptions. Since then, there has been much discussion of possible reasons for why people choose not to annuitise. Finkelstein and Poterba 2002; Finkelstein and Poterba 2004 find evidence of adverse selection into the UK annuity market and Mitchell et al. 1999 find evidence of the same in the US. This means longer-lived individuals select into buying annuities, driving up annuity prices since providers need to pay annuitants for longer than they originally predicted. This makes the 'money's worth' of an annuity lower for the general population as opposed to the population of annuitants, putting off individuals from buying an annuity. However, Mitchell et al. 1999 also find that theory would still predict annuitisation because the money's worth of annuities is not that far from 'actuarially fair' (meaning the present discounted value of annuities equals the price that an individual pays for one).

However, Friedman and M. J. Warshawsky 1990 show that annuitisation decisions can be fully explained by social security and 'actuarially unfair' annuities, at least for decisions in early retirement. They solve an augmented lifecycle model and calculate annuity demand for a range of money's worths. For plausible values, they find that individuals would optimally not annuitise much wealth. Similarly, to Finkelstein and Poterba 2004, Friedman and M. Warshawsky 1988 show that there is a significant difference between the life expectancy of annuitants and the general population in the American annuity market, which therefore implies a degree of adverse selection. But, they find this cannot fully explain the annuitisation puzzle, and only when bequest motives are added to the model can annuitisation rates be rationalised.

More recently, Lockwood 2012 builds on this by showing that a realistic bequest motive in lifecycle simulations achieves realistic annuitisation rates. He solves a simple lifecycle model with bequest motives taken from several recent papers in the retirement savings literature. The bequest motives he picks match other important aspects of the empirical distribution of bequests, such as how much individuals bequeath and the financial characteristics of these individuals. Lockwood 2018 also finds that a model that treats bequests as luxury goods fits the lack of demand for long-term care insurance well. O'Dea and Sturrock 2023 find that subjective life expectancies can explain a large part of the annuitisation puzzle, especially if agents are less risk averse.

Apart from bequests and annuity prices, a range of other reasons for the annuity puzzle have been explored. Precautionary savings for unexpected end-of-life medical expenses might cause individuals to prefer holding assets rather than an annuity. Moreover, Vidal-Melia and Lejárraga-García 2004 suggest that couples might share the risk of long life by pooling their resources, and therefore couples may be less likely to annuitise their wealth. Another explanation is that individuals already have enough guaranteed income from DB pension schemes and state pensions that they do not need to annuitise more.

Given that uncertain end-of-life medical expenses are not such an issue in the UK, as opposed to the US, and that the focus of the recent literature has been on the bequest model and subjective life expectancy, I choose also to focus on these explanations in the UK context. To my knowledge, there has been no attempt to analyse the consumption response to the 2014 reform, nor evaluate predictions from common lifecycle models for this particular policy change.

2 Data and policy reform

2.1 Data

The main dataset I use is the English Longitudinal Study of Ageing (ELSA) (Banks et al. 2023). ELSA follows a sample of individuals over the age of 50, interviewing them every two years until death. If individuals leave the survey, ELSA replaces them so that it is representative of the over 50 population in the UK. Individuals are asked a range of questions relating to their income and wealth as well as expectations about the future. One benefit of using ELSA is that it includes data on pension types for individuals who are working. Therefore, I can differentiate between individuals who have a DC pension and those who have a DB pension. There have been 9 waves of ELSA data collection — the first was in 2002/03, and collections happened every two years thereafter.

Importantly, ELSA also includes information on pension size calculated by the Institute for Fiscal Studies (IFS). This is only available up to and including wave 5 (which was collected in 2010 and 2011), after which point I use a real return of 3% to predict forward the pension wealth variable until retirement. ELSA also includes a measure of all non-housing financial wealth which I use in some specifications because of these issues with pension wealth data. Due to slight differences in the ELSA questions between years, I use 'Harmonized ELSA' [1] which ensures that variables are comparable across waves. Since this only includes a subset of the questions in ELSA, I supplement it with variables taken directly from the data such as questions that deal with life expectancy.

ELSA also includes questions on expenditures. In particular, individuals are asked how much they consume across a range of broad categories including in-house food consumption, out-of-house food consumption, leisure consumption, clothes consumption and consumption on utility bills and rent.

I also use 'life tables' from the UK's ONS from 2014. These provide me with the risk of death for each age group. The tables are produced until age 120 and I adjust them to make death certain at age 110 as is common in the literature (O'Dea and Sturrock 2023). I transform these so that I have risk of death conditional on being a given age since this is what I use in the life cycle simulations. I also use these objective probabilities to calculate annuity prices for individuals.

To illustrate the effect that the reform had on sales of annuities in the UK, I obtained product data from the Financial Conduct Authority (FCA). These track the sales of different financial products over time including data on annuities.

Life expectancy impacts the decision to annuitise for two reasons. Firstly, it directly impacts the price that an annuity will cost for individuals. Older individuals and those with pre-existing health conditions generally can buy an annuity that provides a greater income stream than individuals who are younger. Secondly, private information about life expectancy impacts the perceived value of an annuity. If an individual expects to outlive the general population, an annuity, at a given price, will appear a much better

[1] This analysis uses data or information from the Harmonized ELSA dataset and Codebook, Version G.2 as of July 2021 developed by the Gateway to Global Aging Data. The development of the Harmonized ELSA was funded by the National Institute on Aging (R01 AG030153, RC2 AG036619, R03 AG043052). For more information, please refer to https://g2aging.org/.

deal to them. Likewise, an individual's life expectancy will affect their decisions over how to consume and save through retirement.

To calculate subjective life expectancies from ELSA data, I follow (O'Dea and Sturrock 2023). Individuals were asked "What are the chances that you will live to be age X or more?" where X changed depending on the age of the interviewee. If individuals were under 65 then X was 75; if individuals were 66 and older they were asked the age that was 11 to 15 years older than them and a multiple of 5. From wave 3, respondents were also asked "What are the chances that you will live to be age 85 or more?" if they were under 70. As most recent retirees are under 70 we therefore have two data points. I first drop from the data individuals who think it is more likely that they reach a higher age than a younger age since this shows a misunderstanding of the question. I then add as a third data point their objective chance of reaching 110 according to the ONS life tables. I fit these three points to a Weibull distribution, which is commonly used by demographers to estimate how populations will age, using non-linear least squares. Then I create subjective survival tables using parameters from the Weibull distribution.

2.2 Policy reform

Successive governments in the UK have reformed both the public and private pension system. Prior to 1987, participation in private schemes was limited to employees of firms that had offered them, and there were few alternatives to the public state pension or DB scheme that a public sector employer would offer. From 1989, individuals in the UK were allowed to open tax advantaged self-invested personal pensions alongside any pension their employer offered. The 2004 Finance Act rationalised taxation rates on DB and DC pensions. The rules for DC pension pots were such that an individual had to buy an annuity after optionally taking a maximum of 25% of the pot as a tax-free lump sum withdrawal. DC pension pots were accessible from age 55, and most required that they be accessed before the age of 75.

In the June 2010 budget, the coalition government announced the first of two key reforms it would make to the pension system between 2010 and 2015. The 2010 policy reform created a minimum income requirement above which individuals would not need to annuitise (HMT 2011), meaning high income retirees would not need to annuitise their wealth. The income requirement was set at £20,000. This meant, for example, that an individual who was a member of a DB scheme paying them £20,000 a year would not need to annuitise their DC pension pot. However, the relatively high minimum income requirement meant that most individuals still had to purchase an annuity.

In spring 2014, Osbourne, the chancellor at the time, announced the so called 'pensions freedom act', scrapping the minimum income requirement and eliminating the compulsory annuities market (HMT 2014). One government minister infamously brought the message home by saying pension pots 'can be used to buy Lamborghinis' if retirees wanted to (Watt and Elliott 2014). The government also announced plans to make switches between DB and DC pension schemes possible although this was only realised in the next parliament.

The impact of the reforms on annuity demand has been documented by Cannon, Tonks, and Yuille 2016. Figure 1 shows purchases of annuities over time and demonstrates the sharp decrease in purchases that occurred from 2014 to 2015. There was an increase in the number of pensions that were being accessed using an income drawdown product, but these only partly account for the drop in annuitisation as is shown by the graph.

Figure 2 shows the distribution of methods used to access pension pots at retirement in 2021–22. In 2021, 196,736 pots were fully withdrawn at retirement, accounting for over 50% of pots. Prior to the policy reform this was not the case — most DC pension pots were accessed through annuitisation.

Also of specific interest to the annuity market was the European Union's 'Equal Treatment in Goods and Services Directive' of 2004. This prohibited discrimination in the provision and cost of goods and services based on sex. Up until 2011, there was a clause that stated insurers were allowed to charge different premiums if this was based on evidence that sex is correlated with different amounts of risk. However, in March 2011, the European

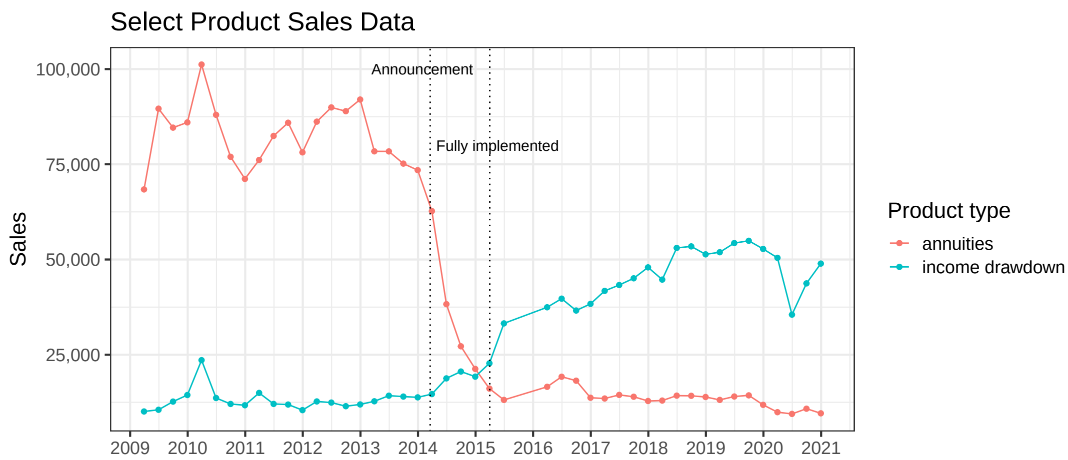


Figure 1: Product Sales Data

Court of Justice ruled that insurers were not allowed to charge different amounts and gave them until December 2012 to implement the ruling. This change meant that annuity products could no longer be priced differently for men and women in the UK — changing the money's worth of an annuity. I run a robustness test in the empirical section to check whether this reform biases my results.

2.3 Covariate balance

Table 1 shows various summary statistics for each variable of interest from ELSA and the ONS.

An individual is defined as treated if they retired between and including 2015 and 2017, and an individual is in the control group if they retired in 2014 or earlier. I use retirement year relative to 2014 as the running variable, and restrict the bandwidth to 3 years.

The treated retirement group is smaller with just 303 non missing observations for gender as opposed to 765 individuals in the control group. The control group are more male, retired at a slightly younger age and expected to retire slightly earlier. This could be

[2]Partial UFPLS (uncrystallised funds pension lump sum) is similar to Partial drawdown but with a different tax schedule. With partial drawdown you take the whole 25% tax-free amount at once whereas with UFPLS you only claim the tax relief on 25% of the amount you are taking out. This option is better if you may want to buy another retirement product in the future such as an annuity.

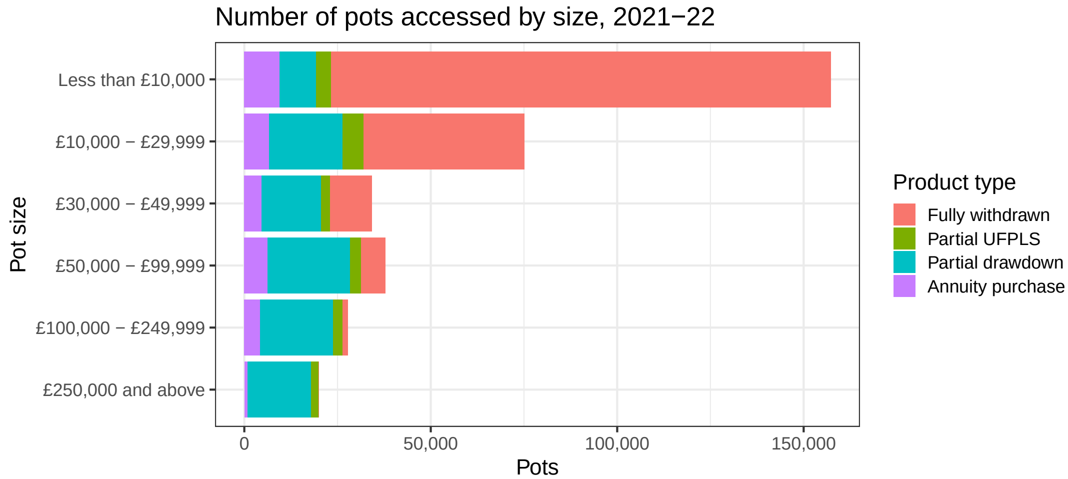


Figure 2: How pension pots are accessed[2]

because this period was affected by the increase in the state pension age for women from age 60 in 2010 to age 65 in 2018, so early cohorts had slightly earlier state pension eligibility ages. But, this change happened gradually and occurred over the whole period, so I do not expect it to influence the results. The DifferenceAge row tracks the difference between expected and actual retirement age.

The treatment group has higher financial wealth with a median of £67,000 at the time of interview as opposed to £54,300 in the control group. Likewise, the second group are more likely to have held a DC pension at some point and have more money in them. Both groups are equally likely to have a DB pension with roughly 45% of individuals across both samples having a DB pension. In general, DB pensions are more prevalent than DC pensions in the data — this reflects the trend that is observed in the general UK population. Home ownership is roughly equal across groups although the second group has slightly higher housing wealth.

Both groups are similarly long-lived when using ONS life tables to calculate life expectancy based on gender, age and the year the interview was carried out in. Subjective life expectancies are also similar across groups, with individuals expecting to live another 21 years as opposed to the 24 that the ONS would expect them to live.

Unfortunately, some consumption data is missing for some individuals. The food categories have the least missing data and the leisure consumption category has the most missing data.

Overall, the groups appear to have slightly different wealth profiles with the treatment group being richer and slightly more likely to have DC pension wealth. On key demographic characteristics, however, the groups are similar. The difference in retirement age between the two groups can be mostly explained by the difference in expected retirement age meaning that individuals have not en masse decided to delay retirement and avoid annuitisation. Moreover, for the regression discontinuity models I only use individuals who have a DC pension, so it does not matter that there are more individuals with DC pensions in the second group.

Table 1: Summary statistics

	Max		Mean		Median		Min		Non Missing	
	Control	Treat	Control	Treat	Control	Treat	Control	Treat	Control	Treat
Gender	1.0	1.0	0.470	0.495	0.0	0.0	0.0	0.0	753	301
RetirementYear	2013.0	2017.0	2011.875	2015.389	2012.0	2015.0	2011.0	2015.0	753	301
InterviewYear	2016.0	2017.0	2013.328	2016.326	2014.0	2016.0	2011.0	2015.0	753	301
YearsSinceRetirement	2.0	2.0	1.057	0.528	1.0	1.0	0.0	0.0	753	301
RetiredAge	82.0	79.0	63.052	63.877	63.0	64.0	55.0	55.0	753	301
AgeAtInterview	83.0	79.0	64.109	64.405	64.0	64.0	55.0	55.0	753	301
ExpectedRetiredAge	120.0	120.0	62.317	62.773	60.0	60.0	54.0	50.0	605	264
DifferenceAge	48.0	44.0	-0.660	-0.981	-1.0	-1.0	-8.0	-22.0	605	264
FinWealth(£000s)	1910.5	2037.0	121.989	168.487	54.3	67.0	-32.0	-19.8	738	297
DCPension	1.0	1.0	0.198	0.259	0.0	0.0	0.0	0.0	753	301
DCValue(£000s)	8171.7	17313.5	73.335	115.612	0.0	0.0	0.0	0.0	684	259
DBPension	1.0	1.0	0.466	0.455	0.0	0.0	0.0	0.0	753	301
StatePension	19.1	14.6	4.642	4.567	5.8	5.9	0.0	0.0	750	298
OwnsHouse	1.0	1.0	0.875	0.880	1.0	1.0	0.0	0.0	753	301
HouseValue(£000s)	1300.0	1700.0	229.664	296.470	200.0	250.0	0.0	-143.0	753	301
ObjectiveLifeExp	33.7	34.1	23.732	23.904	23.9	23.5	7.9	10.8	753	301
SubjectiveLifeExp	36.6	37.9	20.898	20.950	21.3	21.2	4.6	5.3	527	198
TotalConsump	2925.1	3495.7	729.239	780.975	647.6	699.5	130.2	136.9	753	301
FoodConsump	1938.1	1938.1	415.753	425.780	363.3	373.8	51.5	36.1	748	296
FoodConsumpIn	440.0	400.0	79.964	77.706	70.0	70.0	10.0	1.0	749	296
FoodConsumpOut	750.0	1200.0	68.302	88.208	50.0	50.0	0.0	0.0	752	298
ClothingConsump	1450.0	2000.0	89.224	83.824	45.0	40.0	0.0	0.0	753	301
LeisureConsump	530.0	150.0	82.072	75.000	60.0	75.0	0.0	0.0	657	2
UtilityConsump	483.1	580.9	107.840	113.324	96.0	100.0	0.0	0.0	753	301

As a further test for balance I regress demographic and financial characteristics of individuals on the treatment dummy. We can then see if the treatment and control groups differ on key characteristics such as financial wealth or retirement age. For a regression discontinuity to be valid we need the groups to be similar along all other characteristics apart from the treatment variable.

In particular I run:

$$Y_i = \alpha + \beta_1 PostRef_i + \beta_2 RetirementYear_i + \beta_2 RetirementYear_i PostRef_i + \epsilon_i$$

Where Y_i are the different demographic and financial characteristics for only those individuals with a DC pension.

Table **??** shows these results. As expected, retirement year and interview year are greater for the treated group. The difference between expected and real retirement age is 0, which shows that individuals are not delaying retirement, beyond their original expectation, in order to be part of the treatment. DC pension value is higher, as is financial wealth but these are both imprecisely estimated. Because of the differences in these variables I add them to the regression model.

One threat to validity is manipulation of the running variable, retirement year. As observed above in Tables 1 and **??**, it does not appear as though individuals are delaying retirement. However, it is possible that individuals do not buy an annuity at the time of retirement since the law prior to 2014 only required that they access the pot by age 75. They may decide to keep their DC pension untouched and live off other income and assets before accessing it later. Since I do not have data for when individuals purchase annuities, I cannot track whether annuity purchases were delayed for people in the treatment group. However, there is relatively stable annuity demand before the policy reform. If individuals delayed annuity purchases in expectation of the reform, so that they would not have to buy an annuity at all, we would observe declines in purchases before the reform was announced. Likewise, if individuals bought an annuity early in expectation

Table 2: Covariate Balance

	Pt.est.	*SE*
Gender	0.130	0.069
RetirementYear	3.518	0.098
InterviewYear	3.075	0.137
YearsSinceRetirement	−0.488	0.092
RetiredAge	0.314	0.448
AgeAtInterview	−0.174	0.455
ExpectedRetiredAge	0.340	0.590
DifferenceAge	0.000	0.565
FinWealth(£000s)	55.245	34.511
DCPension	0.000	0.000
DCValue(£000s)	50.092	210.816
DBPension	0.021	0.069
StatePension	−0.688	0.591
OwnsHouse	0.005	0.043
HouseValue(£000s)	98.249	31.135
ObjectiveLifeExp	0.855	0.477
SubjectiveLifeExp	0.273	1.023

that the end of the compulsory market would cause prices to go up, we would observe a spike in annuity purchases prior to 2014.

Moreover, if individuals retired and then delayed purchasing an annuity, the control group would have lower rates of annuitisation as well. This would bias my results downward, since then individuals who retired in prior to the policy change would also be consuming more.

3 Empirical models

In this section, I outline the key empirical models I run, first with real data from ELSA, and then with simulated data from the lifecycle models. I then see which lifecycle model better fits the consumption response that occurred as a result of the pension reform.

I use a fuzzy regression discontinuity design for which I compare the consumption of individuals who retired after the policy reform to that of people who retired just before the reform. The key assumption implicit in regression discontinuities is that nothing else changes at the time of the jump apart from the policy of interest, and that the policy occurs without individuals predicting it and altering their behaviour. As I have argued above, the demographic information in the data suggests that individuals did not delay retirement and that there was no delay in annuitisation as shown by the quick and sudden decline in annuity purchases. Moreover, anecdotal evidence from media and business sources at the time of the announcement show that there was surprise the government put forward the reform, with Money Marketing describing the change as a "bombshell" (Selby 2014).

Because of the differences in financial characteristics between the groups, I add controls for financial wealth, housing wealth, whether an individual owns their own home, their gender and the size of their state pension. The following regression equation is used.

$$Y_i = \alpha + \beta_1 PostRef_i + \beta_2 RetirementYear_i + \beta_2 RetirementYear_i X PostRef_i + \epsilon_i$$

Where Y_i is one of five different consumption variables and X_i is a set of controls.

Table 3 shows the results of this specification on the various consumption indicators. Column 1 has total monthly consumption on the left hand side of the regression equation. We can see that being in the treatment group is associated with £36 more a week in spending overall. This is statistically significant using robust standard errors clustered at the treatment level. Being further into retirement at the time of interview is associated with higher total consumption—this is surprising since lifecycle models predict consumption decreases over retirement and this has also been documented empirically (Hurd and Rohwedder 2003).

Columns 2 through 4 use food consumption as the outcome variable. Interestingly, food consumption inside the house does not increase as a result of the policy reform but food consumed away from the house does increase. A shock to income, caused by no longer needing to annuitise, may cause spending on luxury goods to increase and for spending on their substitutes, like food in the house relative to food away from home, to decrease. This wealth effect may be driving the results we observe in Table 3, since food consumption outside the home increases as does expenditure on clothing—seen in column 5.

One concern is that the group who retired after 2014 are just generally different to those who retired before and perhaps consume more outside the home anyway. The financial characteristic data presented in Table 1 would support this hypothesis as it shows all retirees are richer post-reform. To test for these cohort effects, I run a difference-in-difference (DD) regression to complement the regression discontinuity just shown. I add individuals who have a DB pension and those with no private pension into the model and interact the policy change with dummies for having different types of pension. Specifically, I run:

$$Cons_i = \gamma X_i + \beta_1 PostReform_i + \beta_2 PostReform * DC_i + \beta_3 PostReform * DB_i + \epsilon$$

This makes the coefficient of interest β_2, which shows us the difference in the change in consumption between the DC-only group and the base group that has neither a DB or DC pension. Since rules for DB pensions did not change under the pensions freedom act, those with a DB pension or no pension can be seen as a natural counterfactual group to judge the consumption of the DC group against.

The key identifying assumption for DD is the parallel trends assumption. In this context, it means that consumption differences between the DB, DC and no pension groups across cohorts would have been the same were it not for the policy change. Therefore, for DD to be invalid, we would need a reason to expect that the individuals with a DB and no pension who are retiring post-2014 are impacted by some factor that did not equally impact the DC group. Given that there were no other pension reforms at this time that differently affected these groups, I claim that the parallel trends assumption holds.

Table 4 shows these results. The interactions at the bottom of the table show us what happened to individuals with a given pension type relative to the reference cohort, which has no pension. Those with only a DC pension had an increase in total consumption which was higher than those with a DB pension and higher than those with no pension. Consumption on food decreased slightly for the DC group relative to no pension, but the decrease was less than that for the DB group. Expenditure on clothing increased for the DC group relative to the no pension and DB pension groups. The increase in sample size also brings decreases in the standard errors of these variables — the interactions are now all significant a the 5% level as is the main coefficient on retiring post-reform.

However, it is worth noting that there is a significant change between the DB and the no pension group. A natural test of the parallel trends assumption is to see whether two different, untreated, units have different outcomes post-treatment. If they are different post treatment then there could be something else driving the differences between the treatment group and the non-treated groups. This therefore raises questions about the validity of the DD regression in this setting.

We can also test whether treatment intensity is correlated with larger increases in spending. Those who have more money in a DC pension would be impacted by the policy to a greater extent than those with smaller pensions, since they would be forced to annuitise a larger amount. So, I interact the policy with DC wealth. As in Table 3, this regression only uses those individuals who have a DC pension.

Specifically, I run:

$$Cons_{it} = \gamma X_{it} + \beta PostReform_{it} * DCValue_{it} + \epsilon_{it}$$

Table 5 shows the results. The interaction with DC pension size is positive, meaning that a larger DC pension pot is associated with a greater increase in total monthly consumption. For the all other categories, more pension wealth is associated with lower consumption, though for food out the house and for clothing the main coefficients are still positive and significant.

As mentioned above, the DC pension pot value data after wave 5 has not been released yet, so for individuals who retire after 2011 I have no DC wealth variable. For Table 5, pension wealth from the last available year for an individual was given a real return of 3% and compounded until year of interview. Given that this is an imperfect measure, I also run the regression with financial wealth interacted with the treatment variable.

Table 6 contains these results and shows a similar pattern to Table 5. The reform is associated with an increase in total monthly consumption and more financial wealth increases the size of this effect. As for the DC pension value variable, the interactions in the regressions of the other consumption variables have negative signs.

Table 3: DC Only

	TotalConsump	FoodConsump	FoodConsumpIn	FoodConsumpOut	ClothingConsump
(Intercept)	933.927	331.229	51.887	104.379	50.095
	(435.409)	(92.554)	(46.177)	(107.889)	(192.855)
PostReform	36.461	−4.412	−2.842	9.411	26.601
	(3.684)	(5.477)	(0.829)	(1.134)	(11.776)
RetiredAge	−1.064	0.468	0.270	−0.695	−0.335
	(6.597)	(1.148)	(0.719)	(1.979)	(3.513)
FinWealth(£000s)	0.249	0.142	0.006	0.110	−0.014
	(0.114)	(0.015)	(0.002)	(0.013)	(0.027)
Gender	−48.956	−33.161	−7.945	0.641	7.873
	(31.752)	(13.802)	(2.023)	(21.223)	(30.010)
DCValue(£000s)	−0.014	0.005	0.002	−0.004	−0.003
	(0.008)	(0.007)	(0.001)	(0.002)	(0.003)
YearsSinceRetirement	17.207	−5.748	−0.295	−5.315	2.265
	(2.962)	(10.017)	(4.083)	(7.310)	(12.267)
OwnsHouse	−89.665	117.383	24.588	11.256	77.057
	(3.126)	(39.084)	(0.674)	(35.600)	(6.352)
StatePension	−9.936	−4.981	−1.097	−0.012	−3.290
	(2.133)	(3.000)	(0.911)	(0.789)	(6.208)
Num.Obs.	208	205	205	208	208
R2	0.047	0.060	0.050	0.091	0.036
R2 Adj.	0.008	0.022	0.011	0.055	−0.003

I use robust standard errors clustered at the treatment level since standard errors are likely correlated within these groups.

Table 4: All individuals with interaction

	TotalConsump	FoodConsump	FoodConsumpIn	FoodConsumpOut	ClothingConsump
(Intercept)	588.449	376.400	81.643	23.591	129.552
	(140.286)	(31.367)	(12.656)	(85.192)	(35.146)
PostReform	94.121	14.164	−1.591	21.122	−1.439
	(4.541)	(0.419)	(0.335)	(1.215)	(0.657)
DCPension	48.471	29.337	3.056	15.300	−3.224
	(4.408)	(2.544)	(0.503)	(0.260)	(1.616)
DBPension	90.885	16.998	−0.356	18.744	22.568
	(2.243)	(5.906)	(0.190)	(5.217)	(1.797)
RetiredAge	2.320	−0.781	−0.218	0.140	−1.609
	(2.643)	(0.136)	(0.272)	(1.301)	(0.867)
FinWealth(£000s)	0.166	0.072	−0.002	0.080	0.017
	(0.009)	(0.028)	(0.006)	(0.005)	(0.013)
Gender	−19.453	−19.704	−5.024	2.024	−0.014
	(9.136)	(26.358)	(4.913)	(4.729)	(2.243)
DCValue(£000s)	−0.012	0.004	0.002	−0.003	−0.004
	(0.000)	(0.009)	(0.002)	(0.002)	(0.002)
YearsSinceRetirement	37.784	−10.041	−2.018	−1.564	6.843
	(10.397)	(0.877)	(0.992)	(3.449)	(1.411)
OwnsHouse	−90.415	110.119	20.541	20.923	42.791
	(27.860)	(2.329)	(2.187)	(7.207)	(5.948)
StatePension	−5.971	−2.925	−0.445	−0.957	0.669
	(3.949)	(2.058)	(0.416)	(0.269)	(2.020)
PostReform:DCPension	12.823	−4.930	−0.463	−2.085	37.406
	(3.134)	(0.311)	(0.172)	(0.262)	(0.411)
PostReform:DBPension	−139.946	−24.437	−1.744	−16.814	−15.134
	(2.228)	(0.024)	(0.290)	(1.385)	(0.565)
Num.Obs.	926	917	918	923	926
R2	0.039	0.049	0.031	0.105	0.029
R2 Adj.	0.027	0.036	0.018	0.093	0.016

I use robust standard errors clustered at the treatment level since standard errors are likely correlated within these groups.

Table 5: DC Pension Size interaction

	TotalConsump	FoodConsump	FoodConsumpIn	FoodConsumpOut	ClothingConsump
(Intercept)	933.480	332.103	52.065	104.467	50.218
	(436.426)	(91.703)	(46.069)	(108.199)	(193.072)
PostReform	34.354	−0.153	−1.974	9.828	27.181
	(5.102)	(4.596)	(0.671)	(0.962)	(11.025)
RetiredAge	−1.053	0.449	0.266	−0.697	−0.338
	(6.601)	(1.108)	(0.712)	(1.987)	(3.512)
FinWealth(£000s)	0.250	0.140	0.005	0.109	−0.014
	(0.115)	(0.015)	(0.002)	(0.013)	(0.027)
Gender	−49.495	−31.847	−7.677	0.748	8.021
	(32.170)	(14.074)	(1.987)	(21.316)	(30.292)
DCValue(£000s)	−0.020	0.016	0.004	−0.003	−0.002
	(0.007)	(0.000)	(0.000)	(0.002)	(0.006)
YearsSinceRetirement	17.917	−7.264	−0.604	−5.456	2.070
	(3.155)	(9.745)	(4.025)	(7.327)	(12.641)
OwnsHouse	−89.060	116.154	24.338	11.136	76.890
	(3.464)	(39.263)	(0.686)	(35.726)	(6.123)
StatePension	−9.903	−5.061	−1.113	−0.018	−3.299
	(2.165)	(2.983)	(0.909)	(0.795)	(6.235)
PostReform:DCValue(£000s)	0.008	−0.016	−0.003	−0.002	−0.002
	(0.004)	(0.001)	(0.000)	(0.000)	(0.003)
Num.Obs.	208	205	205	208	208
R2	0.047	0.063	0.052	0.091	0.036
R2 Adj.	0.004	0.019	0.009	0.050	−0.008

I use robust standard errors clustered at the treatment level since standard errors are likely correlated within these groups.

Table 6: DC Financial Wealth interaction

	TotalConsump	FoodConsump	FoodConsumpIn	FoodConsumpOut	ClothingConsump
(Intercept)	792.453	157.868	56.231	−89.273	110.932
	(380.887)	(479.454)	(55.927)	(238.508)	(241.514)
PostReform	77.996	9.980	−2.599	20.981	30.043
	(3.083)	(6.929)	(0.644)	(9.406)	(8.346)
RetiredAge	2.134	4.024	0.201	3.187	−1.370
	(3.940)	(8.389)	(0.919)	(4.432)	(4.258)
FinWealth(£000s)	0.322	0.164	0.009	0.117	0.059
	(0.068)	(0.001)	(0.003)	(0.011)	(0.026)
Gender	−31.169	−47.768	−8.490	−11.772	8.354
	(33.636)	(21.976)	(2.569)	(31.747)	(32.934)
YearsSinceRetirement	0.541	−23.842	−2.771	−12.460	−11.846
	(8.561)	(1.625)	(4.359)	(16.759)	(4.174)
OwnsHouse	−139.190	102.073	25.433	−8.030	74.816
	(121.783)	(6.659)	(2.061)	(2.063)	(1.233)
StatePension	−15.442	−7.971	−0.775	−4.373	−0.596
	(9.403)	(7.492)	(1.175)	(2.615)	(7.285)
PostReform:FinWealth(£000s)	0.098	−0.025	−0.003	−0.002	−0.116
	(0.064)	(0.015)	(0.001)	(0.015)	(0.030)
Num.Obs.	222	219	219	222	222
R2	0.077	0.072	0.048	0.088	0.030
R2 Adj.	0.042	0.037	0.012	0.054	−0.007

I use robust standard errors clustered at the treatment level since standard errors are likely correlated within these groups.

Table 7: Robustness: DC only and retire in year expected

	TotalConsump	FoodConsump	FoodConsumpIn	FoodConsumpOut	ClothingConsump
(Intercept)	223.328	228.152	16.780	155.238	379.560
	(718.134)	(418.206)	(36.356)	(260.230)	(280.871)
PostReform	−85.132	−13.556	−0.221	−12.597	18.688
	(36.067)	(35.093)	(4.856)	(13.994)	(5.473)
RetiredAge	12.738	1.438	0.685	−1.538	−5.667
	(12.368)	(7.840)	(0.779)	(4.456)	(4.088)
FinWealth(£000s)	0.020	−0.111	−0.039	0.058	−0.065
	(0.040)	(0.215)	(0.022)	(0.121)	(0.195)
Gender	−43.490	−7.026	−2.946	5.777	−32.277
	(80.291)	(77.202)	(14.379)	(14.723)	(13.827)
DCValue(£000s)	−0.064	0.018	0.008	−0.015	−0.018
	(0.001)	(0.031)	(0.006)	(0.006)	(0.017)
YearsSinceRetirement	7.220	3.169	−1.952	11.651	0.371
	(70.654)	(42.979)	(6.381)	(15.251)	(7.456)
OwnsHouse	−61.528	152.220	31.645	14.714	74.843
	(62.367)	(72.091)	(11.458)	(22.301)	(12.059)
StatePension	−39.402	−8.484	−1.134	−3.555	−0.388
	(1.804)	(5.496)	(1.132)	(0.578)	(4.111)
Num.Obs.	65	65	65	65	65
R2	0.183	0.092	0.093	0.135	0.127
R2 Adj.	0.066	−0.038	−0.037	0.011	0.002

I use robust standard errors clustered at the treatment level since standard errors are likely correlated within these groups.

Table 8: Robustness: DC only and retired later than 2012

	TotalConsump	FoodConsump	FoodConsumpIn	FoodConsumpOut	ClothingConsump
(Intercept)	1524.689	207.316	−0.021	206.030	−77.148
	(602.488)	(78.332)	(35.665)	(69.557)	(66.097)
PostReform	−129.407	−0.283	3.941	−17.300	26.287
	(45.616)	(5.313)	(0.269)	(4.585)	(16.931)
RetiredAge	−6.681	1.996	0.987	−2.276	2.379
	(11.222)	(1.139)	(0.537)	(1.100)	(1.274)
FinWealth(£000s)	0.051	0.142	0.012	0.089	−0.047
	(0.061)	(0.018)	(0.004)	(0.000)	(0.033)
Gender	63.550	−14.860	−3.892	2.186	31.105
	(92.963)	(52.718)	(2.789)	(39.938)	(23.118)
DCValue(£000s)	−0.010	0.000	0.001	−0.006	−0.002
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
YearsSinceRetirement	−48.503	13.926	6.890	−15.919	−17.179
	(78.693)	(2.126)	(1.381)	(7.674)	(26.821)
OwnsHouse	−161.994	110.350	16.508	38.709	61.227
	(96.075)	(82.579)	(11.563)	(32.757)	(30.533)
StatePension	−7.413	−2.976	−1.191	2.201	−8.844
	(4.752)	(8.688)	(1.654)	(1.490)	(3.568)
Num.Obs.	104	103	103	104	104
R2	0.049	0.049	0.042	0.075	0.053
R2 Adj.	−0.031	−0.032	−0.040	−0.003	−0.027

I use robust standard errors clustered at the treatment level since standard errors are likely correlated within these groups.

3.1 Robustness checks

I carry out two checks for robustness. Firstly, I exclude those individuals who retired more than one year away from their expected retirement year — I define an individual's expected retirement year as their expected retirement age in their first interview with ELSA, added to the year that the interview was carried out in. This checks whether the effects shown above are being driven by individuals either retiring early in order to buy an annuity, since one may be cheaper pre-reform because the compulsory market reduces adverse selection Finkelstein and Poterba 2002, or retiring later to avoid annuitisation altogether.

I also check whether the EU reform to annuity pricing is changing the results in some way. Since the reform only came into effect in December 2012, there are some retirees in the sample who may have purchased an annuity before annuity pricing was made the same for men and women. I drop anyone with a retirement year in 2012 or 2011 and repeat the analysis from Table 3.

Tables 7 and 8 show these results. In Table 7, we see that the sign is reversed on PostReform in all consumption categories apart from clothing, however the sample size is a third of what it was prior to excluding individuals so there is more uncertainty in these estimates. In Table 8, the sample size is again much smaller and the sign has flipped on all consumption categories apart from clothing and food consumed in the house. These regressions show that there are potentially identification issues with the regression discontinuity and DD strategies that I have presented thus far. However, since the sample sizes for both the robustness tests and main results are small it is difficult to assess what the true impact of the reform was.

In a third set of robustness checks, I would have varied which years of retirement I assign to treatment or not, and varied the years of retirement that I collect consumption data for. But, due to space constraints I do not present these. The consumption response should diminish the longer the retirement year period either side of 2014 that we take data from, and we should not see positive results if we pick a 'fake' treatment year, such as 2009, and run the same set of regressions using this year.

In conclusion, the main results tables show that the reform could have had a positive impact on consumption in early retirement, and this increase is clearer for more 'luxury' consumption goods, such as expenditure on clothing and eating out. And, when we interact with a proxy for treatment strength (financial wealth or pension size) the impact of the policy is larger the stronger the treatment. However, the robustness checks point in the other direction, and there are significant differences between the DB and no pension groups in the DD regression, perhaps highlighting that other, unobserved, variables are driving changes in consumption. For example, consumer confidence between years could be changing, or, because of the small sample size in the ELSA dataset, there is too much noise in the consumption values each year.

Theoretically, a null or small change in consumption is evidence for a bequest motive explaining a lack of annuitisation rather than pessimistic life expectancies being the cause. In the next section, I solve and simulate a lifecycle model for individuals in the ELSA dataset. I find that the bequest motive most closely matches the patterns observed in the empirical models above.

4 Lifecycle theory

In the second part of the paper, I first solve a modified retirement lifecycle model, then simulate the ELSA data and run the empirical models from above on the implied consumption data.

In recursive form, the problem that retirees face is as follows. Every period retirees solve:

$$\max_{a_{t+1},c_t} \{u(c_t) + p_t B(a_{t+1}) + \beta(1 - p_t)V(a_{t+1}, y, t + 1)\}$$

Where the maximised value of this objective function is denoted: $V(a_t, y, t)$. This is what I refer to as an individuals value function. This is maximised subject to their budget constraint:

$$c_t = a_t(1 + r) - a_{t+1} + y$$

where a_t are asset holdings in time t, y is constant income for all periods, p_t is probability of death in period t conditional on being alive at the start of the period. And $B()$ is a bequest function. Income comes from the state pension and purchased annuities. I follow the literature and use $\beta = 0.97$ as an individual's discount rate and $r = 1/0.97$ as the interest rate. I enter t directly into the value function as a state variable to make it clear that value is also conditional on age — through the chance of death and the total number of periods left until terminal age.

Solving the value function gives us two 'policy functions': $a_{t+1}(a_t, y, t)$ for assets, and $c_t(a_t, y, t)$ for consumption. Policy functions are functions of the state variables that maximise the value function.

As is common in the literature (Lockwood 2012; Nardi, French, and Jones 2010), I use a constant relative risk aversion utility function.

$$u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}$$

Where $\sigma = 2.5$ which is around the median found in the retirement savings literature.

In some specifications retirees can leave bequests. I use the bequest function from Lockwood 2012; Lockwood 2018.

$$B(a_{t+1}) = \Big(\frac{m}{1-m}\Big)^{\sigma} \frac{\big(\frac{m}{1-m}c_0 + a_{t+1}\big)^{(1-\sigma)}}{1-\sigma}$$

Where a_{t+1} is the amount left at death. c_0 is the amount of consumption below which individuals will not leave bequests. If $c_0 > 0$, then bequests are a luxury good and the wealthier the individual the more they will bequest. m is the marginal propensity to bequeath after consuming at least c_0, and a higher value of m means that individuals will leave a greater share of wealth to their heirs. I pick values of $m = 0.95$ and $c_0 = £20,000$ since these generate low rates of annuitisation. For comparison, Lockwood 2018 finds c_0 is in the range of $\$12,000$ to $\$30,000$ and m is between 0.93 and 0.96 in a variety of estimated models.

To solve this problem, I first discretise the state space. I create a grid from £500 to £50,000 incrementing by £500 for income and £1,000 to £500,000 incrementing by £1,000 for financial assets. I solve the retirees' problem using backward induction. At age 110, there is certainty of death so any leftover assets are bequested. This means that the value of any remaining assets at age 111 is either 0 (if we do not allow a bequest motive) or the value of bequests. I then take this value function and solve an individual's problem at age 110, choosing assets for next period (i.e. those to bequest) and how much to consume. This will be all assets for individuals with no bequest motive or with assets below £20,000 (c_0).

Using the policy function at age 110, which we just found by doing the optimisation at age 110, I calculate the value for all income and asset states at age 110. This value is then used to solve the problem an individual at age 109 faces. Specifically, for each income and asset state, they need to find the assets next period that maximise: utility from consumption; bequests multiplied by the probability of death; and the value function at age 110, discounted by β, multiplied by the probability of being alive. I repeat this process back to the age of retirement to obtain optimal consumption amounts for each year of retirement and the associated value functions. I write code in Julia that solves this maximisation problem.

To simulate the ELSA data, I solve this retirement problem for each new retiree in the dataset. I solve the problem with subjective and objective life expectancies, and with and without a bequest motive.

In a retiree's first year of retirement, I sometimes annuitise a portion of their wealth. In practical terms, this is moving down the asset grid but up the permanent income grid.

To assess this trade-off I calculate the annual annuity payment that follows from a given annuity cost. I calculate this, using objective life tables from the ONS, with the following equation:

$$Ann = \delta * C * \left[\sum_{t=Retage}^{110} \frac{1 - p_{t|Retage}}{(1+r)^{t-Retage}} \right]^{-1}$$

Where C is the one-off payment, δ is the 'money's worth' of an annuity and $p_{t|Retage}$ is the probability of death at age t conditional on being age $Retage$. So individuals can move down C on the asset grid for gaining Ann on the permanent income grid for the rest of their lives. The 'money's worth' of an annuity is the ratio of expected present discounted value to the price of an annuity that an individual can purchase. An actuarially fair annuity will have a money's worth of 1 whilst an annuity that pays more than it costs will have a money's worth greater than 1. Generally, they have been found to be between 0.8 and 0.9 for the population as a whole in the UK (Finkelstein and Poterba 2002; Finkelstein and Poterba 2004; Mitchell et al. 1999).

To see that δ is the money's worth, I rearrange the above equation:

$$\delta = \frac{Ann * \sum_{t=Retage}^{110} \frac{1-p_{t|Retage}}{(1+r)^{t-Retage}}}{C}$$

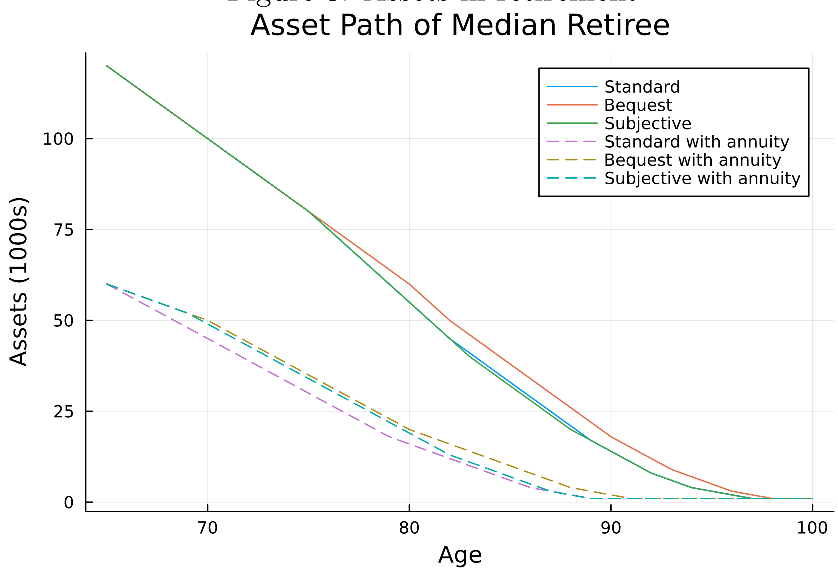
5 Lifecycle results

Having found optimal policy functions and value functions, I can now simulate the change in consumption given different rates of annuitisation versus no annuitisation. There are multiple benefits to building a model of individuals' decisions. Firstly, we can directly compare what a given individual would have consumed with what they actually consumed, conditional on our model being correct. In other words, we have the counterfactual world in which individuals were not forced to annuitise. Secondly, I can simulate the impact of different policy changes on the consumption, savings and bequest behaviour of individuals.

For example, I could change the proportion of wealth that will be annuitised and see the corresponding changes in consumption indicators for all individuals.

I now plot the retirement path of consumption for a median individual in my subsample of ELSA. I plot consumption with different proportions of starting wealth annuitised (either 0% or 50%) and the different lifecycle model types.

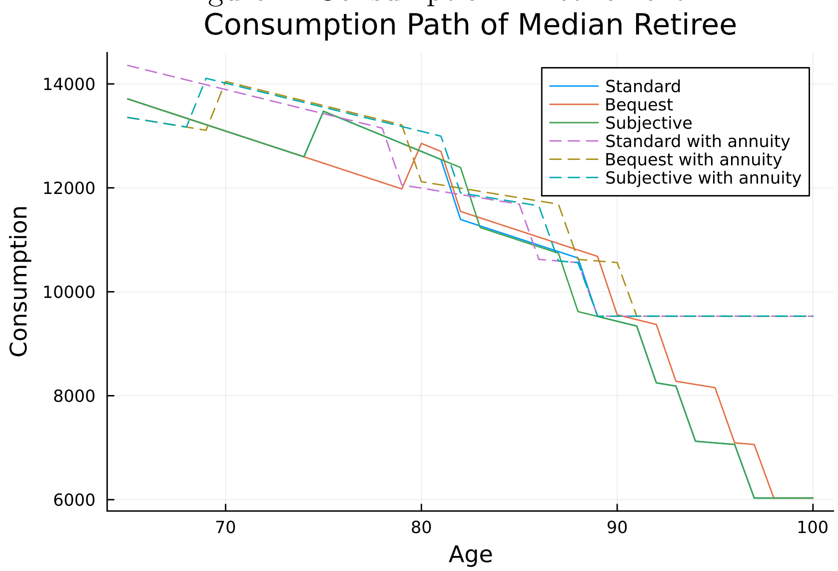
Figure 3: Assets in retirement



Figures 3 and 4 show the retirement path of consumption and assets for a median retiree. This hypothetical female has £120,000 of assets at age 65 when she retired in 2012 with a state pension income of £6,000. The dashed lines show consumption and assets with an annuity that costs half of her wealth. This buys her £3,500 of annuity income, which, given her objective life expectancy, is a money's worth of about 90%.

We can see that the asset path with the bequest motive remains higher for longer but still decreases, and by the woman's late 90s she has completely run down her wealth. Interestingly, the asset path with the quickest run down is the standard lifecycle model using objective life expectancies, which points towards this individual being optimistic about her life chances. Also rather surprisingly, the asset paths of all three types are similar without annuities. The paths only diverge after age 75, at which point the bequest path stays high and the other paths start to decrease faster. This is contrary to the path

Figure 4: Consumption in retirement



with annuities which show the standard path diverging from the bequest and subjective paths immediately.

The consumption paths all start at around £14,000 a year. The three models without an annuity start at exactly the same amount and stay that way until the individual reaches her mid seventies—showing that even quite different lifecycle models can generate similar paths. As expected, the consumption path with the bequest motive with an annuity is lower at the start of retirement than the bequest path without an annuity as individuals seek to build their savings back up. But it is also lower for the subjective life expectancy case, again pointing toward this individual being optimistic. However, the subjective consumption line rises at a younger age than the line with bequests, showing that the models align with the prediction that subjective lifecycle agents consume more in early retirement compared to the other lifecycle models because people underpredict lifespan.

It is worth noting that the period of interest of this study is early retirement and although differences across the lifecycle are not large, there are significant differences at the start of retirement. This means that different lifecycle models will produce substantive differences in predictions, so knowing which model is correct is important for policy.

Table 9: Model consumption predictions

	Mean		Non Missing		Sd	
	Control	Treat	Control	Treat	Control	Treat
Bequest	891.3230	1041.2196	98	49	553.5802	540.8520
Standard	918.5339	1068.4305	98	49	602.9341	573.0909
Subjective	1018.3042	1144.9085	98	49	720.9637	597.3735
Total Monthly (ELSA)	763.5413	887.8606	98	49	367.2683	538.9208

To simulate consumption and asset paths for the individuals in my ELSA dataset, I round financial wealth and state pension income to the closest point on the discrete asset and pension grids respectively. I then take the treatment group and evaluate their consumption in the year of interview with an annuity, given that they annuitised 50% of their financial wealth in their retirement year. I also evaluate consumption without annuitisation. The treatment group did not need to annuitise their wealth, so I use their predicted consumption from the lifecycle models with their starting values of assets and pension income taken from their values in the ELSA dataset. To be clear, the only individuals for whom I annuitise wealth are those with DC pension pots who retired before 2014.

Because I discretised the state space, annuity prices are rounded down to the nearest income grid point. I set the money's worth of annuities to 0.9 when calculating annuity prices, but because I round down to the nearest income grid point the real money's worth an individual receives is lower. I assume that those who have a DC pension have half of their financial wealth in it since this matches roughly what is seen in the summary statistics, so, for the untreated group—those who retired pre-reform—I annuitise half of wealth. I also only annuitise when an individual has financial assets large enough to move up at least one unit of income (£500). I do not let these individuals, with low assets, annuitise, setting consumption with and without an annuity to the same amount.

Table 9 shows the mean of consumption that each lifecycle model predicts for the treated and control groups as well as the original mean of consumption from the ELSA data for the individuals with non-missing values. The sample size of those with a DC pension is greatly reduced. This is mainly because not everyone in the ELSA data answers the life expectancy questions, and of those who do answer, some give answers that I cannot use for reasons listed in the data section.

We can see that the means for the treatment group are higher than the control for all models, but there is significant difference between the consumption levels for the different models. The bequest and standard model both predict lower consumption than the subjective model. This is not surprising given the subjective lifecycle individuals generally think their lives will be shorter and therefore can consume more early in retirement. Likewise, it makes sense that the bequest model predicts lower consumption, since there is utility to be gained from saving so that an individual can bequest to their heirs.

I now run the empirical models on this simulated data. This lets us see which lifecycle model gives us the closest match to the coefficients seen in the real data. In the structural modelling literature, it is often common to run policy tests on estimated models to see if simulated responses match real world responses, for example see McGee 2021. Due to the time constraints of this project, I did not estimate a full structural model but I do check which lifecycle model fits the response seen in the ELSA data.

Table 10: Empirical models with simulated consumption data

	Bequest			Standard			Subjective		
	DCOnly	DCInt	FinInt	DCOnly	DCInt	FinInt	DCOnly	DCInt	FinInt
(Intercept)	−447.67	−543.51	−439.95	−681.17	−648.12	−588.16	−1026.68	−779.75	−1031.89
PostReform	16.69	−10.85	24.81	2.84	−4.68	30.65	−62.88	−14.69	63.14
RetiredAge	7.58	9.15	7.45	10.69	10.33	9.09	16.56	12.67	16.39
FinWealth(£000s)	4.08	4.07	4.10	4.43	4.32	4.51	5.05	4.75	5.43
Gender	13.73	19.65	13.38	13.07	23.30	14.34	−62.50	−30.43	−52.37
DCValue(£000s)	0.00	0.00		0.00	0.00		0.00	0.01	
YearsSinceRetirement	−1.22	−0.89	−2.27	−6.22	−0.62	−7.27	−33.07	1.92	−42.02
OwnsHouse	5.06	17.85	3.84	14.67	21.49	13.22	66.45	44.94	51.10
StatePension	84.42	84.99	84.40	89.06	89.24	89.27	92.85	92.99	91.54
DCPension		−20.63			−15.38			7.56	
DBPension		0.56			1.52			−13.52	
PostReform:DCPension		25.53			17.76			−30.89	
PostReform:DBPension		2.66			−11.35			16.74	
PostReform:FinWealth(£000s)			−0.06			−0.22			−0.95
Num.Obs.	139	584	147	139	584	147	139	584	147
R2	0.996	0.995	0.996	0.995	0.993	0.995	0.961	0.943	0.966
R2 Adj.	0.995	0.995	0.995	0.994	0.993	0.995	0.958	0.942	0.964

Table 10 shows all these results. Each set of colums shows the results from the empirical models using a different lifecycle model to simulate the data. The sub columns show the empirical modes: the first runs the regression discontinuity just on those with DC pensions, the second looks at all individuals and uses the DD set up, whilst the third interacts financial wealth with the treatment indicator for those with DC pensions only.

Comparing the DC-only column across lifecycle models, we can see that the simulated bequest model gives us the highest increase in consumption as a result of forced annuitisation. This could be because this type of individual was previously saving out of their annuity income to regain assets, so when they do not need to buy an annuity anymore their consumption increases. Surprisingly, when using the predictions from subjective models, the coefficient on PostReform is negative, even though the mean increased for this model as shown in Table 9.

The lifecycle model that is closest to the empirical models shown in Table 3 is the bequest model which gives an increase of 17 in monthly consumption. However, this coefficient is just under half of the change estimated in Table 3 and reflects only a 0.6% rise in consumption after the reform.

In the second column, the coefficient of interest is the DC pension interaction with the treatment variable since I use the DD setup again. The bequest model has a coefficient of 25.5, the standard model one of 17.8 and the standard model with subjective life expectancies has one of -30.9. The bequest and subjective coefficients are higher than the coefficient seen in Table 4 with the predictions from the standard model matching the empirical model best. The subjective model again has the opposite sign to the one seen in the empirical model.

The interaction model in column 3 has the sign for the main reform effect in the standard and bequest models. Although in both the interaction with financial wealth has a negative coefficient, showing that the increase in consumption caused by the reform was progressively lower for those who would have had to annuitise more wealth. In the subjective model table, the signs are again wrong apart from for the main treatment effect in the financial interaction column. The lifecycle model that appears closest to the empirical results is again the bequest model, which matches the signs from Tables 5 and 6, but the coefficients are smaller.

Across all regressions, the lifecycle model using subjective life expectancies does not match the change in consumption that is seen when using ELSA data. It is surprising that the consumption response is also very different to the other lifecycle models used. One possible explanation for this could be that the control and treatment groups have quite different sets of subjective life expectancies, which therefore cause different consumption paths in early retirement. This heterogeneity in death probabilities would not occur in the other models because the difference in objective death probabilities at a given age for different birth cohorts is not that large, whereas differences in subjective life expectancies between individuals can be big. The structure that the Weibull distribution imposes on the death probabilities could also be causing discontinuities in a given individuals subjective probability of death between two periods, which would impact how they consume across that part of retirement.

The evidence just presented points towards data simulated using the bequest model being best able to replicate the consumption response observed in the empirical models. As highlighted above, the benefit of having a theoretical model is that we can trace out the asset path of consumption for individuals, only needing to know their retirement wealth as we were able to do in Figure 3.

6 Conclusion

The results from the empirical section of this paper point towards there being some impact of the UK's pensions freedom act on the consumption of retirees early in retirement. The specifications that used the full available dataset show a clear increase in total monthly consumption, and particularly an increase in food consumption away from home and on spending on clothes. Although the increase of £36 in total monthly consumption only equates to £432 a year, over a longer period it may mean some retirees end up with fewer resources than they require toward the end of their life.

Moreover, the results from the lifecycle section show not just that the models create different consumption predictions, but they also add to the evidence that lifecycle models with bequests can do a good job of explaining the consumption patterns of retirees in the UK. That simulated data from a bequest model matches the consumption response also points towards bequests being able to explain the annuitisation puzzle.

Since the bequest motive model fits the consumption response best, we can worry about the increase in early retirement consumption less. This is because, as highlighted in the analysis of the median individual, assets in the bequest model diverge from the objective and subjective lifecycle models during retirement, reducing at a slower rate. Therefore, the government should not worry about spending early in retirement being linked to low assets at the end of an individual's life. The bequest explanation also has implications for the macroeconomic impact of other public policy — for example it means an inheritance tax could impact the savings of retirees.

Future research is still needed to understand the full impact the reform has had on consumption across the whole of retirement, especially as more data on retirees impacted by the reform becomes available. The effect that reforms since this one, such as allowing individuals on DB plans to switch to DC plans, has had on consumption could also be studied. Moreover, as the number of individuals retiring with a DC pension grows, understanding the mechanisms behind their choices will matter more to policy makers. For example, if the annuitisation puzzle is caused by a bequest motive rather than low money's worth or short subjective life expectancies, then policies that force annuitisation or tax assets to fund state pensions will not be welfare-enhancing.

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