HOW DOES DELAYED RETIREMENT AFFECT MORTALITY?

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Abstract:

Older Americans have been retiring later for a number of reasons, including jobs becoming less physically demanding, the shift from defined benefit to defined contribution pensions, and changes in Social Security incentives. But what are the implications of working longer for workers' mortality? Answering this question is complicated, because work and health are jointly determined – e.g., healthy people with lower mortality tend to work longer. Previous studies looking at the causal effect of work on mortality have found mixed results and have tended to focus on the effects of *early* retirement on mortality, not *delayed* retirement. Yet, people deciding whether to retire are likely much different than those deciding to work longer, for example they are likely less healthy. This paper uses administrative data from the Netherlands and exploits a tax policy variation designed to *delay* retirement to explore the link between work and mortality, in a two-stage-least-squares framework. The 2SLS results suggest that later retirement leads to a reduction in the five-year mortality risk of 1.6 percentage points for men. For women, the effect in the instrumental variable approach is not statistically significant.

Introduction

Labor force participation rates among older Americans have been rising over the past 20 years for a variety of reasons, including the extension of the Social Security Full Retirement Age, the shift from defined benefit to defined contribution pensions, and the fact that jobs are becoming less physically demanding (e.g. Munnell 2015; Coile 2018). As workers postpone their retirement, what are the implications for workers' mortality – an important outcome for the fiscal situation of programs like Social Security?

Answering this question is complicated, because work and health are jointly determined – healthy people with lower mortality tend to work longer. To deal with this issue, the literature has applied instrumental variable techniques to uncover the causal relationship between work and mortality and other health measures, but with mixed results (Lindeboom et al. 2002; Dave et al. 2008; Coe and Lindeboom 2008; Kuhn et al. 2010; Hernaes 2013; Hallberg 2015; Bloemen et al. 2017; Fitzpatrick and Moore 2018). Moreover, the studies have not been well-suited to answer the question of how *delayed* retirement affects these outcomes, because they have tended to focus on the effects of policies that induce *early* retirement. A simple assumption would be that the relationship is symmetric – if early retirement decreases mortality then delayed retirement increases mortality – but it is unclear that that assumption is correct. After all, people making the decision to keep working are likely a healthier group than those who are deciding to stop early. Furthermore, prior studies have tended to focus on a specific sector or birth cohort, not the general population, making it difficult to extend results to the broad population of workers affected by policies that, explicitly or implicitly, encourage later retirement. In other words, the literature does not offer much insight into what will happen to individuals in their 60s should policies push them to work longer.

This project seeks to shed some light on this topic by exploiting a policy that has induced delayed retirement among early Baby Boomers in the Netherlands. Although the analysis focuses on the Dutch instead of the U.S. population, the policy affected people across all sectors of the economy – a population more similar to those affected by the far-reaching impact of U.S. Social Security reforms. Specifically, this paper uses a confidential, administrative panel dataset showing how health among older workers in the Netherlands changed after the introduction of the "Doorwerkbonus" (DWB), a tax-reduction program that encourages Dutch workers to delay

retirement. The analysis estimates the causal effect of delayed retirement using the exogenous variation in the timing of this policy – which previous work has found to delay retirement, especially among men – to estimate the effect of work on mortality.[1]

The paper proceeds as follows. The next section reviews the literature on the relationship between retirement and health, and provides background on the Dutch institutional setting. The third section describes the Dutch administrative data and the econometric strategy used in this study. The fourth section discusses the results. The final section concludes that among those induced by the DWB policy to delay retirement, the 5-year mortality rate for men ages 62-65 was significantly lower. Results for women are insignificant, largely because the instrument is weak since the DWB did not induce many women to delay retirement. The magnitude of the effect for men represents about a 23 percent reduction in 5-year mortality compared to non-workers, and has the potential to add about 2 months to the age-60 life expectancy if the reduction affects only the ages studied, and more if the reduction is permanent. While this increase is not large, this paper suggests that retirement policies that change the Social Security program in a way that extends careers may also extend lives and ultimately the period in which benefits are paid out.

Background

This section first reviews prior research on the relationship between work and mortality. The section then describes the pension system and labor force participation in the Netherlands, and discusses the policy used in this paper to analyze the causal relationship between work and mortality.

Prior Literature on Work and Health Outcomes

Although a rich literature has examined the relationship between work and health, distinguishing the causal effect has proved difficult and findings have been mixed.

Two examples from recent studies illustrate the issue. The first, Bloemen et al. (2017), exploit an early retirement opportunity among civil service workers in their 50s in the Netherlands (in contrast to the DWB, which affects a broader group of workers across sectors). The study finds that early retirement *decreased* the affected group's 5-year mortality rate by 2.6

[1] See Zulkarnain (2015) and Zulkarnain and Mastrogiacomo (2017).

percentage points – an extremely large decrease given 5-year mortality was only about 3-4 percent at those ages in the first place. The second study, Kuhn et al. (2010), finds that blue-collar workers in Austria who were given an early retirement opportunity in their early 60s experienced an *increase* in the probability of dying before the age of 67 of 2.4 percentage points per year of early retirement. In other words, these papers found effects in the opposite directions.[2]

Aside from the mixed results, studies tend to only provide insight into specific sectors of the economy, i.e. the public sector in Bloemen et al. (2017) and blue-collar workers in Kuhn et al (2010), instead of into the broad range of occupations affected by programs such as the DWB or Social Security.[3] Furthermore, despite the fact that most recent policies have encouraged later retirement, these studies have tended to focus on the effects of earlier retirement.[4] Inferences from this literature on the effect of delayed retirement implicitly assume that delayed retirement would have the same effect, just in the opposite direction. This project contributes to this literature by exploiting a Dutch policy that induced delayed retirement for which people across all sectors were eligible – a group that is more similar to those affected by the far-reaching impact of U.S. Social Security reforms. To understand how the Dutch policy fits into the institutional setting, the next section describes the pension system in the Netherlands.

The Pension System of the Netherlands

The pension system in the Netherlands has three pillars. The first pillar is a national pay-as-you-go pension called the Algemene Ouderdomswet (AOW), established in 1957 and

[2] Other evidence on the relationship between early retirement and mortality is also mixed. Coe and Lindeboom (2008) find no significant effect of early retirement on mortality in the HRS, but the point estimate suggests that early retirement before age 62 reduces the 4-year mortality risk by 5 percentage points. Kalwij et al. (2013) find that early retirement among the general population of the Netherlands is not significantly associated with higher mortality risk, except among those who use DI as an early retirement pathway. Hernaes et al. (2013) find no significant effect of early retirement before age 67 in Norway, but the point estimates suggest that a year of earlier retirement reduces mortality by age 67 and age 70 by 0.2 percentage points, mortality by age 74 by 2.5 percentage point, and mortality by age 77 by 6.6 percentage points. Hallberg et al. (2015) finds that early retirement among Swedish military officers in their 50s reduces the probability of dying before age 70 by 26 percent using a hazard model. Fitzpatrick and Moore (2018) find that the "early" eligibility age for U.S. Social Security increases male mortality at age 62 by about 2 percent. They estimate that early retirement increases mortality by 62 percent. They find no statistically significant effect for women.

[3] Examples of studies that study the effects across the general population are Hernaes (2013), who looks at all Norwegians born between 1928-1938, Coe and Lindeboom (2008) and Fitzpatrick and Moore (2018) who study Americans across all industries. All three studies however study the effect of early retirement options.

[4] One study that does focus on delayed retirement is Hagen (2018), who studies delayed retirement among Swedish women, and finds no effect on health care utilization and mortality.

available to all individuals who have lived in the Netherlands for at least 50 years.[5] The AOW provides a basic income linked to the minimum wage for everyone above the eligibility age, which was 65 for the cohorts studied in this paper.[6] Benefits do not vary across people; for a single person, benefits are equal to 70 percent of the minimum wage (about EUR 1,000 per month), and 100 percent of the minimum wage for a couple (about EUR 1,400 per month). Claiming is automatic, cannot be claimed early or delayed, and does not require actual retirement from the labor force.[7] Compared to other countries, the state pension provides only a small portion of retirement income in the Netherlands.

While the first pillar serves all Dutch citizens regardless of their work situation, the second two pillars are more person and job specific. The second pillar consists of collective employer-provided pensions. Although no law requires individuals to join pension funds, the government can make it mandatory for an entire industry or profession to provide a pension if representatives of employers and employees (e.g. unions) within the industry decide to offer one. As a result, over 90 percent of employees take part in a collective pension plan. In most plans, workers accrue either 1.75 percent of final salary or 1.75 to 2.25 percent of average salary per year of service. The third pillar is made up out of private, individual pension products. This pillar allows employees in sectors without a collective pension scheme or self-employed workers to build up savings, although anyone can purchase these products.

While the normal retirement age in the three pillars of the Dutch system was 65 before 2012, labor force participation among older workers in the Netherlands has been low since the 1980s and 90s (Kapteyn and De Vos 1999). For example, in 2006, only 34.6 percent of Dutch men and 19.8 percent of Dutch women between 60 and 64 were working (OECD 2018). This low labor force participation has been attributed to one feature of the second retirement pillar, namely the availability of so-called "early retirement plans," which allowed retirement from as early as 59.[8] These schemes, originally intended to create employment opportunities for younger

[5] Benefits are reduced by 1/50 for each year a person lived outside of the Netherlands.

[6] For people born before 1948, the eligibility age (NRA) was 65. Starting in 2013, it has been increased by 1 to 3 months per birth cohort starting in 2013, so that the NRA is 66 in 2018 and 67 in 2021. After 2022, it will be linked to life expectancy.

[7] The Employee Insurance Agency (Sociale Verzekeringsbank) invites people to apply for benefits through a simple online process six months before reaching the NRA. When an application is filed late, benefits will be paid retroactively for up to 12 months, and in certain cases for more.

[8] The early retirement plans are called "VUT" schemes, which stands for "Vervroegde Uittreding en Pre-Pensioen" – in English, "early exit and pre-pension."

workers, made it possible for older workers to claim pensions and retire early, until they reached an age when their pension income would be supplemented by AOW benefits (Euwals et al. 2010). Additionally, Dutch regulations facilitated the use of disability insurance (DI) and unemployment insurance (UI) as pathways to early retirement (Kapteyn and De Vos 1999; Kerkhofs et al. 1999; Lindeboom 1998).

Over the past few decades, the Netherlands introduced policies to address the low labor force participation among older workers. Since the mid-1990s, early pension schemes have been phased out and sometimes replaced with pre-pension schemes that allow retirement before the Normal Retirement Age (NRA) (Euwals et al. 2010).[9] Starting in 2002, retirement through DI and UI was made more difficult, and in 2006 laws governing early retirement reduced the generosity of plans for cohorts born after 1950 (De Vos et al. 2012). Still, because the AOW system is funded through a payroll tax and, given the aging of the Baby Boom cohorts, the Dutch government has continued its push toward longer careers for older workers. Part of this push is the policy exploited in this paper, the "Doorwerkbonus."

The Doorwerkbonus

Introduced in January 2009, the Doorwerkbonus (DWB) offers a reduction in taxes on labor income for each year in which a person worked after age 62 – effectively, a temporary wage increase for older workers (Euwals et al. 2009). Table 1 shows the DWB structure and maximum bonus amounts by age in the top panel, and the labor income cap and floor in the bottom panel. At age 62, workers are eligible for a bonus of 5 percent of their taxable income, up to a maximum (EUR 2,296 in 2009). The DWB percentage rises with age until age 64, and decreases thereafter, down to 1 percent for ages 67 and up. The bonus payout rates remained the same from 2009 through 2011 but were amended in 2012. The policy was repealed in 2013 and replaced by a less generous bonus aimed at people 61-64. The DWB has been shown to be effective at encouraging work among people in their 60s – Zulkarnain (2015) found that it increased male labor force participation for men ages 62-64 by about 4.5 percentage points on

[9] Exact retirement rules of collective pension funds, including pre-pension eligibility ages and potential work restrictions, are negotiated between unions and employer organizations and may differ by pension fund. Dutch administrative data reveals that about 60 percent of men that work between age 62 and 65 also receive a pension.

average, with smaller effects for women (about a 1-percentage-point increase in labor force participation) (Zulkarnain and Mastrogiacomo 2017).

Data and Methodology

To study the relationship between delayed retirement and mortality, this paper exploits the introduction of the DWB in 2009 as a natural experiment, encouraging some people to work longer based solely on their birth cohort. To perform the analysis, the paper uses a confidential administrative longitudinal dataset, collected by *Statistics Netherlands*, covering the entire population from 1999-2016. The data consist of high-quality administrative records on labor market outcomes, income and benefit receipt, marital status, and dates of death. All of this information is linked together by a personal identifier.

The sample for this study includes men and women born between 1943 and 1950, whose labor force participation and other characteristics are studied between 1999 and 2011. Of key interest is mortality in the 5 year period after observation, therefore mortality data through 2016 is used. Because there was little effect of the DWB policy among cohorts born before 1946 (Zulkarnain 2015; Zulkarnain and Mastrogiacomo 2017), the analyses focus on the effects among cohorts born between 1946 and 1949 (Table 2a). Because the cohorts born between 1943 and 1945 are being used as a control cohort, observations from people in these cohorts are dropped after 2009, when they also became eligible for the DWB.[10]

Disentangling the causal relationships between continued work and mortality is complex, because work and health are jointly determined. The observation that individuals who are not working die earlier or have worse health outcomes could be the result of three different causes: 1) bad health could trigger workers to retire earlier; 2) retirement itself could negatively affect health; or 3) a third, unobserved factor could both decrease health and trigger retirement, such as a job loss or spousal health shock. The consequence is that the simple Ordinary Least Squares (OLS) regression equation below is likely to produce results that do not actually capture a causal relationship:

[10] The study estimates the effect of working on the 5-year mortality risk. The 5-year mortality risk at age 63 of persons born in 1945 could also been affected because of eligibility for the DWB after 2009. However, labor force participation among these cohorts at these ages was low (below 30 percent), and take up among the older cohorts was likely low (Zulkarnain 2015). Eligibility for the DWB among these cohorts would bias the estimates towards zero.

$$D_{i,t+5} = \alpha + X'_{it}\beta + \gamma Working_{it} + \delta year + A_k + Y_m + S_n + \varepsilon_{it} \qquad (1)$$

In equation (1), the dependent variable $D_{i,t+5}$ is an indicator for whether the person dies within the next five years. A five-year period is chosen for the analysis simply because this is the maximum length of time we can observe all individuals in the sample. $Working$ is an indicator for whether person *i* is working in year *t*.[11] The base specification includes a vector X'_{it} with controls for marital status, for income in 1999, and for whether the person was in a DWB-eligible cohort.[12] It also includes A_k, a vector of age fixed effects, where *k* ranges from age 51 to age 65, and Y_m a vector of year fixed effects, where *m* ranges from 2000 to 2011. Alternative specifications include a vector of industry fixed effects, S_n, and controls for whether a person receives a pension, welfare, UI, DI or other social benefits.[13] A negative coefficient γ would suggest that continued work reduces the risk of mortality. But since health and work are jointly determined as was discussed above, that conclusion could be misleading.

To address the issue of endogeneity in equation (1), the project exploits the introduction of the DWB policy in an instrumental-variable model, using a two-stage least squares (2SLS) framework to estimate the causal effect of continued work between ages 62 and 65 on five-year mortality risk.[14] The first stage in this empirical strategy estimates the following equation:

[11] Statistics Netherlands bases labor market status on the largest income source each month.

[12] While secular increases in education could be correlated with both working longer and mortality (Kalwij, Kapteyn, and De Vos 2018) it may be less of a concern in the current setting, due to the narrow range of cohorts studied and because a linear control for calendar year adjusts would for secular trends. Ideally, an education control would ideally be included, however, Statistics Netherlands does not have education information for these cohorts. The regression includes income in 1999 as a proxy for education. Some specifications also include binary controls for receipt of pension, UI, DI, Welfare or other social benefits.

[13] Industry is either the industry that the person is currently working in, or the last industry the person was observed working in. Because many employer-provided pensions are industry-wide pensions, the industry fixed effects control for potential (unobserved) differences in exact retirement rules between industries.

[14] The instrument needs to satisfy the following three conditions to be valid: 1) it needs to be effectively randomly assigned; 2) it needs to be not directly related to mortality and health; and 3) it needs to affect labor force participation. The DWB instrument satisfies these criteria. First, because eligibility for the DWB policy is based on age, which is out of any individual's control, it can be seen as randomly assigned. Second, mortality and health should not be directly affected by eligibility for the DWB policy; the aging process decreases health and increases mortality risk, but not differentially for those who were in the cohorts eligible for the DWB after controlling for time. While the income effect could theoretically affect mortality directly, the maximum amount of €10,000 over three years is not likely to have a significant effect. Furthermore, the literature has found little evidence of a causal effect of income on mortality (e.g. Lindahl 2005; Snyder and Evans 2006; Schnalzenberger 2011; Ahammer et al. 2017). Third, Zulkarnain (2015) and Zulkarnain and Mastrogiacomo (2017) show that the policy increased labor force participation.

$$Working_{it} = \pi + X_{it}'\rho + \lambda DWB_{it} + A_k + Y_m + S_n + \eta_{it} \quad (2)$$

where DWB is a binary indicator for whether a person was eligible for the bonus, which is 1 for any individuals observed in 2009 or later from the 1946-1949 cohorts. Results from Zulkarnain (2015) suggest that coefficient λ is positive – that is, the policy exogenously increased working.

The second stage is:

$$D_{i,t+5} = \mu + X_{it}'\vartheta + \phi\widehat{Working}_{it} + A_k + Y_m + S_n + \nu_{it} \quad (3)$$

where $\widehat{Working}_{it}$ is the predicted working status from the first stage and the other variables are as defined above. The coefficient ϕ gives the local average treatment effect (LATE) of continued work on mortality – that is, the effect of delayed retirement on mortality among those who were induced to work longer by the DWB policy.[15]

A potential concern with the study design is the occurrence of the Great Recession, which coincided with implementation of the DWB. Although the effects of the DWB could be confounded by changing labor market conditions during this time, the Dutch unemployment rate was relatively stable between 2006 and 2009 (see Appendix Figure 1). The unemployment rate in the Netherlands fell from 6.1 percent in early 2006, to 3.7 percent in late 2008. The rate started rising in 2009, but remained below early 2006 levels until spring 2012. Another concern is that the sample includes individuals in their early 60s, regardless of their employment status in their 50s. While the DWB policy induced people to delay retirement, it was not very effective in inducing people to return to work after retirement. A robustness check will assess whether those induced by the policy to return to work experienced differential effects compared to those who were in the labor force throughout their 50s. Finally, the paper will assess the extent to which the decision to control for baseline income affects the results, as income could be endogenous.

[15] The models are estimated with robust standard errors to correct for potential heteroskedasticity in the error terms, and are clustered at the birth cohort-year level to control for serial correlation of the error terms.

Results

This section first presents the descriptive differences in mortality risk between workers and non-workers and between those eligible for the DWB and those who are not eligible. The section then presents the OLS regression results and, finally, the 2SLS results.

Unadjusted Differences in Mortality Risk

Tables 3a and 3b show unadjusted mortality rates and other descriptive statistics for men and women respectively based on their work status and on eligibility for the DWB. The main takeaway is that the 5-year mortality risks for men who were not working at ages 62 - 65 were 3-4 percentage points higher than for those who were working, both before and after the DWB took effect. For women, the mortality gap was slightly smaller, at roughly 2 percentage points. Figures 1a and 1b plot out the gap in 5-year mortality between non-workers and workers for men and women over time and show that while mortality improved across the board (albeit less so for women), the gap between the two groups has remained relatively stable. Other characteristics by working status shown in Tables 3a and 3b are as expected. For example, men who do not work are more likely to receive a pension, UI, DI, welfare, and other social benefits.

The main contention of this paper is that the gap in mortality between workers and non-workers seen in Tables 3a and 3b and illustrated in Figures 1a and 1b may overstate the actual effect of working on mortality. The instrumental variables approach is designed to deal with this issue, but requires that the DWB actually impacts work through longer careers. Figures 2a and 2b show, for men and women respectively, that the policy did impact the propensity to work, especially at ages 62 - 64, although the effect for women is smaller. For example, just under half of the men were working at age 62 before the introduction of the DWB (2006-2008), but that increased to 60 percent after the introduction (2009-2011). However, the difference in labor force participation by DWB status at age 65 is much smaller than at older ages (consistent with Zulkarnain 2015).

OLS Regression Estimates

Before proceeding to the 2SLS regressions, it is useful to examine the OLS regressions of mortality on working to see if observable characteristics alone can explain the gap described above. Table 4 shows the estimates from equation (1) where the dependent variable is an

indicator for dying within five years and the key independent variable is the indicator for working among men (first three columns) and women (latter three columns). The results in the first and fourth columns include only controls from the base specification. The second and fifth columns show results from models that also include industry fixed effects. The results in the third and sixth columns are also adjusted for whether someone receives a pension, welfare, unemployment, disability, or other social benefits. Full results are available in Appendix Table A1a and b.

The results in Table 4a confirm the earlier unadjusted evidence that, even after controlling for differences between working and non-working men, working is associated with lower mortality risk for men and for women. The first column of Table 4a shows that men who work are 2.1 percentage points less likely to die in the following five years, while women are 1.2 percentage points less likely to die. Including industry fixed effects does not affect the coefficients for men, and only slightly reduces it to a difference of 1.1 percentage points in 5-year mortality risk for women (column 2). The association is reduced to 1.9 percentage points and 0.8 percentage points, respectively, after including additional controls for pension receipt and social benefits, although the results remain statistically significant.

2SLS Regression Estimates

To control for the fact that people who work longer may also live longer for other reasons that cannot easily be controlled for, the analysis exploits the introduction of the DWB policy as an instrument in a two-stage-least squares framework. Table 4b shows the second-stage estimates from this regression, where the indicator for dying within the next five years is again the outcome of interest and work status is instrumented with DWB eligibility among men (first three columns) and women (latter three columns).[16] These estimates represent the Local Average Treatment Effect (LATE) of working on one's 5-year mortality risk for men and women induced by the DWB to remain in the workforce. The bottom panel reports the coefficient on the DWB indicator and the first-stage F-statistic; the higher the F-statistic, the stronger the DWB predicted work behavior.[17]

[16] Full results are available in Appendix Table A2a and b.
[17] The table reports the Kleibergen-Paap F statistic. The full 2SLS results are shown in Appendix Table A2a and A2b.

The controls for benefits may be somewhat endogenous, since DI receipt is likely correlated with labor force participation and mortality; therefore, the second specification is preferred. The results from the second specification (second column of Table 4a) shows that working reduced 5-year mortality risk by 1.6 percentage points for men who were induced into working by the DWB, or a 23-percent reduction relative to the average mortality risk of non-working men. While a 23-percent reduction appears large, it is much smaller than the estimates from the literature discussed above. To put these estimates into better context, a 23-percent reduction in the 5-year mortality risk at these ages would increase life expectancy at age 60 from 21.5 to 21.7 years – an increase of about 2 months.[18] Of course, if the effect instead were to last beyond these ages, the increase in life expectancy would be larger.[19] In the first and third specifications, the reductions of working are similar, between 1.5 and 2.1 percentage points. For women, the 2SLS analysis finds no significant change in the probability of death among those induced to work longer because of the DWB.

It can be informative to compare the results from 2SLS approach in Table 5 to the OLS approach in Table 4a to see how much the simpler approach overstates the gains to working. For men, this comparison suggests that across the first two specifications, OLS overstates the mortality reductions from working. OLS understates the mortality reduction in the third specification although the difference is small. Overall, the coefficients in Table 4b are smaller but still significant. For women, the effect in Table 4a vanishes, suggesting that none of the causal effect remains. Still, this null result should be interpreted with caution, since the DWB instrument is weaker for women than for men (see the low F-statistics presented in Table 4b), meaning it is possible that the lack of significance is a consequence of the smaller relationship between the DWB and working for women than for men. In other words, the weakness of the first stage for women limits the interpretation of the second.

Robustness checks

Because instrumental variable regressions can be more sensitive than OLS to the underlying assumptions of the analysis, this section describes the results of robustness checks to

[18] Based on authors' calculations from the 2009 life table for Dutch men (WHO 2018).
[19] If the improvement would be permanent, authors' calculations suggest an increase in life expectancy of a little over 2 years.

ensure the results are sensible and hold up to changes in the assumptions. These robustness tests are performed only for men, for whom the 2SLS results were significant.

The first test has to do with the sample chosen in the initial analysis – namely the one that includes individuals in their early 60s regardless of their past employment status during their 50s. This choice is important, because while the DWB policy induced people to delay retirement, it was not effective in inducing people to return to work after retirement. In other words, people who were not working in their 50s were unlikely to be moved by the DWB to begin working. This could lead to a weaker effect than actually exists. To test whether those who were unlikely to be induced by the policy to work did not add noise to the estimates, column 3 in Table 4c shows the results from a sample limited to people who were working at age 55. The point estimates are very similar to the result from the preferred model in column (1), corresponding to the result in column (2) from Table 4a, indicating this aspect of sample selection does not seem to be driving the results.

A second concern is that income itself might play an important role in the relationship between working and mortality and that the decision to control for income affected the results.[20] Even though the specifications in Tables 4a and 4b controlled for income in 1999, which was the earliest period available in these data and thus the period least susceptible to the endogeneity, this control might still bias the estimated relationship between working and mortality. Column 3 in Table 4c shows that leaving out the control for labor income in 1999 leads to a slightly larger (more negative) result, though within the range of prior estimates.

Conclusion

The previous literature found mixed evidence of a relationship between early retirement and health outcomes, but has tended not to study the effects of delaying retirement, and has tended to focus on smaller segments of the population. This study contributes to the literature by exploiting a policy that induces delayed retirement instead of early retirement and by estimating the causal effect of continued work in one's early 60s among a broad cohort of early Baby Boomers in the Netherlands. The results indicate that an OLS regression does overstate the

[20] While the positive correlation between income and longevity has been well documented (e.g. Kitagawa and Hauser 1973; Deaton and Paxton 1998; Chetty et al. 2016), the literature has either found no causal effect of income on mortality (Lindahl 2005; Schnalzenberger 2011; Ahammer et al. 2017) or a small negative effect (Snyder and Evans 2006).

effect of working on mortality, but that, even after using the DWB as an instrument, delaying retirement reduces the 5-year mortality risk in the early-60s for men by about 23 percent relative to non-workers.

These results contribute to the discussion on the fiscal balance of social insurance systems like Social Security in the United States. If retiring later reduces mortality, it would also lengthen the period in which benefits are paid out. The extent to which reduced mortality would increase benefit expenditures depends on whether this mortality effect is limited to just the ages studied or is longer-lasting. A back-of-the-envelope calculation indicates that a temporary 23-percent reduction in the 5-year mortality during the ages studied increases life expectancy at age 60 by only about 2 months, which suggests a limited financial effect on the program. Of course, if the mortality effect is longer-lasting the financial effects would be larger.

This paper attempts to obtain causal estimates of the effect of working longer on mortality, but two caveats are in order. First, it should be noted that the estimated effects are specific to the people who responded to the DWB policy (because the estimate is a LATE) and may not translate to everyone retiring later. Second, the effect may not translate to a delayed retirement response in the United States from the current proposals affecting Social Security that might induce Americans to retire later. The reason is that the DWB provided an incentive to work longer in the form of a reward – a "carrot" approach, while current U.S. proposals under consideration tend to reduce benefits – that is, a "stick" approach. Nonetheless, these results shed light on the potential mortality effects of policies that lead to delayed retirement, a relationship that policymakers may want to consider going forward.

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Figure 1a. *Five Year Mortality Rate for Men Ages 62-65, by Working Status*

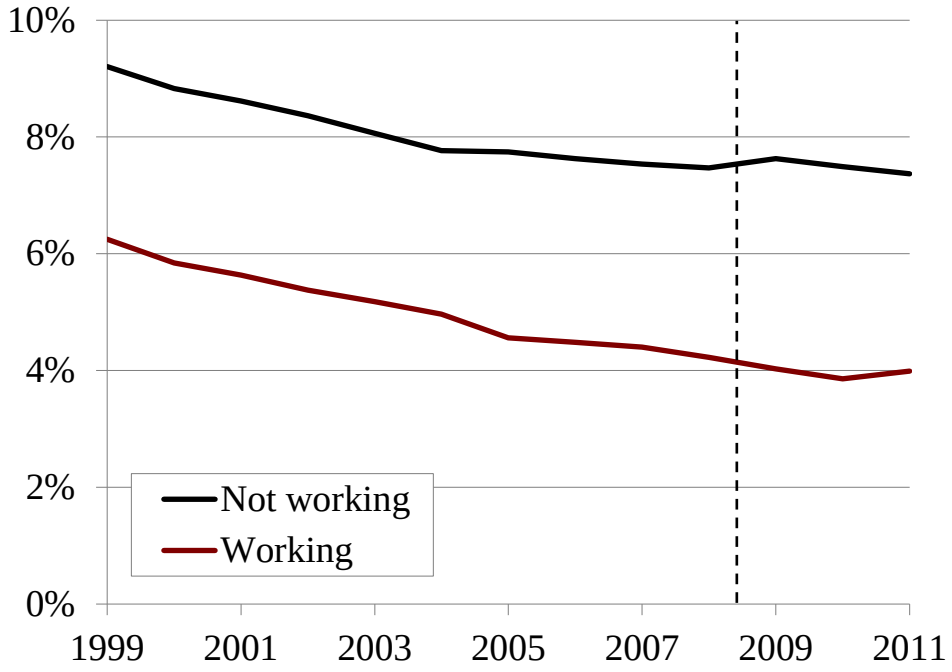
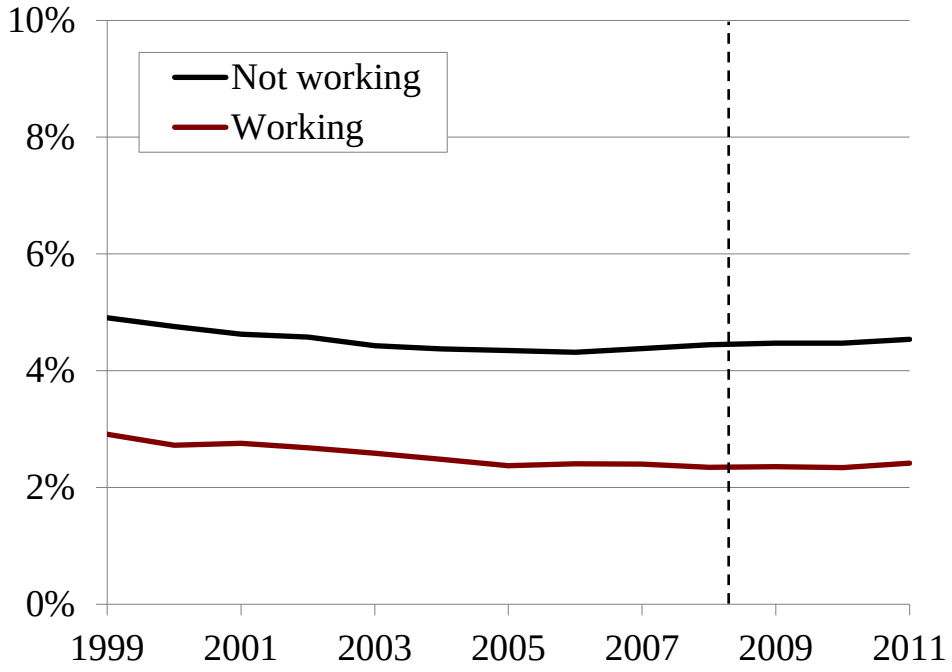


Figure 1b. *Five Year Mortality Rate for Women Ages 62-65, by Working Status*



Source: Authors' calculations using non-public microdata from Statistics Netherlands, 1999-2016.

Figure 2a. *Share Working for Men, by Age and DWB Eligibility*

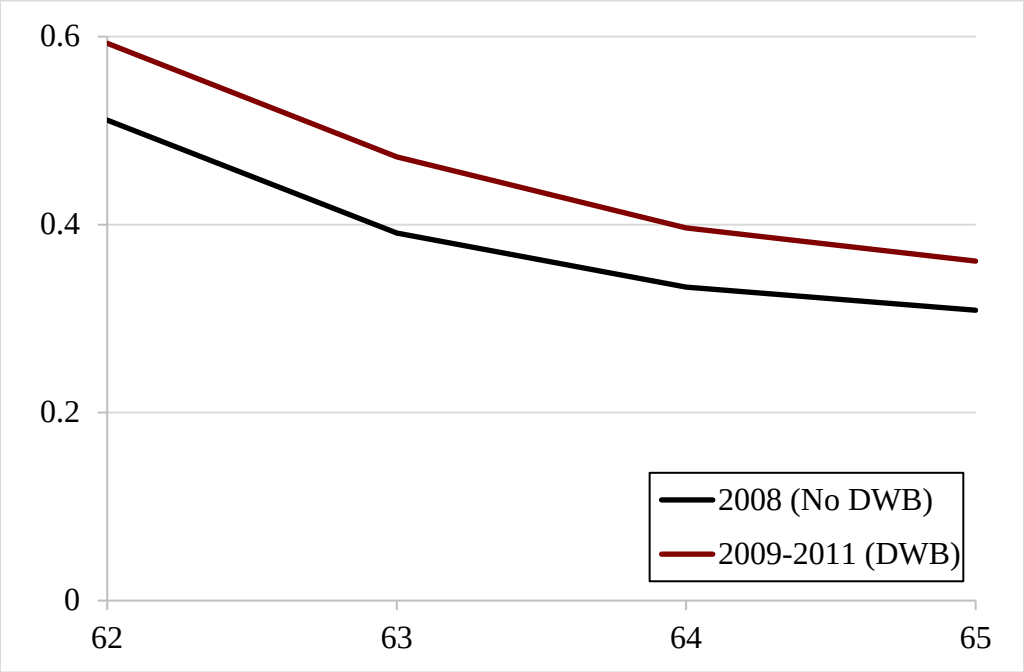
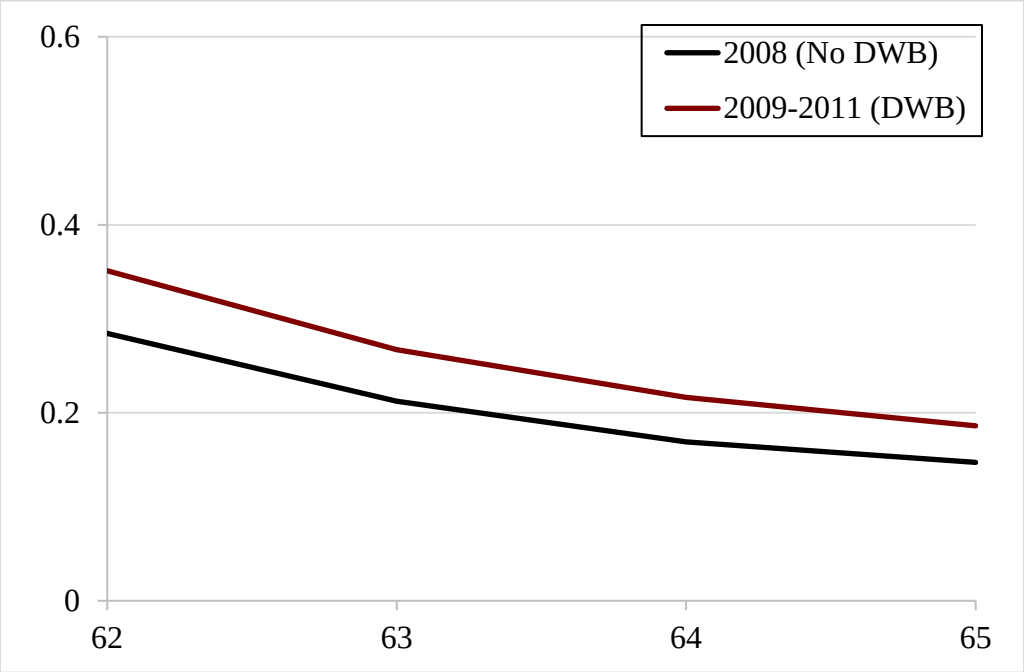


Figure 2b. *Share Working for Women, by Age and DWB Eligibility*



Source: Authors' calculations using non-public microdata from Statistics Netherlands, 2006-2011.

Table 1. *Structure of the "Doorwerkbonus" (DWB), by Age and Year*

	Year								
	2009			2010			2011		
Birth cohort	Age	Bonus	Maximum	Age	Bonus	Maximum	Age	Bonus	Maximum
1939	70	1%	€ 459	71	1%	€ 468	72	1%	€ 471
1940	69	1	459	70	1	468	71	1	471
1941	68	1	459	69	1	468	70	1	471
1942	67	1	459	68	1	468	69	1	471
1943	66	2	918	67	1	468	68	1	471
1944	65	2	918	66	2	936	67	1	471
1945	64	10	4,592	65	2	936	66	2	942
1946	63	7	3,214	64	10	4,679	65	2	942
1947	62	5	2,296	63	7	3,276	64	10	4,708
1948	-	-	-	62	5	2,340	63	7	3,295
1949	-	-	-	-	-	-	62	5	2,354
1950	-	-	-	-	-	-	-	-	-
Income cap		€ 54,776			€ 55,831			€ 56,280	
Income floor		8,860			9,041			9,209	

Source: Belastingdienst (Tax and Customs Administration – The Netherlands).

Table 2. *Overview of DWB Eligible Cohorts in Analysis Sample*

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
1943	56	57	58	59	60	61	62	63	64	65			
1944	55	56	57	58	59	60	61	62	63	64			
1945	54	55	56	57	58	59	60	61	62	63			
1946	53	54	55	56	57	58	59	60	61	62	63	64	65
1947	52	53	54	55	56	57	58	59	60	61	62	63	64
1948	51	52	53	54	55	56	57	58	59	60	61	62	63
1949	50	51	52	53	54	55	56	57	58	59	60	61	62
1950	49	50	51	52	53	54	55	56	57	58	59	60	61
1951	48	49	50	51	52	53	54	55	56	57	58	59	60
1952	47	48	49	50	51	52	53	54	55	56	57	58	59
1953	46	47	48	49	50	51	52	53	54	55	56	57	58
1954	45	46	47	48	49	50	51	52	53	54	55	56	57

Note: Shaded area indicates DWB eligibility.
Source: Belastingdienst (Tax and Customs Administration – The Netherlands).

Table 3a. *Sample Characteristics at Ages 62-65, Men*

	Eligible for DWB		Not eligible for DWB	
5 year mortality risk		5.6%		6.1%
Working		48.1		39.1
	Working	Not working	Working	Not working
5 year mortality risk	3.8%	7.3%	4.2%	7.3%
Married	80.7	74.0	82.5	77.6
Widowed	2.9	3.9	2.9	4.0
Divorced	10.6	12.5	9.7	10.7
Pension recipient	54.3	75.5	56.2	73.6
UI	4.0	5.1	4.3	7.7
DI	11.0	30.8	13.7	32.1
Welfare	0.5	4.9	0.5	4.6
Other social benefits	4.2	10.7	4.7	11.2
Gross income in 1999	30,700 Euro	25,395 Euro	29,519 Euro	23,818 Euro

Notes: Sample contains men born between 1943 and 1949 observed at ages 62 through 65. For cohorts born between 1943 and 1945, observations after 2009 are not included.
Source: Authors' calculations using non-public microdata from Statistics Netherlands, 2006-2016.

Table 3b. *Sample Characteristics at Ages 62-65, Women*

	Eligible for DWB		Not eligible for DWB	
5 year mortality risk		3.8%		3.9%
Working		27.3		20.3
	Working	Not working	Working	Not working
5 year mortality risk	2.4%	4.4%	2.3%	4.3%
Married	66.3	72.9	66.8	72.8
Widowed	8.4	10.5	9.7	11.6
Divorced	18.8	11.6	17.8	11.1
Pension recipient	48.7	48.2	50.2	43.3
UI	2.9	1.8	2.9	2.7
DI	5.9	17.0	6.7	17.0
Welfare	1.0	6.2	1.1	6.3
Other social benefits	1.8	2.9	2.0	3.2
Gross income in 1999	12,383 Euro	5,377 Euro	10,975 Euro	4,308 Euro

Notes: Sample contains women born between 1943 and 1949 observed at ages 62 through 65. For cohorts born between 1943 and 1945, observations after 2009 are not included.
Source: Authors' calculations using non-public microdata from Statistics Netherlands, 2006-2016.

Table 4a. *OLS Estimates of Mortality Risk on Working Status, 1999-2011*

	Men			Women		
	(1)	(2)	(3)	(4)	(5)	(6)
Working (0/1)	-0.021***	-0.021***	-0.019***	-0.012***	-0.011***	-0.008***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
Age-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-fixed effects	No	Yes	Yes	No	Yes	Yes
Benefit controls	No	No	Yes	No	No	Yes
Mean mortality risk non-working	7.0%	7.0%	7.0%	3.6%	3.6%	3.6%
Mean mortality risk working	2.8%	2.8%	2.8%	1.7%	1.7%	1.7%
R2	0.015	0.016	0.019	0.006	0.007	0.009
Observations	10,437,307	10,437,307	10,437,307	10,143,975	10,143,975	10,143,975

Notes: Sample contains men and women born between 1943 and 1950 observed from 1999 through 2011. For cohorts born between 1943 and 1945, observations after 2009 are not included. All models include controls for marital status, income in 1999, an indicator for DWB eligible cohort (cohorts 1946-1949), year fixed effects, and age fixed effects. Benefit controls include indicators for whether a person receives a pension, welfare, UI, DI or other social benefits. Robust standard errors clustered at the birth cohort – year level in parentheses. *** p<0.01.
Source: Authors' calculations using non-public microdata from Statistics Netherlands, 1999-2016.

Table 4b. *2SLS Estimates of the effect of Working Status on the Five Year Mortality Risk, 1999-2011*

	Men			Women		
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{Working}$	-0.015***	-0.016***	-0.021***	0.090	-0.001	0.004
	(0.005)	(0.004)	(0.005)	(0.239)	(0.021)	(0.016)
Age-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-fixed effects	No	Yes	Yes	No	Yes	Yes
Benefit controls	No	No	Yes	No	No	Yes
First stage						
F Statistic	22	23	23	4	4	6
DWB coefficient	0.056***	0.057***	0.046***	0.011*	0.011	0.014*
	(0.012)	(0.012)	(0.010)	(0.006)	(0.006)	(0.006)
Observations	10,437,307	10,437,307	10,437,307	10,143,975	10,143,975	10,143,975

Notes: Sample contains men and women born between 1943 and 1950 observed from 1999 through 2011. For cohorts born between 1943 and 1945, observations after 2009 are not included. DWB instrument is 1 after 2009 for cohorts born between 1945-1949. All models include controls for marital status, indicator for DWB eligible cohorts, income in 1999, year and age fixed effects. Benefit controls include indicators for whether a person receives a pension, welfare, UI, DI or other social benefits. The table reports the Kleibergen-Paap F statistic. Robust standard errors clustered at the birth cohort – year level in parentheses. *<0.01;** p<0.05; *** p<0.01.
Source: Authors' calculations using non-public microdata from Statistics Netherlands, 1999-2016.

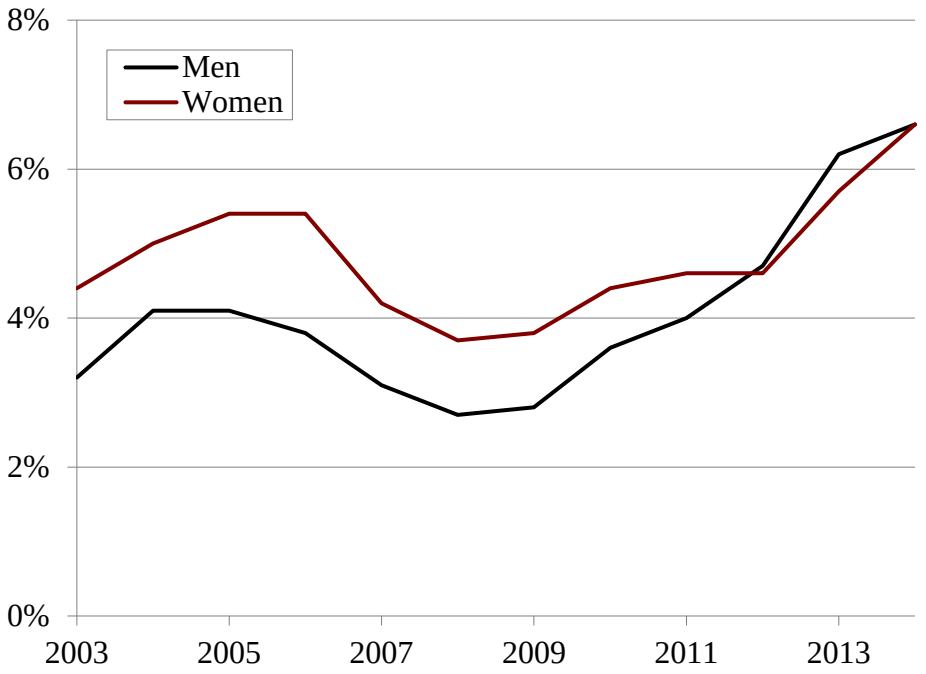
Table 4c. *2SLS Estimates of Mortality Risk on Working Status, Robustness Tests*

	(1)	(2)	(3)
	Preferred estimate	Working at age 55	Without income control
$\widehat{Working}$	-0.016***	-0.017***	-0.020***
	(0.004)	(0.005)	(0.004)
Age-fixed effects	Yes	Yes	Yes
Industry-fixed effects	Yes	Yes	Yes
Benefit controls	No	No	No
First stage			
F Statistic	23	19	23
DWB coefficient	0.057***	0.062***	0.063***
	(0.012)	(0.014)	(0.011)
Observations	10,437,307	5,077,113	10,437,307

Notes: Other controls include for marital status, indicator for DWB eligible cohorts, year fixed effects. The specifications in column 1 and 2 also control for income in 1999. The table reports the Kleibergen-Paap F statistic. Robust standard errors clustered at the birth cohort – year level in parentheses. *** p<0.01.
Source: Authors' calculations using non-public microdata from Statistics Netherlands, 1999-2016.

Appendix

Figure A1. *Unemployment Rate Ages 45-70, by Gender*



Source: Statistics Netherlands, Statline, 2002-2014.