# Pension Incentives and Labor Supply: Evidence from the Introduction of Universal Old-Age Assistance in the UK

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**Abstract**

We estimate the labor supply response to the introduction of means-tested minimum pensions in the UK through the Old-Age Pension Act (OPA) of 1908. The OPA was a major social policy intervention and the first one to universally target older workers in a time of very limited social protection. Using full-count census data covering the entire population, we identify the labor supply effects of the program based on variation at the age-based eligibility threshold between 69 and 70. Our results show a considerable and abrupt decline in labor force participation of 5.3 to 6.0 percentage points when older workers turn 70. This sudden drop only occurs at the age cutoff and only after the OPA was implemented. The unique historical setting permits us to study unintended labor supply responses when labor earnings are taxed implicitly through government transfers.

**Keywords:** Old-Age Assistance, Labor Supply, Retirement, Regression Discontinuity Design

**JEL-Classification:** H24, H55, J14, J22, J26

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# 1 Introduction

Many government old-age assistance programs intend to prevent poverty through income transfers to the elderly. These payments are usually tied to a means test that imposes an implicit tax on the labor of older workers relative to younger workers. Unintended consequences of old-age support programs arise if older workers reduce their labor supply and retire early when becoming eligible for the pension. Such behavioral changes involve distortionary substitution effects if older individuals stop working to pass the means test because they aim at pension eligibility.

This article assesses the labor supply effects of the Old-Age Pension Act (OPA) of 1908 that initiated universal means-tested minimum pensions in the UK. The unique historical setting allows us to estimate these effects when moving from essentially no program to an old-age assistance scheme that covered a large share of the elderly population.[1] We first estimate the labor supply response to the program as an unintended consequence among eligible older workers. We then use our estimates to bound the welfare costs of the program to quantify the welfare impact that the policy had in times of very limited social protection.

Previous studies that investigated aggregate trends in labor force participation (LFP) rates have suggested that the introduction of the OPA had little impact on labor supply (Johnson, 1994; Costa, 1998).[2] This conjecture is based on aggregate trends from British censuses suggesting that, although LFP rates of older workers did decline considerably over the 20th century in the UK, the decline was moderate between 1901 and 1911 and even turned to a slight increase in LFP between 1911 and 1921. We provide striking evidence that, irrespective of the overall trend, LFP rates of older workers did decline promptly and considerably as a direct consequence of the introduction of the OPA.

We make use of recently released full-count population data from three decennial UK census waves (1891, 1901, 1911). The data source includes detailed information on

[1]In 1911, almost 60% of individuals who reached the eligibility age of 70 did receive a pension that was administered through the OPA.

[2]In contrast, the expansion of old-age assistance in the U.S. has been shown to coincide with a strong decline in LFP of older men (see e.g. Feldstein and Liebman, 2002; Krueger and Meyer, 2002; Coile, 2015; Fetter and Lockwood, 2018).

occupations and LFP of the entire workforce that allows us to precisely estimate the effects of old-age assistance on the LFP of older workers. We isolate the causal effects of the program along the lines of two sources of identifying variation. First, we use variation over time across calendar years because the introduction of the OPA (effective in 1909) falls in between the available census waves. Second, the OPA introduces a sharp age-based eligibility threshold at age 70[3], inducing a discontinuity in the retirement probability. To identify the LFP effects in the local environment of this age cutoff, we adopt a regression discontinuity design (RD).

Our main findings indicate an abrupt decline in LFP at the age of 70 that is caused by the availability of old-age assistance. In absolute terms, the effect amounts to a 5.3 to 6.0 percentage point decline of LFP, measurable in the 1911 census just after the implementation of the OPA in 1909. Relative to a participation rate of 46% at age 69, the LFP rate thus declines by 12% to 13% when moving marginally above the age-based eligibility threshold.[4] These estimates are driven by older individuals who stop working and much less by older individuals who leave the labor force from unemployment so that the LFP effects are dominated by reductions in work activity.

Labor supply responses are considerably larger at the bottom of the earnings distribution. The LFP reduction of 16% in the lowest earnings quartile more than doubles the LFP decline of 7.5% in the highest quartile. This finding is consistent with predictions from theory that responses are more likely when forgone earnings from labor supply reductions are low. Forgone earnings arise if individuals with high earnings stop working to pass the means test for pension eligibility.

The empirical framework also indicates that the LFP decline is stronger for older workers without children in comparison to individuals with own children in the household. This finding is consistent with the hypothesis that children served as old-age insurance espe-

[3]Adjusting for child mortality shows that about 35% of the birth cohort 1841 reached age 70 in 1911 (life tables Human Mortality Database, 2018). Conditional on having celebrated the 70th birthday, this cohort had a remaining lifetime of 9 years on average.

[4]In absolute terms, the effects are larger for men (7.9 percentage points) compared to women (3.2 percentage points). In relative terms, however, the reactions are smaller for men (10%) as compared to women (16%) when taking into account that LFP rates marginally below the eligibility age (at 69) are large among men (76%) and rather low among women (20%).

cially when social security did not exist. We further provide evidence for joint retirement decisions of couples. We document a significant LFP drop of 3 percentage points among eligible individuals (having already reached the eligibility age 70), whenever their spouse reaches the eligibility age. This result strongly suggests within-family spillovers and is in line with previous findings on joint retirement decisions of couples.

The considerable decline in LFP that is caused by the availability of pensions is consistent with theoretical expectations on labor supply responses when labor earnings are taxed implicitly through government transfers. The introduction of the OPA induces a financial incentive to stop working after reaching the age-based eligibility threshold. Through the means-test, the availability of the pension induces welfare costs to the extent that one additional pound of old-age assistance replaces labor earnings and is thus valued less than one pound.

This paper makes three major contributions to the literature. First, it adds to earlier studies on the labor supply effects of pension incentives (Krueger and Pischke, 1992; Börsch-Supan, 2000; Mastrobuoni, 2009; Liebman et al., 2009; Brown, 2013; Atalay and Barrett, 2015; Manoli and Weber, 2016). We extend this strand of the literature by studying labor supply effects of an old-age assistance program that was introduced at a time when pension programs and social security systems did not exist, thus investigating the change from no program to universal coverage. In contrast to previous studies that examine marginal changes in existing pension systems, our estimates quantify the full labor supply effects of the OPA starting from a benefit level of zero and thus not having to rely on extrapolations. Quantifying the full labor supply effects of introducing universal old-age assistance programs for the first time is interesting in its own right but also serves as a benchmark value for marginal changes in contemporaneous pension programs.

Second, the institutional setting allows for highly credible and transparent identification. The reform introduced an age-based eligibility threshold at age 70, where every UK citizen became eligible conditional on having passed the means test. Based on an RD, we quantify the abrupt decline in LFP in the local environment of this age cutoff. This type of research design builds on many recent studies that have used age-based eligibility thresholds to identify policy-relevant effects (see e.g. Card et al., 2008; Battistin et al., 2009; Carpenter and Dobkin, 2009; Card et al., 2009; Anderson et al., 2012, 2014; Carpenter and Dobkin, 2015, 2017; Fitzpatrick and Moore, 2018). Our RD design thus adds to previous research that used cross-state variation in benefit levels to identify the labor supply effects of introducing old-age assistance in the U.S. (Fetter and Lockwood, 2018). Our RD design rules out policy endogeneity that could arise if unobserved factors that correlate to policy preferences and old-age labor supply were systematically tied to the identifying variation. The identifying variation we use is purely based on the age-based eligibility threshold which makes identification highly transparent and visible from graphical evidence.

Third, the historical background of this study is not only interesting in its own right but also involves many features that strengthen the empirical analysis. Enacted in 1908 and effectively implemented in 1909, the OPA was the largest means-tested old-age assistance program and one of the first of its kind at that time. It covered the entire UK, one of the largest and wealthiest economies - both in terms of absolute GDP and GDP per capita - in the early 20th century. Private pension schemes and other government programs focusing on older workers were either small and uncommon or did not exist.[5] Another historical feature of the OPA is that it marked the beginning of large-scale expansions of old-age assistance programs in many industrialized countries and served as an archetype for similar programs such as the U.S. Old Age Assistance program that was introduced in the 1930s. Studies that examine the introduction of old-age assistance in the U.S. (Friedberg, 1999; Fetter and Lockwood, 2018) are therefore a valuable benchmark to our results. Consistent with these studies, we document a considerable decline in LFP that is attributable to the disincentive to work when labor earnings are taxed implicitly through government transfers.

The remainder of this paper is structured as follows. Section 2 provides historical and institutional details on the old-age assistance program in the UK and how its introduction creates exogenous variation that we use for identification. Section 3 outlines theoretical predictions on labor supply responses that are generated from a static model of lifetime

[5] All empirical results in this paper are measured in 1911 or earlier. Unemployment and health insurance were only implemented after that in 1912.

labor supply. Section 4 outlines the research design and describes the unique data source from the UK census. Section 5 presents results, sensitivity checks and falsification tests. Section 6 bounds the welfare costs and quantifies the welfare impact of the program. Section 7 concludes.

# 2 Historical Background and Institutional Details

The Old-Age Pension Act of 1908 (OPA) introduced means-tested, non-contributory minimum pensions for British citizens financed by the state government.[6] The OPA was a major social policy intervention and the first one to specifically target the elderly in a time of very limited social protection. The law was debated in the British Parliament in May 1908, passed through in August 1908 and the first pensions were eventually paid out in January 1909. At that time, neither unemployment nor health insurance existed because both of these programs were only introduced in 1912.

Given that pensions were means-tested, the coverage of the OPA was high. In 1911, almost 60% of individuals who had reached the eligibility age were granted a pension in England and Wales (613,873 out of 1,068,486 according to the Department of Labour Statistics, 1915, p. 184). The vast majority of pension recipients (about 93% in 1911) also received the maximum pension of 5 *shillings* per week. According to Feinstein (1990), this amounted to approximately 22% of average wages.

The OPA was a response to the perceived inadequacy of the the existing poor relief system that provided only very basic protection and involved considerable sanctions such as the loss of voting rights and the requirement of working in a workhouse unless the person could prove to be sufficiently unfit. The newly introduced pensions were not only less restrictive but also involved more generous benefits[7], and thus considerably more older individuals applied for them (Thane, 2000). In contrast to the poor law, which was administered and financed at the local level giving local authorities a lot of discretion in the assignment of financial aid, the OPA was enacted as a nation-wide right for older

[6] See Casson (1908) for details.

[7] At the time of the introduction of the OPA, poor relief was about 3 *shillings* per week and thus amounted to 60% of the new pensions that were legislated by the OPA (Casson, 1908).

workers who met the specified eligibility criteria for receiving a pension.

Pension eligibility was mainly based on three criteria: age, citizenship and inadequate means.[8] First of all, older workers only became eligible when reaching the age of 70. The original proposal for the reform, dating back to 1899, recommended a retirement age of 65, which would have been more in line with the retirement rules in the few pre-existing pension schemes that typically specified an age between 60 and 65.[9] However, the original suggestion was considered too expensive. Given the low life expectancy at birth (below 50 for males in 1911), a retirement age of 70 seems high by today's standards. The low life expectancy, however, was mainly driven by high infant mortality. Once reaching the age of 70 in 1911 (birth cohort 1841), individuals could expect to live another 9 years on average (men: 8.5 yrs., women: 9.5 yrs. Human Mortality Database, 2018).

Second, eligibility required being a British subject[10] as well as having resided in the UK within the last 20 years.

Third, eligibility was conditional on a means test. Claimants had to prove to the pension authority that their annual means were below 630 *shillings* (54% of average annual wages at that time) to receive any pension. To become eligible for the maximum pension, an income of less than 420 *shillings* (36% of average annual wages) was required. Annual income was calculated based on the actual income received in the previous year (including family transfers) and augmented, if applicable, by the rental value of living in one's own house as well as a hypothetical return on property that so far had not been used commercially even though it could have been. Income of couples living together was added up and divided by two.[11] The law also prescribed that if individuals intentionally

[8] Even if the claimant had satisfied all of the three eligibility criteria, he could still be disqualified due to the following reasons. First, receiving poor relief or having received poor relief any time between January 1908 and December 1910. Second, habitually failing to work according to her ability. And third, being detained in a lunatic asylum, or in any place as a recipient of poor relief or a criminal lunatic or being in jail (or ordered to be imprisoned) less than ten years ago.

[9] Small-sized pension schemes within the boundaries of the respective firm existed previous to the large-scale introduction of the OPA. However, these pensions were rather informal and discretionary. More formalized schemes only existed in very few larger firms, for example in the railway industry. By far, these pensions did not reach the universal coverage rate that was introduced through the OPA (see Thane, 2000, for details on pre-existing pensions in the UK).

[10] British subjects are defined to be individuals born within the British dominions, i.e. the British empire.

[11] An example provided in Casson (1908) clarifies this rule: imagine a married couple. The man earns

deprived themselves of resources, the value of these resources would still be included in the calculation of the annual means.

Pensions were granted based on a gliding scale as depicted in figure 1 and table 1. However, the overwhelming majority received the maximum pension of 260 *shillings* per year. For simplicity, the pensions did not account for differences in the costs of living across regions, even though this has been considered during the legislation process.

Applications for pensions were typically made at the local post office. They were checked by a pension officer appointed by the treasury and a local pension committee. Most applications were approved with a rejection rate of only 10% (The Times, 1909; Old Age Pensions Committee, 1919). The main reasons for disapproval were the inability to prove the individual age, a failed means test or receiving poor relief. Proving age was easy for pension claimants in England and Wales because birth registers (and thus birth certificates) existed at least since 1837. Verification was more difficult in Scotland and especially challenging in Ireland, making rejections based on the age criterion far more frequent in Ireland (Old Age Pensions Committee, 1919).

Despite the relatively high retirement age, the costs of the newly introduced pension payments were considerable. In the budget year 1911, £6.3 million were spent on old-age pensions in England and Wales. For the entire UK, old-age pension expenditures amounted to £9.8 million, making pensions one of the largest single spending item (5.7% of overall expenditures in the budget of 1911,(House of Commons, 1911)). Pensions were financed almost exclusively by taxes on the wealthy.[12] The tax rates were generally low and ranged between 3.75% and 8.3% (House of Commons, 1911). The maximum tax rate of 8.3% was levied on extremely high earnings of more than £5,000 per year (roughly the top 0.05% of earnings, according to Atkinson, 2005) while the minimum tax rate of 3.75% was levied for individuals with incomes above £160 and below £2,000 per year.

£40 and the woman £10. In this case, the woman had to claim an income of at least £25 ((40+10)/2). The man, however, had to report his entire income of £40. Thus, only the wife would have been eligible for a pension.

[12]Other far less important components of the financing system were death duties as a type of inheritance tax and stamp duties on investments. For details on the financing sources of the OPA, see Murray (2009).

# 3 A Model of Lifetime Labor Supply

We use a static labor supply model to generate predictions on how individuals respond to the introduction of old-age assistance. The model captures the financial incentive from the OPA by relating the present value of lifetime consumption to the retirement age when old-age assistance is available. Figure 2 depicts the lifetime budget constraint both with and without old-age assistance, assuming certain lifetimes ($T$) and that the individual earns $w$ for each year of work. Without the OPA, individuals who never work have lifetime consumption possibilities of $\alpha$ (e.g. from family transfers). Individuals who work over the entire lifespan have lifetime consumption of $\alpha + wT$. With OPA available, the set of lifetime consumption opportunities expands, introducing a parallel upward shift of the lifetime budget constraint. This transfer component induces non-distortionary income effects, such that individuals optimize over leisure and consumption, conditional on the availability of the pension.

Starting at the eligibility age $R_{ELIG}$, the availability of OPA induces a convex kink in the budget set due to the implicit tax through the means test. Since benefits $b$ are conditional on insufficient means (recall figure 1), labor earnings are taxed by an implicit rate of $\tau = min\{1, b/w\}$. Assuming continuously distributed preferences of consumption and leisure in the population and that leisure is a normal good, this feature of the budget constraint implies that some individuals above the kink will reduce their retirement age. For these individuals, consuming marginally more leisure is compensated by the income from pension benefits. Due to the convexity of the kink, the model predicts bunching of retirements just at the eligibility age ($R_{ELIG}$) for those who would retire at ages slightly above $R_{ELIG}$ if pensions were not available. As a key element of our empirical analysis, we will show an immediate drop in labor supply upon reaching the age-based eligibility threshold ($R_{ELIG} = 70$), which is exactly the prediction generated by the static labor supply model.

To further illustrate how labor earnings are taxed implicitly, figure 3 relates annual earnings to the sum of annual earnings and old-age assistance. The figure shows how the pension schedule creates jumps in the total individual income from working and through government transfers, inducing disincentives to increase labor supply at those points where a marginal increase in earnings will lead to a reduction in total income. For example, a person who earns 420 Shillings per year receives annual benefits of 260 Shillings while a person who earns 421 Shillings per year only receives 208 Shillings. On aggregate, this extends to the entire lower region of the earnings distribution, where a person who earns 680 Shillings per year obtains just the same amount of money as a person who earns only 420 Shillings but qualifies for the full amount of old-age assistance of 260 Shillings.

# 4 Empirical Strategy and Data

## 4.1 Exogenous Variation and Research Design

The identifying variation that we use to estimate the causal effect of pension availability on LFP is based on the age cutoff that was introduced by the OPA. Pension eligibility at age 70 creates a discontinuity in the local environment between age 69 and 70. Along the lines of this age threshold, we adopt an RD with the age as assignment variable. The identifying assumption is that the outcome of interest, LFP, would evolve smoothly between age 69 and 70 if the OPA had not been introduced. Any discontinuous jump of the outcome at the eligibility cutoff can be attributed to the availability of the pension if other programs did not affect LFP at the respective age.

Reaching eligibility does not necessarily mean that individuals instantaneously retire and claim pensions. At the eligibility threshold, however, the probability of retiring exhibits a discontinuous jump due to the fact that a substantial share of older workers become eligible for the OPA while claiming the pension was not possible below the age cutoff.[13] Since pension eligibility also depends on other criteria such as the means test, there is imperfect compliance and hence the retirement probability does not jump from zero to one. This setting can be referred to as a *fuzzy* RD[14], where treatment is not fully determined by the age cutoff.

[13]For a similar setting where an age-based eligibility threshold of retirement is used to study consumption outcomes, see Battistin et al. (2009).

[14]See Lee and Lemieux (2010) for an overview on RDs.

## 4.2 Estimation

The observable outcome $y_a$ is an indicator of LFP that takes the value one if the individual is in the labor force at age $a$ and zero otherwise. We thus estimate the equation

$$y_a = \beta_0 + \beta_1 \mathbb{1}(a \geq 70) + \beta_2 f(a) + \varepsilon_a \tag{1}$$

where the coefficient of primary interest, $\beta_1$, measures the percentage point difference in LFP, comparing the share of individuals in the labor force marginally above the age cutoff (age 70) to the respective share marginally below the age cutoff (age 69). To account for the possibility of a functional relationship between the outcome LFP and the assignment variable age, the function $f(a)$, which is allowed to vary on either side of the age cutoff, not only includes age linearly but also as a second order polynomial. However, graphical evidence suggests that the age-LFP relationship is essentially linear especially close to the age-cutoff.

To show that our results are exceptionally robust against changes in the specification, we implement several alternative estimation procedures that are common in the RD literature. We extend the baseline estimation framework with uniform weighting to more flexible local non-parametric estimates that put more weight on observations close to the cutoff (triangular kernel weighting). We also present bias-corrected point estimates with robust standard errors as suggested by Calonico et al. (2014a,b) and provide detailed results on how the estimates differ by bandwidth choice and the order of the polynomial (see section 5.6).

## 4.3 Data and Summary Statistics

The analysis relies on full-count individual level census data for three decennial UK census waves collected in the spring of 1891, 1901 and 1911. The dataset is a recent release by the Integrated Census Microdata (I-CeM) project (Higgs et al., 2013), distributed by Integrated Public Use Microdata Series International (IPUMS International Minnesota

Population Center, 2018).[15] We use information for England and Wales, thus excluding Scotland, Ireland and the Channel Islands because data is not available for the other regions at all points in time. Moreover, birth certificates, which substantially reduce age-misreporting, only existed in England and Wales for a sufficiently long period. Finally, we exclude persons with unknown gender (less than 0.1 % of the population) or age (0.2 % of the population).

#### 4.3.1 Dependent Variable

Our definition of labor force status is based on the gainful employment concept which was used before the UK adopted the current labor force definition in 1961. In contrast to the current definition, which categorizes people based on their activity status (working or seeking work) in a specific reference week, the gainful employment concept derives the labor market status from the occupation of the respondents. In particular, we include people in the labor force (LFP = 1) if they report an occupation (working) or are either unemployed or formerly employed (not working). Individuals are considered out of the labor force (LFP = 0) if they report no occupation or that they have retired from a specific occupation.[16] Both the current definition of LFP and the gainful employment concept are closely related. Costa (1998) constructs participation rates based on the gainful employment concept for the U.S. until the 1990s, showing that the patterns of both series match. Similarly, Johnson (1994) argues that the change of the definition in 1961 did "appear to have had little effect on the enumeration of older workers" (Johnson, 1994, p. 109). Based on this evidence, the two concepts arguably yield very similar patterns of LFP over time. For our empirical analysis, potential differences between the two concepts are of little relevance because the gainful employment concept did not change

[15] The I-CeM project collaborated with the website findmypast.org to transcribe and harmonize several historical British censuses, encompassing data collected in the years 1851, 1861, 1881, 1891, 1901, and 1911. Recent economic studies that have used selected waves are, for example, Arthi et al. (2019) and Beach and Hanlon (2019).

[16] Following the census in 1891, retirement was explicitly recognized as a separate category and retirees were not considered economically active anymore (Johnson, 1994), which is arguably consistent with being out of the labor force. We adjust the labor force variable constructed by IPUMS International by defining individuals to be out of the labor force if they state an occupation but add that they have retired already.

throughout the time under study (1891 - 1911). Differences only need to be kept in mind when comparing the results to the current LFP concept.

#### 4.3.2 Summary Statistics

Using full-count census data enables us to zoom in directly at the age cutoff. Figure 4 shows the distribution of observations over age for the 1911 census, including 150,293 individuals at age 69 and 140,288 individuals at age 70. The drop in sample size from age 69 to 70 is natural as sample size declines steadily with age. While the 1911 census counts more than 400,000 individuals at age 50, the number of individuals drops below 5,000 at age 90.

Summary statistics in table 2 (upper panel) report a considerable decline in LFP between age 69 and 70. The drop totals to 7 percentage points (from 46% to 39%), while differences in other observable characteristics are fairly small. At age 70, individuals are less often married and the share of foreign born individuals is slightly higher. The lower panel in table 2 reports summary statistics for the baseline estimation sample with five age-years below the cutoff (65 - 69, N: 803,208) and above the cutoff (70 - 74, N: 551,100). Including additional age-years naturally leads to a larger differential in mean LFP rates of 48% below the eligibility age and 34% above. The mean values of other socio-economic background variables such as urban share, marital status, and disability status are largely similar across the age threshold and also with respect to only comparing ages 69 vs. 70 in the upper panel.

Throughout this study, we examine the labor supply responses jointly for men and women. Since the participation rates of women were generally low, we also present the main results separately for men and women.[17] In general and for both men and women, the decline of LFP rates over age evolved less steeply than today. We will argue in this paper that one major explanation for this phenomenon was the low coverage by social security and old-age pensions in the early 20th century.

[17]Table 2 indicates that the average LFP rate marginally below the eligibility threshold (age 69) was 46%. However, while only 20% of women were still economically active at that age, the LFP rates of older men were relatively high and totaled to 76% (figure 12). See section 5.4 for separate results regarding men and women.

The majority of older workers (almost one third) was active in sectors such as crafts or related trades (table 3). The second largest sector included service workers, followed by skilled agricultural and fishery work and elementary occupations. In contrast, only few older workers earned a living as senior officials or managers, technicians or other professionals. We use occupational information later-on to construct a measure of labor earnings. This allows for estimates of the labor supply response to pension availability in different regions of the earnings distribution and is insightful regarding the functioning of the means test.

# 5 Results

## 5.1 Baseline Results

Table 4 reports baseline RD estimates from our preferred specification that quantifies the LFP differential at the eligibility threshold when moving from age 69 to 70.[18] The estimates indicate a precisely measured drop in LFP of 5.3 percentage points (quadratic polynomial) to 6.0 percentage points (linear polynomial). Contrasting the LFP distribution over age separately for the 1901 and the 1911 censuses, figure 5 reveals the striking difference in age-specific LFP patterns before and after the OPA became effective in 1909. Without universal coverage by old-age assistance in 1901, participation rates decline gradually over age (figure 5, panel a). In contrast, we observe an abrupt drop of LFP in 1911 (figure 5, panel b) exactly at the age cutoff between 69 and 70. The sudden drop only appears at the eligibility age after the introduction of the OPA. Since no other social security programs existed that would impact LFP between age 69 and 70, the LFP reduction is caused by the availability of the OPA.

The estimated decline is sizable both in absolute and relative terms. Departing from a

[18]Our preferred specification uses a bandwidth of 5 age-years to the left (65 - 69) and to the right (70 - 74) of the age cutoff, a linear polynomial in age, and uniform kernel weighting putting the same weight on all observations. Although graphical evidence in figure 7 suggests that linear and quadratic polynomials reproduce the LFP-age relationship very similarly, we present the baseline estimates for both. For brevity, we use the linear specification for all subsequent RD specifications, including placebo and robustness checks. Throughout, the results are very similar for the quadratic polynomial and are available from the authors upon request.

participation rate of 46% at age 69, the estimated absolute decline of 5.3 to 6.0 percentage points translates into a relative decline of 12% to 13%. Given the scale of the program and the absence of other social security programs such as unemployment insurance at the time, the substantial decline in participation rates is not surprising. The considerable negative impact of the OPA on LFP rates of older workers can, however, be easily overlooked in aggregated labor market trends: as noted by Johnson (1994); Costa (1998), the decline of LFP rates in the UK has not accelerated throughout the first decade of the 20th century. In fact, splitting our sample in two groups of ages marginally below eligibility (age 69) and marginally above (age 70), shows that LFP rates at age 69 were falling between 1891 and 1901 but slightly increasing between 1901 and 1911. In contrast, the LFP rates constantly declined among eligible workers (age 70) both between 1891 and 1901 and between 1901 and 1911. This pattern is apparent from a simple difference-in-differences (DiD) representation in figure 6.[19] Without the OPA, LFP would have declined more slowly among eligible older workers (age 70).

Our results are consistent with findings of Fetter and Lockwood (2018), who study the effects of the introduction of the old-age assistance program in the U.S. They find that the labor supply of men aged 65 to 74 declined by 8.5 percentage points between 1930 and 1940 as a consequence of the introduction of old-age assistance in 1935. Our estimated LFP decline of 5.3 to 6.0 percentage points is slightly smaller in magnitude. In contrast to the U.S. case, where almost half of the decline was explained by exits from work relief programs and unemployment, direct transitions from work to retirement were more prevalent in the UK.

To examine the labor supply response of the population that retires directly from

[19]For this exercise, we add the census wave of 1891 in addition to 1901 and 1911, which allows us to graphically test the common trend assumption. For the two age groups at the eligibility threshold set by the OPA, the graph indicates a common trend in the pre-treatment period between 1891 and 1901, showing that LFP rates of the two groups move in tandem between 1891 and 1901. The common trend is stable for neighboring ages below the eligibility threshold (65-69) and above (70-74), as is evident from figure A.15 in the appendix. After that, between 1901 and 1911, the two age groups diverge in terms of LFP. The DiD estimate quantifies the LFP differential to range between 4.0 to 4.5 percentage points difference between older workers aged 69 and 70 (table 5). It eliminates any time-constant unoberservables that would confound estimating the impact of the introduction of the OPA on LFP. The DiD is robust against including any available observable characteristics such as number of own children in the household, household size, and indicators for being married, foreign born, disabled, and region (covering the 53 counties in England and Wales).

active work, we now disregard the unemployed and the formerly employed and deviate from the main LFP measure by setting LFP = 1 only for those who are actually working (and LFP = 0 for everyone else). We assume that those individuals in the data who report an occupation are actively working and that those who report to be unemployed or formerly employed are not working. This exercise shows that almost the entire decline in LFP is driven by people who stop working (figure 8). The LFP rate among active workers declines significantly by 5.7 percentage points at the age-based eligibility threshold (table 6, column 1). When setting LFP = 1 for those in the labor force who are unemployed or formerly employed, the drop is virtually non-existent (table 6, column 2). The declining LFP rates are hence strongly driven by older workers who directly retire from active work.

## 5.2 Labor Supply Effects Across the Earnings Distribution

Looking at labor supply responses across the earnings[20] distribution allows to test the key implication of the earnings test that individuals with higher earnings have to forgo more income to become eligible for old-age assistance. Figure 9 depicts the earnings distribution in 1911 and indicates the quartiles of the distribution (mean: 56£).

Figure 10 shows that the negative labor supply response is more pronounced at the lower margin of the earnings distribution. In the first quartile, the 15.4% reduction in LFP more than doubles the one in the fourth quartile (7.2%). This finding is consistent with the theoretical prediction that substituting labor earnings (from work) with pensions is less likely when earnings are high. High-earnings individuals have to trade-off a considerable drop in consumption opportunities against leisure gains from retiring.

## 5.3 Family Background and Old-Age Insurance

Several dimensions of the family background can function as old-age insurance, especially in absence of a social security system. This has mainly been pointed out with regard to children (Leibenstein, 1957; Caldwell, 1982; Cain, 1983; Boldrin and Jones, 2002),

[20]The census data do not directly measure earnings, but as detailed in appendix B, we construct earnings based on occupational information that we match to more recent UK census data that do report individual earnings.

but establishing a pension system can replace any type of family-related transfers from spouses or other related household members. This mechanism was also recognized during the legislation process of the OPA and, after some debates, it was finally decided that voluntary family transfers must be included in the calculation of the annual means of a pension claimant (Casson, 1908).

Given that voluntary transfers from family and household members to older individuals are considered in the means-test, this could impact eligibility and corresponding labor supply responses. Individuals without close family ties who marginally fail to become eligible for the pension due to the means-test, are expected to react more strongly because they could replace one pound of labor earnings one-to-one with an additional pound from the pension by substituting work against leisure. In contrast, older workers who receive family transfers are expected to react less if they have access to alternative sources of old-age income and are therefore less likely to pass the means test. Although we do not have information on within-family cash transfers, we can test three dimensions of family background based on available information in the census. First, we proxy intergenerational transfers from children by distinguishing older workers with and without own children in the household. Second, we use marital status to proxy transfers in spousal relationships. And third, we compare single versus multiple person households as a more general measure for transfers from closely related individuals.

Table 7 reports RD estimates from samples that are stratified by individuals with and without own children in the household. These estimates indicate that older workers without own children in the household have stronger declines in LFP rates: at the age-based eligibility threshold the reduction amounts to 6.9 percentage points. In contrast, the LFP reduction only amounts to 5.1 percentage points among older workers without children. The finding of stronger LFP reactions among older workers without children is consistent with the hypothesis that the availability of the pension enables them to retire, supporting the view that children served as a type of old-age insurance before social security systems existed. Graphical evidence in figure 11 further supports the estimation results, however, it must be noted that comparisons between individuals with and without children do not have a causal interpretation.

The insurance argument is particularly salient when looking at solitaire individuals. Consistent with this view, the labor supply reductions among non-married individuals are larger compared to the sub-sample of married individuals (table 7) although these estimates do not significantly differ (z-statistic = 0.6). Individuals living on their own, having to make their own ends meet, generally tend to be more responsive to stopping work and claiming the pension. This relationship becomes even more evident when comparing estimates of the labor supply response in single person households versus multiple person households. Individuals living alone show large LFP reductions of 9.5 percentage points, while those living with one or more other persons significantly less (5.7 percentage points, z-statistic: 3.2).

## 5.4 Labor Supply Effects by Gender

A particularly robust finding documented in the literature on labor supply is that women have much larger labor supply elasticities than men, especially on the extensive margin of labor supply (see Keane, 2011, for a review). One important difference between men and women, in particular when using data from the 20th century, is that a large share of women never worked. This also holds in the cohorts under study here and is apparent from comparisons of LFP rates between older men and women (figure 12). The figure indicates that LFP rates at the age of 69 were much larger among men (76%) compared to women (20%). RD estimates on separate male and female samples (table 8) show that, in absolute terms, the labor supply responses are larger among men (7.9 percentage points) as compared to women (3.2 percentage points). When placing the smaller female labor supply reduction into context of their smaller LFP rate, their relative reduction of 16% is much larger compared men (10%), which is consistent with larger female labor supply elasticities as documented in the literature.

RD estimates across the earnings distribution also differ between men and women (figure 13). Especially in the second earnings quartile, women show dramatic labor supply reductions of up to 27%. Due to their relatively low earnings[21], women also had low

[21] The mean earnings of women in 1911 are 41£, which amounts to two thirds of mean earnings among men (60£).

adjustment costs in terms of forgone earnings to pass the means test. This is largely in line with the observation that the female labor supply response is particularly large at the lower margin of the female earnings distribution.

### 5.5 Within-Family Spillovers: Joint Retirement of Couples

Many empirical studies suggest that within-family spillovers play an important role in retirement decisions (Blau and Riphahn, 1999; Gustman and Steinmeier, 2000; Baker, 2002; Atalay et al., 2019). Any correlation of tastes for leisure between partners may lead to joint retirement behavior of couples.

The UK census includes information on the labor force status of the partner, if existing, for each individual. We use this information to look at individuals who have already reached the eligibility age (70) and to show their LFP rates as a function of the age of the corresponding spouse. Figure 14 shows that there is a sizable jump at the age cutoff in 1911 (OPA available), indicating that LFP rates drop among individuals whose spouse reaches age 70 and thus also becomes eligible. This graphical evidence is further supported by RD estimates in table 9 that report a significantly measured LFP drop of 3.1 percentage points of eligible individuals whenever their spouse becomes eligible. The significant drop in LFP is mainly driven by eligible men (3.3 percentage points) in the moment when their wife becomes eligible but not vice versa. These results are strongly suggestive for within-family spillovers and are in line with previous findings on joint retirement decisions of couples.

### 5.6 Validity and Robustness of the RD

Several sensitivity checks and falsification tests support the validity of our RD design. Based on these exercises, the estimates presented above can be given a causal interpretation.

#### 5.6.1 Smoothness Analysis

We start verifying the validity of the RD by testing whether pre-determined covariates exhibit a discontinuity at the threshold. This smoothness analysis includes observable characteristics on the number of own children in the household, the share of individuals living in urban areas, the share of married, foreign born and disabled persons, and household size (similar to the summary statistics reported in table 2). These variables mainly evolve smoothly around the age-based eligibility threshold, as suggested by the estimates in table 10 and figure A.16. Although discontinuities arise for some variables (share of married, foreign born, disabled and single individuals), these differences are negligibly small. Further estimates on respective sub-samples indicate that these groups do not drive the results (table 11 and figure A.17). We conclude that measurable discontinuities in observables at the age-based eligibility threshold are small and uncorrelated to LFP and thus unproblematic for the identification. In summary, the smoothness analysis suggests that no relevant changes other than the outcome of interest (LFP) take place at the age cutoff, thus supporting the validity of the RD.

#### 5.6.2 Placebo Tests

Next, we conduct two placebo tests to show that LFP effects do not appear at any arbitrarily chosen age cutoff. First, we run the baseline RD specification on the 1901 census to ensure that the abrupt LFP decline measured after the introduction of the OPA in 1911 does not occur in 1901. Table 12 (upper panel) indicates that there is no sizable LFP decline in 1901, consistent with graphical evidence in figure 5 (panel a) that indicates a smooth LFP decline over age before the pension was introduced. Table 12 also shows that there is no substantial drop in LFP at age 60 in the 1901 census. Since the birth cohort that reached age 60 in 1901 eventually reached age 70 in 1911, it includes those individuals that are marginally eligible because they are marginally above the eligibility threshold. Hence this robustness check rules out that individuals that play a key role for the identifying variation in the RD design did not already exhibit an LFP decline at earlier ages before the OPA was introduced.

Second, we repeat the analysis for arbitrarily chosen placebo age cutoffs in 1911. RD estimates in table 12 (lower panel) show that we do not observe a similar decline in LFP rates at any hypothetical age cutoff other than the true eligibility threshold at age 70.[22]

#### 5.6.3 Bandwidth Choice, Polynomials, and Bias Correction

We finally present several adjustments to the baseline specification that have been proposed in the RD literature to verify robustness of the estimates (table 13). First, the estimates are not sensitive to bandwidth choice and only change little when making the bandwidth arbitrarily large. Second, changing the polynomial degree when modeling LFP as a function of age does not indicate sizable changes in the coefficients. Alternative estimation techniques also indicate that the baseline estimates are robust when estimating local non-parametric and bias-corrected point estimates with robust standard errors as suggested by Calonico et al. (2014a,b). Overall changes in estimates are only moderate even when undertaking considerable changes in bandwidth, age polynomials, weighting scheme (uniform vs. triangular kernel) or estimation procedure.

## 6 Welfare Costs of the Means Test

We now translate the causal estimate of the labor supply reduction into the welfare impact of the introduction of the OPA. This formal attempt to translate our estimates into a statement about welfare departs from bounding the welfare costs of the means test. For this purpose, we look at two classes of pension recipients. The first group consists of infra-marginal individuals who are eligible for pension payments from the OPA irrespective of their behavior. Infra-marginal individuals pass the means test without stopping to work. The second group consists of marginal individuals who only become eligible if they reduce their labor earnings because they would otherwise fail the means test.

The bounds of the welfare costs are obtained from relating the causal estimate of the labor supply reduction (6 percentage points) to the pension recipience rate in close

[22] This result holds for any other hypothetical age cutoff. Additional placebo tests on arbitrarily chosen age cutoffs are available from the authors upon request.

distance to the eligibility threshold that corresponds to the individuals used in the baseline RD framework (17.5% in the age group 70 - 73).[23] Among recipients, this yields a share of 34% marginal individuals who reduce their labor supply to become eligible for the pension. This is a direct implication from the 6 percentage point decline in labor supply that is caused by the introduction of the pension. It also implies that 66% of the recipients do not have to reduce labor supply to become eligible and thus belong to the group of infra-marginal individuals.

Assuming that infra-marginal individuals valued their pension benefits fully[24], the average recipient valued pension benefits with at least 66% of their pound amount. This average is a lower bound to the extent that infra-marginal individuals value their benefits fully while marginal individuals value their benefits at zero. The average valuation of benefits thus ranges somewhere between 66% and 100% because it is likely that marginal individuals value their pension benefits higher than zero and is probably close to 100% for individuals with low earnings or who left the labor force from unemployment.

We conclude that the average recipient is likely to have valued one pound of benefits much higher than 66%, indicating that the welfare costs of the program were low despite its considerable labor supply impact. Large labor supply responses that coincide with low welfare costs not only suggest that older workers in active employment had to forgo only little earnings to become eligible for the pension. It is also consistent with recent evidence by Gelber et al. (2019) who show that the smaller the adjustment costs from responding to a policy, the larger the absolute changes in bunching before and after the policy was introduced. Against the historical background, the OPA involved arguably

[23] The census data do not directly report information on pension recipients. However, we do have information on the total number of recipients in 1911 (Department of Labour Statistics, 1915) which allows computing a lower bound of the recipience rate in the local environment of the age cutoff under fairly plausible assumptions. In particular, the total number of recipients in 1911 was 613,873 and the population size of individuals aged 70 and older was 1,068,486. When subtracting the population aged 74 and older (517,386 individuals), we obtain the population size for the age group 70 - 73 (551,100 individuals), which corresponds to the age group marginally above the age cutoff that we use in the baseline RD. Assuming that every individual above age 73 received the pension, there would be a minimum of 96,487 individuals in the age group 70 - 73 who receive the pension (613,873 - 517,386 = 96,487). Relating this minimum number of recipients at age 70 - 73 to the population in that age range (551,100) thus yields the lower bound for the recipience rate between age 70 to 73.

[24] This assumption is plausible since infra-marginal individuals would receive the pension anyway as they have sufficiently low means to pass the means test.

small adjustment frictions so that it was straightforward to stop working and claim the pension once having reached the eligibility age and having passed the means test.

We further elaborate on the marginal value of public funds (MVPF) as a framework for translating our causal estimate of the labor supply effect that the OPA had into the welfare impact of the policy. The MVPF, introduced by Hendren (2016) and recently summarized and interpreted by Finkelstein (2019), is the benefit-to-cost ratio of the individuals' willingness to pay for the policy change, relating to the cost of the policy to the government

Finkelstein et al. (2019) have provided an empirical example for welfare analysis of non-marginal expansions of a program, that is useful in our context as we are looking at the first-time introduction of a pension system. This non-marginal policy change thus implies a switch from no program to full program that can be summarized as a discrete (non-marginal) change.

# 7 Conclusions

This paper adopts a regression discontinuity design to estimate the effects of universal old-age assistance on labor supply of older workers in the UK. The Old-Age Pension Act introduced means-tested minimum pensions in 1909 and created an age-based eligibility threshold at the age of 70. At this age cutoff, we measure the identifying variation from a large share of individuals who become eligible for the pension when turning 70. We use full-count census data, covering the entire male population between 1891 and 1911. Our outcome is a measure of labor force participation that we derive from detailed information about occupations and labor force withdrawal.

The main results of this paper are summarized as follows. We find a considerable reduction of labor supply in the local environment of the eligibility threshold. When turning 70, the labor force participation rate declines by up to 6 percentage points, thereby reducing the workforce by about 13%. These estimates can be interpreted as a labor supply response as they are dominated by individuals who directly retire from active work. Further heterogeneity analysis suggests that individuals without children react more strongly to pension incentives, thus showing larger declines in labor supply.

The historical background of the policy under study provides unique insights on the relationship between pension incentives and labor supply. The early 20th century introduction of old-age assistance in the UK was one of the largest programs of its kind at that time. It was also the only government program that specifically targeted the elderly in the UK. This setting allows us to identify the full labor supply effects and thus extends a large body of literature that quantifies the incentive effects of marginal changes of program parameters in existing pension schemes. Learning about the full effects of such programs is policy-relevant even today, especially in developing countries without universal coverage of pension systems. Studying such a particular setting is beyond the scope of this paper but the parameters identified here would be informative when introducing pension schemes for the first time.

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# Appendix

## Tables

Table 1: Pension Schedule

| Annual Means X | Weekly Pension Entitlement |
|---|---|
| X $\leq$ £21 | 5 Shillings |
| £21 $<$ X $\leq$ £23, 12s and 6d | 4 Shillings |
| £23, 12s and 6d $<$ X $\leq$ £26 and 5s | 3 Shillings |
| £26 and 5s $\leq$ $<$ X £28, 17s and 6d | 2 Shillings |
| £28, 17s and 6d $<$ X $\leq$ £31, 10s and 6d | 1 Shilling |
| X $>$ £31 and 10s | – |

*Source:* UK legislation (1908). *Note:* X denotes annual means, s denotes shillings and d denotes pence. £1 corresponds to 20s or 240d.

Table 2: Summary Statistics by Age (Census 1911)

| | 69 | | 70 | |
|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. |
| Share Female | 0.55 | 0.50 | 0.56 | 0.50 |
| Share Urban | 0.10 | 0.30 | 0.10 | 0.30 |
| Share Married | 0.50 | 0.50 | 0.47 | 0.50 |
| Share Foreign Born | 0.04 | 0.20 | 0.06 | 0.24 |
| Share Disabled | 0.02 | 0.13 | 0.02 | 0.14 |
| N Children in the Household | 0.8 | 1.1 | 0.7 | 1.0 |
| Share Single Households | 0.07 | 0.26 | 0.08 | 0.28 |
| Labor Force Participation Rate | 0.46 | 0.50 | 0.39 | 0.49 |
| Observations | 150,293 | | 140,288 | |

| | 65 - 69 | | 70 - 74 | |
|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. |
| Share Female | 0.55 | 0.50 | 0.57 | 0.50 |
| Share Urban | 0.10 | 0.30 | 0.10 | 0.29 |
| Share Married | 0.54 | 0.50 | 0.43 | 0.50 |
| Share Foreign Born | 0.04 | 0.20 | 0.05 | 0.22 |
| Share Disabled | 0.02 | 0.13 | 0.02 | 0.14 |
| N Children in the Household | 0.9 | 1.2 | 0.7 | 1.0 |
| Share Single Households | 0.07 | 0.25 | 0.09 | 0.29 |
| Labor Force Participation Rate | 0.48 | 0.50 | 0.34 | 0.47 |
| Observations | 803,208 | | 551,100 | |

*Source:* UK Census wave 1911 and IPUMS. *Note:* Reported values for men and women. The upper panel reports values marginally below and above the age cutoff (69 and 70). The lower panel reports values for the baseline estimation sample with 5 age-years below the cutoff (65 - 69) and above the cutoff (70 - 74).

Table 3: Occupational Composition

| | Census 1911 | |
|---|---|---|
| Occupation | Frequency | Percent |
| Legislators and Managers | 10,781 | 0.8 |
| Professionals | 17,262 | 1.3 |
| Technicians | 9,292 | 0.7 |
| Clerks | 14,500 | 1.1 |
| Service Workers | 151,528 | 11.2 |
| Agriculture and Fishery | 105,472 | 7.8 |
| Crafts and Related Trades | 170,959 | 12.6 |
| Machine Operators and Assemblers | 39,143 | 2.9 |
| Elementary Occupations | 54,348 | 4.0 |
| Armed Forces | 1,881 | 0.1 |
| Active | 575,166 | 42.5 |
| Inactive | 779,142 | 57.5 |
| Total Observations | 1,354,308 | 100 |

*Source:* UK Census wave 1911 and IPUMS. *Note:* Reported values on occupations based on ISCO classification at the 1-digit level for individuals aged 65 - 74.

Table 4: RD Estimates of Labor Force Participation at the Age Cutoff (Baseline)

| | Linear | Quadratic |
|---|---|---|
| | -0.060** (0.006) | -0.053** (0.003) |
| Observations | 1,354,308 | |

*Source:* UK Census wave 1911 and IPUMS. *Note:* RD estimates of the labor force participation rate (dependent variable) using an indicator for the age cutoff (= 0 if age < 70; = 1 if age >= 70). Each specification (linear and quadratic) uses a bandwidth of 4 age-years to the left (age 66-69, N: 803,208) and to the right (age 70-73, N: 551,100) of the age cutoff and uniform weighting on all observations. **, * denotes significance at the 1% and 5% level respectively. Standard errors (in parentheses) are clustered at age in years.

Table 5: Difference-in-Differences Estimates of Labor Force Participation

| | (1) | (2) | (3) |
|---|---|---|---|
| DiD Estimate | -0.045** (0.003) | -0.040** (0.002) | -0.040** (0.002) |
| Controls | – | ✓ | ✓ |
| Controls X Census Year | – | – | ✓ |
| Observations | 715,714 | 698,921 | 698,921 |

*Source:* UK Census wave 1891, 1901, 1911 and IPUMS. *Note:* Estimates for men and women aged 69 and 70. **, * denotes significance at the 1% and 5% level respectively. Standard errors in parentheses. The dependent variable is the labor force participation rate.

Table 6: RD Estimates of Labor Supply Response

| | Actively Working (1) | Unemployed/Not Working (2) |
|---|---|---|
| | -0.057** (0.006) | -0.002* (0.001) |
| Observations | 1,354,308 | |

*Source:* UK Census wave 1911 and IPUMS. *Note:* RD estimates of the labor force participation rate (dependent variable) using an indicator for the age cutoff (= 0 if age < 70; = 1 if age >= 70). Estimates based on separate definitions of labor force status: LFP = 1 for individuals who are actively working (column 1) or LFP = 1 for individuals who are unemployed/not working (column 2). All regressions use a bandwidth of 5 age-years to the left (age 65-69) and to the right (age 70-74) of the cutoff, a linear polynomial in age, and uniform weighting on all observations. **, * denotes significance at the 1% and 5% level respectively. Standard errors (in parentheses) are clustered at age in years.

Table 7: RD Estimates Stratified by Family Background

| | RD Coefficient | Observations |
|---|---|---|
| *Children* | | |
| Children in Household | -0.051** (0.006) | 627,733 |
| No Children in Household | -0.069** (0.008) | 726,575 |
| z-Test on Significant Differences | $z = \frac{\beta_C - \beta_{NC}}{\sqrt{SE^2_{\beta_C} + SE^2_{\beta_{NC}}}} = 1.8$ | |
| *Marital Status* | | |
| Married | -0.056** (0.006) | 679,145 |
| Non-Married | -0.062** (0.008) | 675,163 |
| z-Test on Significant Differences | $z = \frac{\beta_M - \beta_{NM}}{\sqrt{SE^2_{\beta_M} + SE^2_{\beta_{NM}}}} = 0.6$ | |
| *Household Size* | | |
| Single Person Households | -0.095** (0.008) | 102,938 |
| Multiple Person Households | -0.057** (0.007) | 1,251,370 |
| z-Test on Significant Differences | $z = \frac{\beta_{SP} - \beta_{MP}}{\sqrt{SE^2_{\beta_{SP}} + SE^2_{\beta_{MP}}}} = 3.2$ | |

*Source:* UK Census wave 1911 and IPUMS. *Note:* RD estimates of the labor force participation rate (dependent variable) using an indicator for the age cutoff (= 0 if age < 70; = 1 if age >= 70). Estimates for sub-samples along the lines of three types of family background variables. All regressions use a bandwidth of 5 age-years to the left (age 65-69) and to the right (age 70-74) of the cutoff, a linear polynomial in age, and uniform weighting on all observations. **, * denotes significance at the 1% and 5% level respectively. Standard errors (in parentheses) are clustered at age in years. Testing for differences between two coefficients with known variances yields a z-test statistic (assumed to be normally distributed), where $\beta$ is the estimated coefficient for the respective sub-sample and $SE$ denotes the corresponding standard errors.

Table 8: RD Estimates by Gender

| | Men | Women |
|---|---|---|
| | (1) | (2) |
| | -0.079** (0.012) | -0.032** (0.004) |
| Observations | 602,458 | 751,850 |

*Source:* UK Census wave 1911 and IPUMS. *Note:* RD estimates of the labor force participation rate (dependent variable) using an indicator for the age cutoff (= 0 if age < 70; = 1 if age >= 70). Estimates for the sub-samples of men (column 1) and women (column 2). All regressions use a bandwidth of 5 age-years to the left (age 65-69) and to the right (age 70-74) of the cutoff, a linear polynomial in age, and uniform weighting on all observations. **, * denotes significance at the 1% and 5% level respectively. Standard errors (in parentheses) are clustered at age in years.

Table 9: RD Estimates Conditional on Eligibility, by Age of Spouse

| Own Age | Total | Men | Women |
|---|---|---|---|
| | | True Age Cutoff | |
| | | *Age of Spouse: 70, Census 1911* | |
| | -0.031** (0.010) | -0.033** (0.009) | 0.004 (0.003) |
| Observations | 142,263 | 90,815 | 51,448 |
| | | Placebo Cutoffs | |
| | | *Age of Spouse: 60, Census 1911* | |
| | -0.008 (0.008) | -0.005 (0.015) | 0.020* (0.010) |
| Observations | 33,669 | 28,085 | 5,584 |
| | | *Age of Spouse: 65, Census 1911* | |
| | 0.012 (0.005) | 0.015 (0.005) | 0.001 (0.003) |
| Observations | 76,804 | 57,616 | 19,188 |
| | | *Age of Spouse: 60, Census 1901* | |
| | 0.020** (0.005) | 0.018** (0.006) | -0.003 (0.009) |
| Observations | 31,163 | 26,894 | 4,269 |
| | | *Age of Spouse: 70, Census 1901* | |
| | -0.006* (0.003) | 0.012* (0.007) | 0.002 (0.001) |
| Observations | 112,066 | 73,370 | 38,696 |

*Source:* UK Census wave 1901 and 1911 and IPUMS. *Note:* RD estimates of the labor force participation rate (dependent variable) using an indicator for the age cutoff (= 0 if age < 70; = 1 if age >= 70) of the respective spouse. Estimates conditional on having reached the eligibility age of 70, separately for the full sample (1), men (2), and women (3). All regressions use a bandwidth of 5 age-years to the left (age 65-69) and to the right (age 70-74) of the cutoff, a linear polynomial in age, and uniform weighting on all observations. **, * denotes significance at the 1% and 5% level respectively. Standard errors (in parentheses) are clustered at age in years.

Table 10: Smoothness Analysis

| | |
|---|---|
| Share Urban | 0.003 (0.003) |
| Share Married | -0.012* (0.005) |
| Share Foreign Born | 0.013** (0.004) |
| Share Disabled | 0.001* (0.000) |
| N Children | -0.007 (0.004) |
| Share Single Households | 0.005** (0.001) |
| | |
| Observations | 1,354,308 |

*Source:* UK Census wave 1911 and IPUMS. *Note:* RD estimates of the respective observable (dependent variable) using an indicator for the age cutoff (= 0 if age < 70; = 1 if age >= 70). All regressions use a bandwidth of 5 age-years to the left (age 65-69) and to the right (age 70-74) of the cutoff, a linear polynomial in age, and uniform weighting on all observations. **, * denotes significance at the 1% and 5% level respectively. Standard errors (in parentheses) are clustered at age in years.

Table 11: RD Estimates on Sub-Samples

| Sub-Sample | RD Coefficient | Observations |
|---|---|---|
| Married | -0.056** (0.006) | 679,145 |
| Non-Married | -0.062** (0.008) | 675,163 |
| Native-Born | -0.061** (0.007) | 1,247,484 |
| Non-Disabled | -0.061** (0.007) | 1,329,510 |
| Non-Single Person Households | -0.057** (0.007) | 1,251,370 |
| Single Person Households | -0.095** (0.008) | 102,938 |

*Source:* UK Census wave 1911 and IPUMS. *Note:* RD estimates of the labor force participation rate (dependent variable) using an indicator for the age cutoff (= 0 if age < 70; = 1 if age >= 70). Estimates for sub-samples as indicated. All regressions use a bandwidth of 5 age-years to the left (age 65-69) and to the right (age 70-74) of the cutoff, a linear polynomial in age, and uniform weighting on all observations. **, * denotes significance at the 1% and 5% level respectively. Standard errors (in parentheses) are clustered at age in years.

Table 12: Placebo Tests

| Age Cutoff | RD Coefficient | Observations |
|---|---|---|
| | *Census 1901* | |
| 70 | -0.009* (0.004) | 1,041,111 |
| 60 | 0.001 (0.003) | 1,889,492 |
| | *Census 1911* | |
| 69 | -0.017 (0.013) | 1,446,757 |
| 65 | -0.004 (0.002) | 1,820,152 |
| 60 | 0.001 (0.002) | 2,293,676 |

*Source:* UK Census wave 1901 and 1911 and IPUMS. *Note:* RD estimates of the labor force participation rate (dependent variable) using an indicator for different placebo age cutoffs (as indicated). All regressions use a bandwidth of 5 age-years to the left (age 65-69) and to the right (age 70-74) of the cutoff, a linear polynomial in age, and uniform weighting on all observations. **, * denotes significance at the 1% and 5% level respectively. Standard errors (in parentheses) are clustered at age in years.

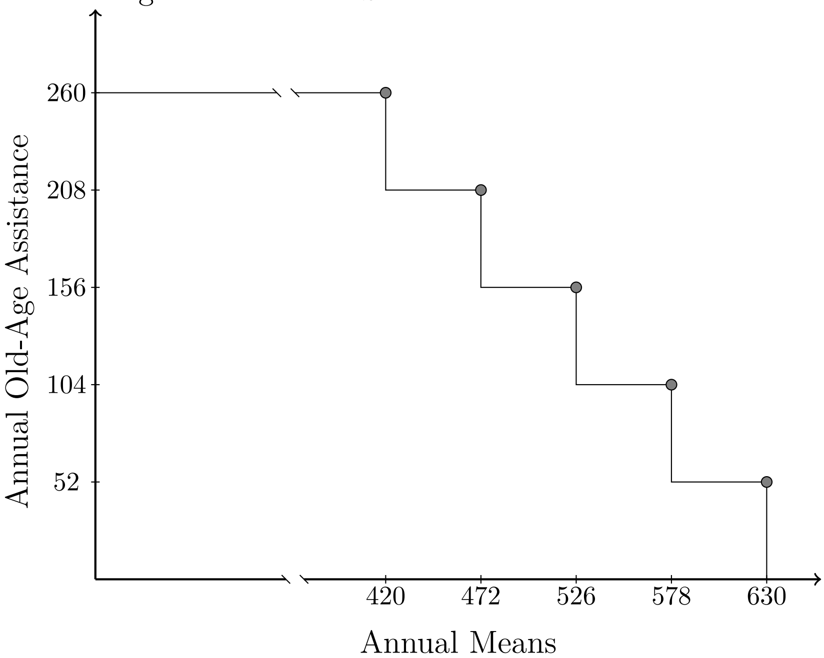
Table 13: Alternative Specifications of the Baseline RD - Bandwidth Choice, Local Polynomials, and Bias-Corrected Confidence Bands

| | | | Local Non-Parametric | |
|---|---|---|---|---|
| | Parametric Linear | Parametric Quadratic | Conventional | Bias-Corrected |
| *Bandwidth (Age-Years)* | | | | |
| 2 | -0.048** (0.000) | -0.036** (0.000) | – | – |
| 3 | -0.056** (0.004) | -0.038** (0.000) | – | – |
| 4 | -0.058** (0.005) | -0.053** (0.005) | -0.054** (0.003) | -0.038** (0.001) |
| 5 | -0.060** (0.006) | -0.053** (0.003) | -0.056** (0.004) | -0.050** (0.005) |
| 6 | -0.063** (0.007) | -0.055** (0.003) | -0.058** (0.005) | -0.052** (0.003) |
| 7 | -0.064** (0.008) | -0.056** (0.004) | -0.059** (0.006) | -0.053** (0.003) |
| 8 | -0.066** (0.008) | -0.058** (0.004) | -0.061** (0.007) | -0.055** (0.003) |
| 9 | -0.070** (0.009) | -0.055** (0.005) | -0.062** (0.007) | -0.056** (0.003) |
| 10 | -0.072** (0.009) | -0.057** (0.005) | -0.064** (0.008) | -0.054** (0.003) |
| 20 | -0.110** (0.012) | -0.061** (0.007) | -0.090** (0.011) | -0.055** (0.007) |

*Source:* UK Census wave 1911 and IPUMS. *Note:* RD estimates of the labor force participation rate (dependent variable) using an indicator for the age cutoff (= 0 if age < 70; = 1 if age >= 70). OLS estimates use uniform weighting of all observations. Local non-parametric estimates use triangular kernel weighting, putting more weight on observations closer to the cutoff. Bias-corrected estimates use the bias correction proposed by Calonico et al. (2014a,b) including robust standard errors and triangular kernel weighting. **, * denotes significance at the 1% and 5% level respectively. Standard errors (in parentheses) are clustered at age in years, unless otherwise specified.

# Figures

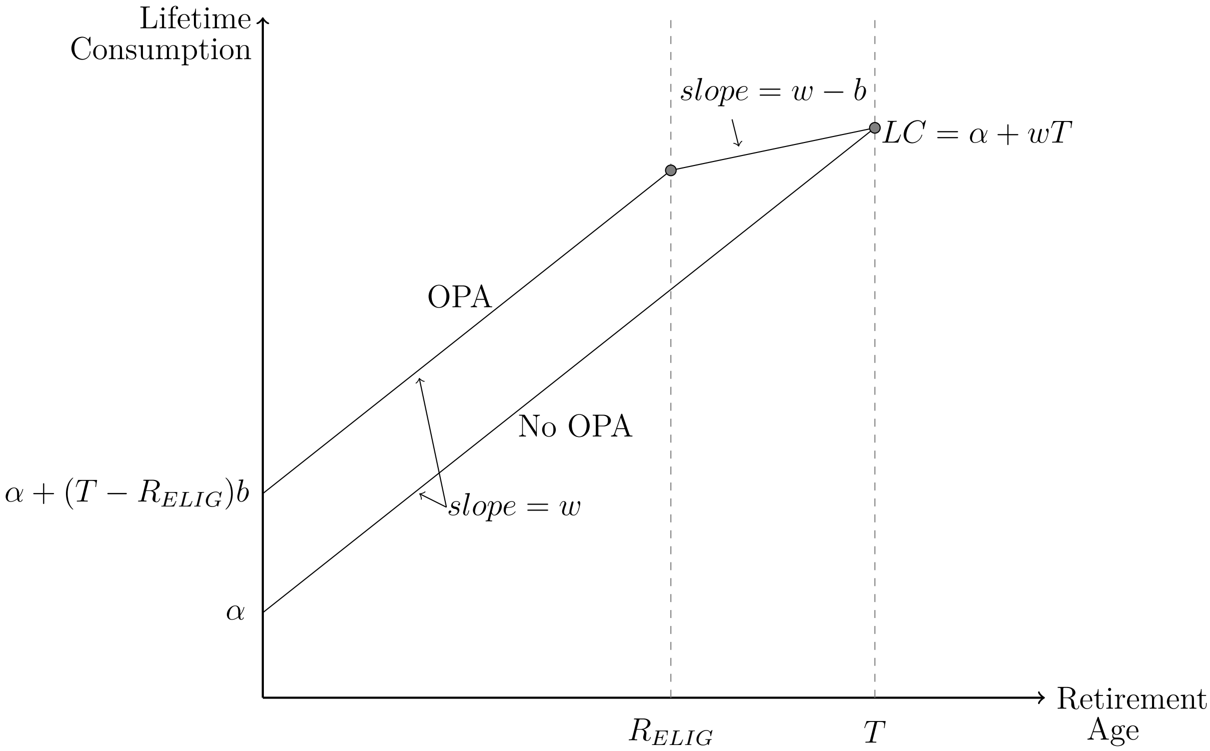
Figure 1: Pension Schedule and Means Test




*Source:* Own graph.

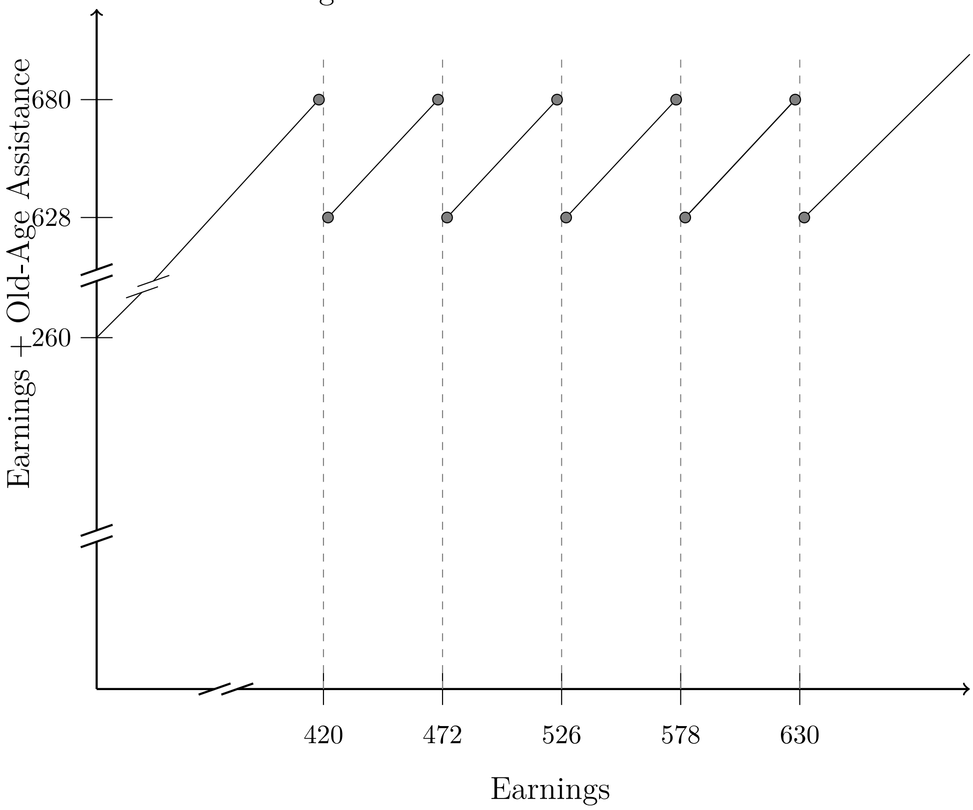
*Note:* The figure depicts critical values of the means test. 20 Shillings = 1 Pound. The maximum pension of 260 Shillings per year (5 Shillings per week) was granted to individuals with annual means of no more than 420 Shillings (36% of the average annual wage in 1911). Individuals with annual means of more than 630 Shillings (54% of the average annual wage in 1911) did not qualify for the pension.

Figure 2: Lifetime Budget Constraint




*Source:* Own graph.
*Note:* The figure relates the present value of lifetime consumption to the retirement age.

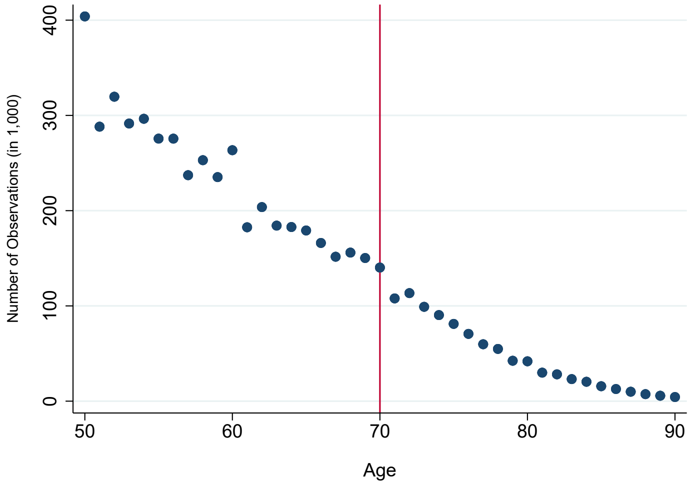
Figure 3: Pension Incentives




*Source:* Own graph.

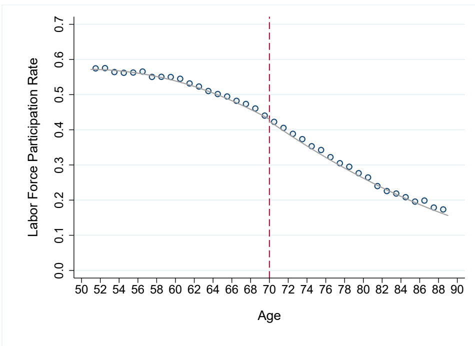
*Note:* The figure depicts the piece-wise constant regions of pension benefits by relating earnings to the total of earnings and old-age assistance.

Figure 4: Number of Observations by Age (Census 1911)

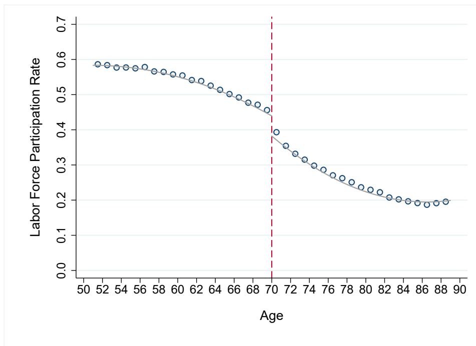



*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* The vertical line indicates the age-based eligibility threshold at age 70 that was introduced by the OPA in 1909.

Figure 5: Labor Force Participation by Age



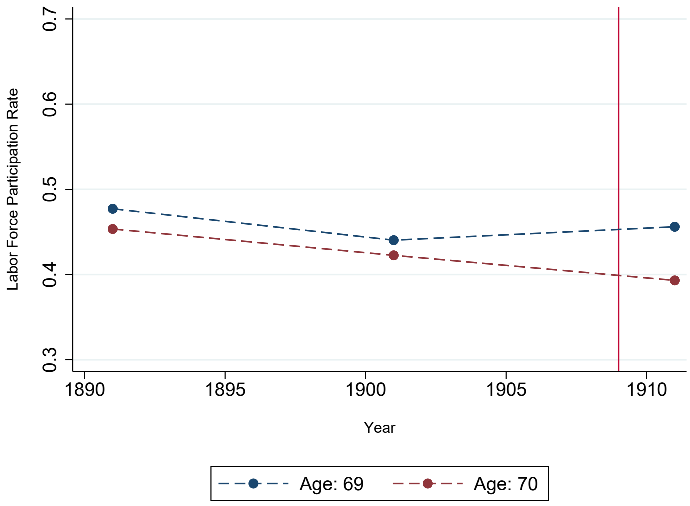

(a) Census 1901




(b) Census 1911

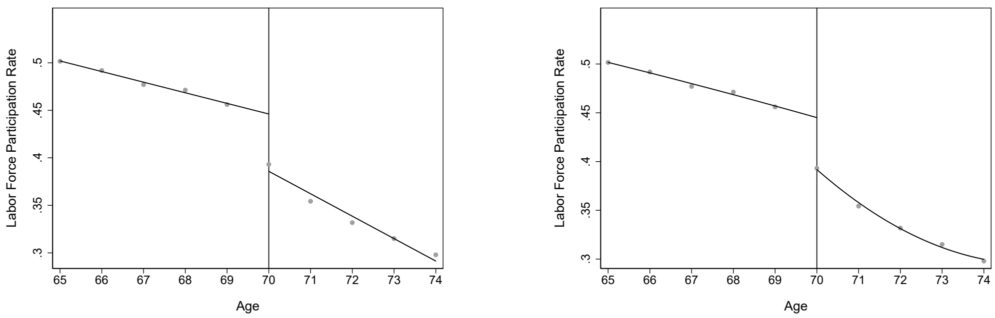
*Source:* Own calculations based on UK Census (waves 1901 and 1911) and IPUMS. *Note:* The vertical line indicates the age-based eligibility threshold at age 70 that was introduced by the OPA in 1909.

Figure 6: Labor Force Participation Over Time by Age-Based Eligibility




*Source:* Own calculations based on UK Census (waves 1891, 1901 and 1911) and IPUMS. *Note:* The vertical line indicates the introduction of old-age assistance by the OPA in 1909.

Figure 7: Functional Form of Labor Force Participation and Age Around the Cutoff

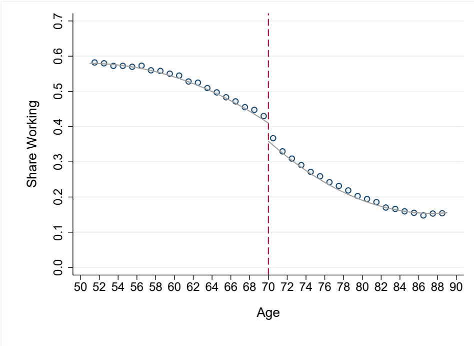



(a) Linear

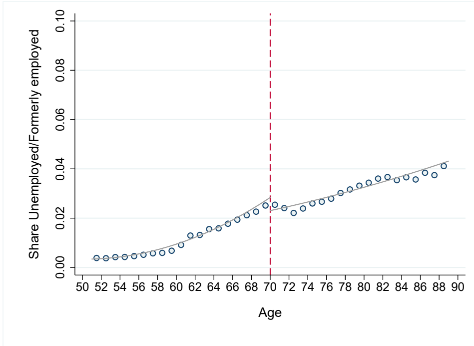
(b) Quadratic

*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* The vertical line indicates the age-based eligibility threshold at age 70 that was introduced by the OPA in 1909.

Figure 8: Work Status (1911)



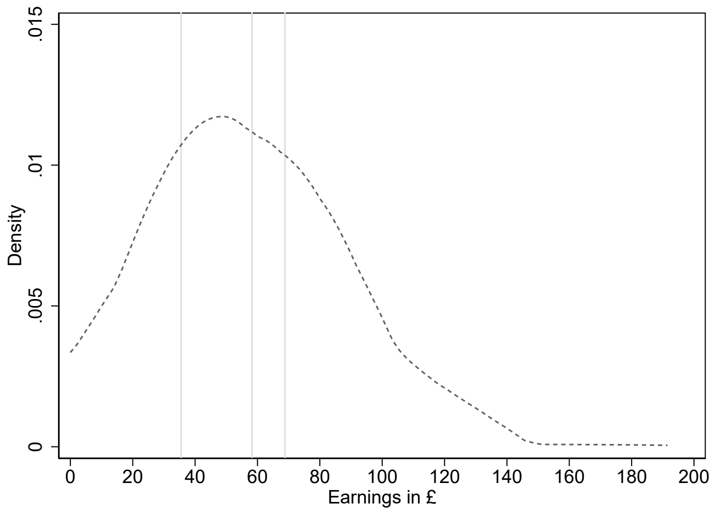

(a) Actively Working




(b) Unemployed/Formerly Working

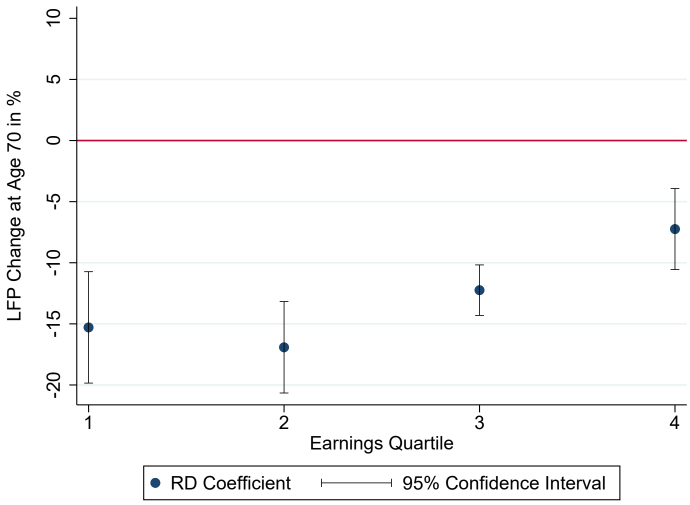
*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* The vertical line indicates the age-based eligibility threshold at age 70 that was introduced by the OPA in 1909.

Figure 9: The Distribution of Earnings in 1911



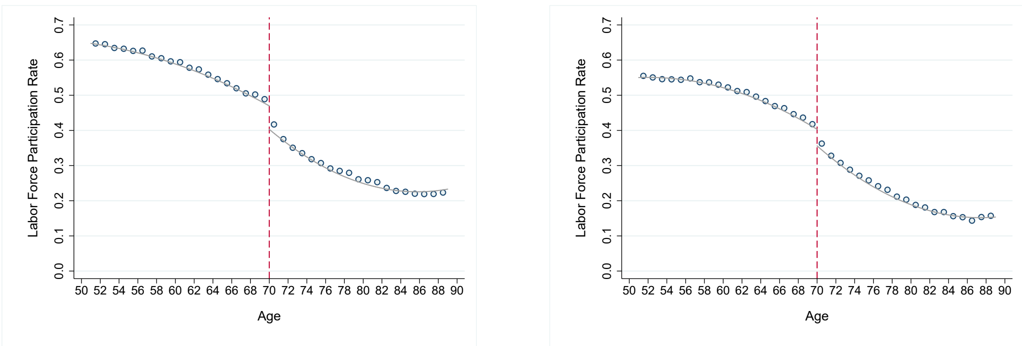

*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* The graph reports the earnings distribution as approximated from 3-digit occupational scores (for details, see appendix B). Vertical lines indicate the earnings quartiles.

Figure 10: RD Estimates Across the Earnings Distribution




*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* RD estimates of LFP by earnings quartile in percent.

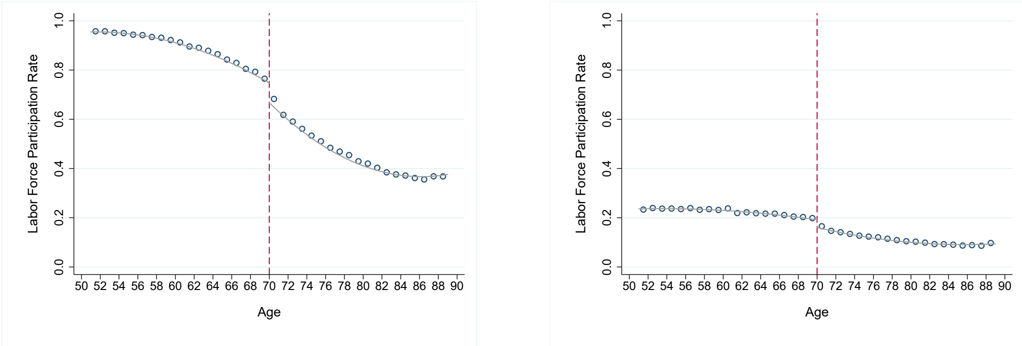
Figure 11: Labor Force Participation by Age and Children (1911)




(a) Without Own Children (b) With Own Children

*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* Reported values are labor force participation rates over age, separately for individuals without own children in the household (panel a) and with own children in the household (panel b). The vertical line indicates the age-based eligibility threshold at age 70 that was introduced by the OPA in 1909.

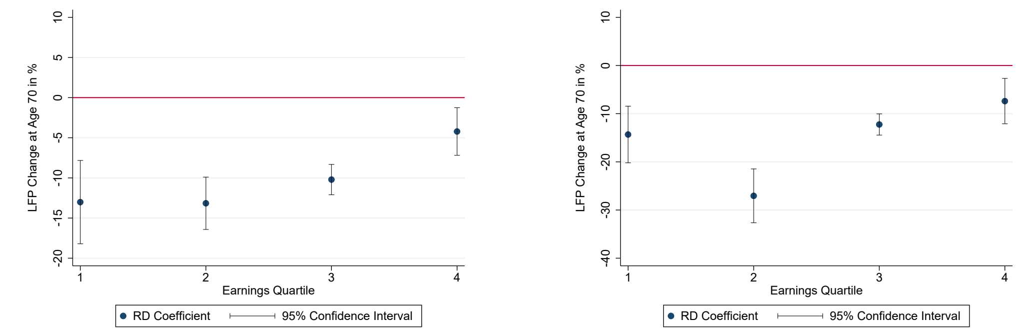
Figure 12: Labor Force Participation by Gender (1911)




(a) Men (b) Women

*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* Reported values are labor force participation rates over age, separately for men (panel a) and women (panel b). The vertical line indicates the age-based eligibility threshold at age 70 that was introduced by the OPA in 1909.

Figure 13: RD Estimates Across the Earnings Distribution by Gender




(a) Men (b) Women

*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* RD estimates of LFP by earnings quartile in percent, separately for men and women.

Figure 14: Labor Force Participation by Age of Spouse

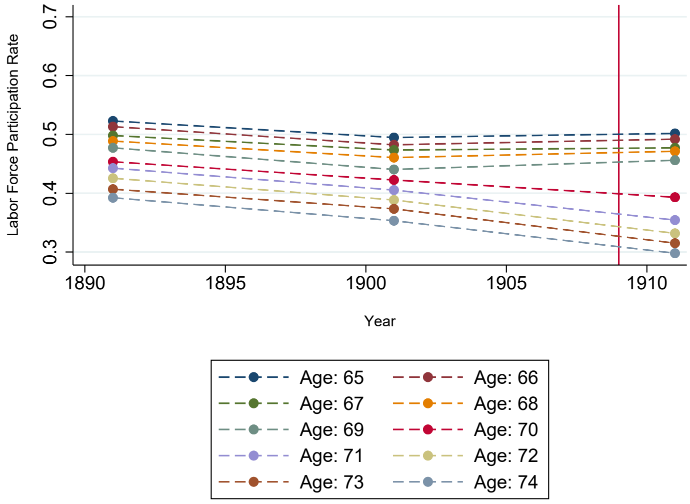

(a) Census 1901


(b) Census 1911

*Source:* Own calculations based on UK Census (waves 1901 and 1911) and IPUMS. *Note:* LFP rates (vertical axis) are conditional on having reached the eligibility age (70) and are plotted by age of the respective spouse (horizontal axis). The vertical line indicates the age-based eligibility threshold at age 70 that was introduced by the OPA in 1909.

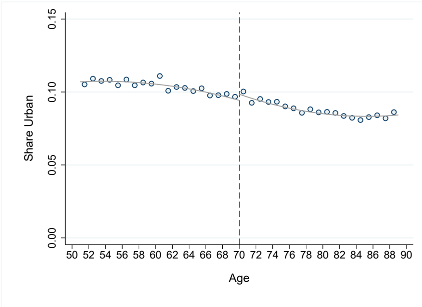
# A Additional Figures

Figure A.15: Labor Force Participation Over Time by Age-Based Eligibility: More Ages

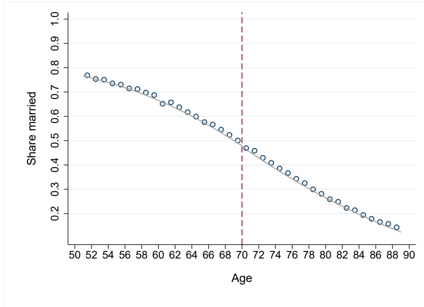



*Source:* Own calculations based on UK Census (waves 1891, 1901 and 1911) and IPUMS. *Note:* The vertical line indicates the introduction of old-age assistance by the OPA in 1909.

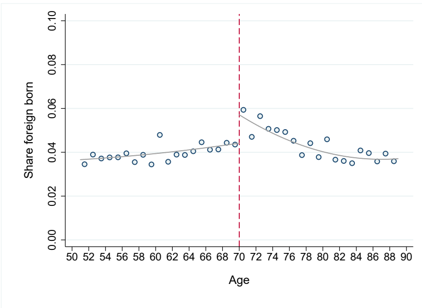
Figure A.16: Continuity of Observable Characteristics at Age Cutoff



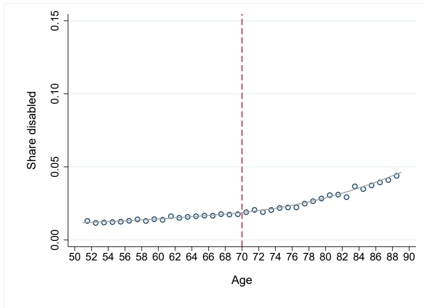

(a) Urban



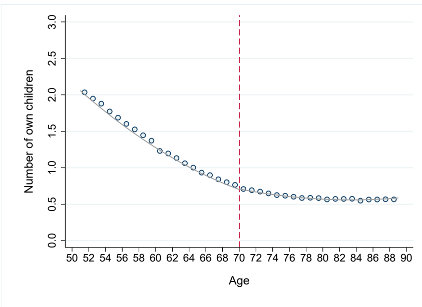

(b) Married



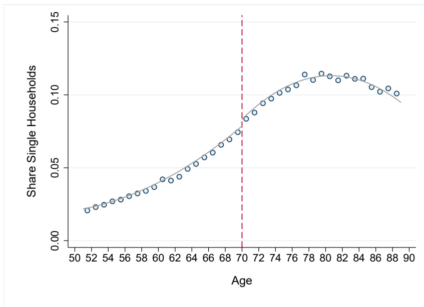

(c) Foreign born




(d) Disabled



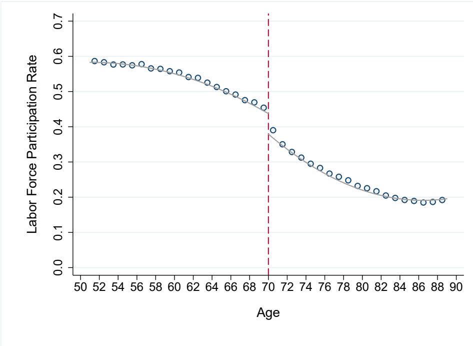

(e) Own Children in Household



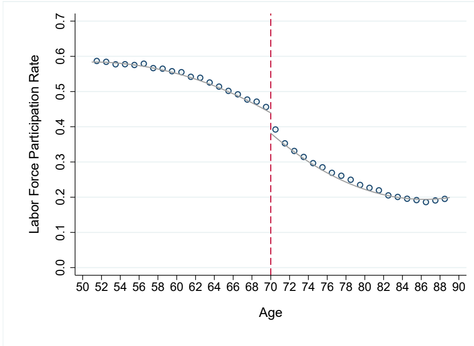

(f) Share Single Households

*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* The vertical line indicates the age-based eligibility threshold at age 70 that was introduced by the OPA in 1909.

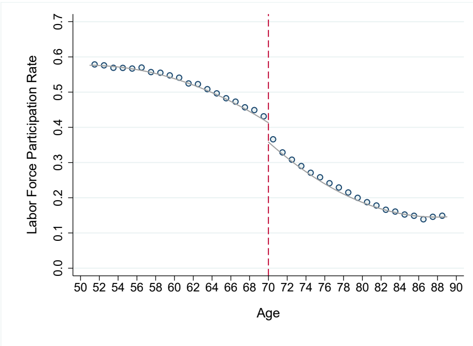
Figure A.17: Further Sensitivity Checks: Labor Force Participation by Sub-Samples



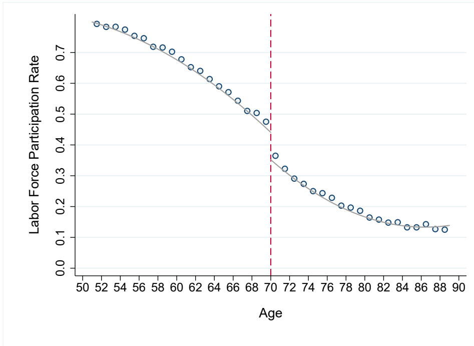

(a) Native-Born



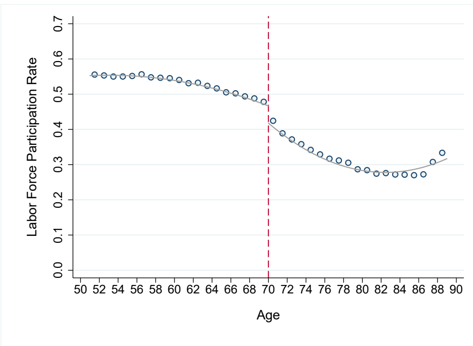

(b) No Disabled



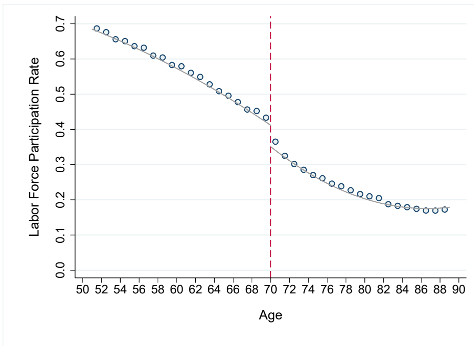

(c) Large HH (>= 12 Persons)




(d) Single HH




(e) Married




(f) Non-Married

*Source:* Own calculations based on UK Census (wave 1911) and IPUMS. *Note:* The vertical line indicates the age-based eligibility threshold at age 70 that was introduced by the OPA in 1909.

# B Approximating Individual Labor Earnings

Earnings are neither reported directly in the UK census of 1911 nor in 1901 and 1891. Based on available occupational information, however, we approximate earnings as has been done in the previous literature (e.g. Abramitzky et al., 2014). For this purpose, we match the occupational income score (occscore) that is generated from the three-digit occupational level (occ1950) from IPUMS for the U.S. census in 1950 to the UK census in 1911 (see details below). We use the U.S. 1950 census because individual level census data that include earnings are not available for the UK before 1991. Moreover, comprehensive earnings information for the U.S. has not been collected before 1950.

Based on this procedure we can match an earnings score to 97% of individuals who state an occupation in the UK census of 1911. The implicit assumption to this is that the earnings distribution, conditional on occupation, is similar in the UK in 1911 and the U.S. in 1950. Since we are interested in the ordering of earnings (from occupations) rather than exact earnings levels, this exercise preserves a valid earnings distribution with little error.

## B.1 Further Details on Matching the Income Score from the U.S. 1950 Census to the UK 1911 Census

Given that the occupational classification in IMPUS differs between the U.S. and UK census, in some cases a one-to-one match of occupations is not possible. In particular, the three-digit occupational system used in the U.S. (1950 Census Bureau Occupational Classification system: occ1950) does not directly match with the five-digit occupational level used in the UK (Historical International Standard Classification of Occupations HISCO: occhisco). To solve this problem, we make use of the fact that the U.S. census of 1880 from IPUMS includes both occupational coding systems (occ1950 and occhisco), which means that every individuals' occupation is coded both in the occ1950 and occhisco coding scheme. We thus match the U.S. census from 1880 that also includes the occupational income score (occscore), derived from the incomes of the U.S. census 1950, to the UK census of 1911. In case that multiple occ1950 codes are matched to one occhisco code, we assign the average occscore for each occhisco code (except for "occupational title unclassifiable", "ambiguous responses", "other non-occupational response" and "no occupation and not in universe/not applicable").

To circumvent several adjustments regarding aggregate price changes (deflating from 1950 to 1911), differential trends in GDP growth between the U.S. and the UK, and the overall conversion of U.S. dollars to British pounds, we first implement the matching procedure as described above to obtain an earnings measure in the 1911 UK census. We then normalize the mean value of earnings (measured in 1950 U.S. dollars) to UK mean earnings in 1911 that are documented in historical earnings data. This simple and transparent procedure preserves the ranks of the earnings distribution that is needed for the analysis (depicted in figure 9).

Occupation information is available for all individuals in the work force, but only for a subset of retirees who reported their former occupations. Restricting the sample to those who reported their occupation may provide flawed results due to selectivity.[25] To avoid selectivity and to be able to nevertheless use the universe of older workers for studying labor supply effects across the earnings distribution, we proceed as follows. First, we construct a dependent variable for each earnings quartile (obtained from occupation information, see above) that indicates whether the individual is in the labor force *and* in the specific earnings quartile (LFP = 1) or not (LFP = 0). The estimates obtained from this exercise represent the LFP decline, separately for each earnings quartile, relative to the total size of the respective age group. The advantage of this approach is that we can include all retired individuals irrespective of their reporting status because we only need occupational data for older workers who are still active. Since the interpretation of the estimates changes, figures 10 and 13 report the relative activity decline for each earnings quartile, dividing the estimate by the percentage of individuals in the labor force in the respective quartile (LFP = 1) at the age of 69.

[25] Consider the extreme case where only individuals with prestigious occupations report their original occupation. In this case, we would observe no decline in LFP by age for non-prestigious occupations because men who retire from these occupations simply drop from the universe.