Extending the Social Safety Net: Female Labor Supply and Rural Pension Eligibility in Brazil

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Abstract

Low female labor-force participation is endemic in the developing world, and hinders economic development and gender norms. Substantially boosting female labor supply while expanding the social safety net can, in turn, help drive structural transformation. In 1991, Brazil expanded its rural old-age pension system to cover millions of previously uncovered women, conditional on subjective work requirements. We argue that this change led to a sizeable increase in female employment. An extended difference-in-differences approach suggests that this expansion led to a sustained increase in female labor supply of almost ten percentage points, or 30 percent over the baseline participation rate. This increase in labor force participation has two components, driven by the work requirement criteria. First, rural women made immediately eligible by age temporarily increased their labor supply. Second, some cohorts of younger rural women eligible in the future also increased labor supply, presumably as an anticipatory response. These results shed light on the capacity of elderly workers to respond to financial incentives for labor participation in old age, and the extent to which younger workers might be forward-looking in the responses to retirement incentives.

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1 Introduction

Many emerging economies provide old-age pensions targeted at the poor, either through geographic requirements or means-tests. One would expect the availability of these pensions to affect labor supply over the life-cycle, but much of the research in this area focuses on the labor supply of people near the age-eligibility cutoff, usually finding a negative effect on labor supply (Huang & Zhang, 2021; Bando et al., 2016, 2020, 2022; Kaushal, 2014; de Carvalho Filho, 2008). The design of these pensions, however, often alters labor supply incentives beyond the negative wealth effect by changing work requirement criteria as well. In this paper we leverage changes in the Brazil old-age pension scheme to explore the competing effects of changes in expected wealth and work-requirements throughout the life-cycle. We argue that the work requirements underlying the pension scheme led to one of the largest increases in female labor supply seen in a span of a few years.

Low female labor-force participation is endemic in most parts of the developing world. Yet, it is often associated with structural transformation, economic development and broader improvements in gender relations. We posit that this drastic expansion in the social safety net raised the labor supply of rural women in Brazil by ten percentage points, or approximately thirty percent, between 1990 and 1992, and remained elevated for the next 20 years. These years saw an expansion of a non-contributory rural pension scheme to married women age 55 and older, provided that they could produce evidence of previous rural work. We use annual large-scale household data to show that the pension expansion led to an immediate and short-lived increase in the labor supply of women who were near retirement age when the expansion took effect, and a sustained increase in labor supply among women in younger cohorts.

This paper's finding that an increase in pension generosity is associated with an increase in labor supply is uncommon among the literature exploring old-age pensions and labor supply. Much of the existing literature presents evidence consistent with pensions influencing labor supply through a wealth effect: more pension generosity decreases labor supply (Huang & Zhang, 2021; Bando et al., 2016, 2020, 2022; Kaushal, 2014; de Carvalho Filho, 2008), while less pension generosity increases labor supply (Staubli & Zweimüller, 2013; Neumark & Song, 2013; Brown, 2013; Mastrobuoni, 2009; Duque, 2021). This paper is also uncommon in its focus on a reform that expands access to old-age pensions to a group that otherwise is unlikely to work. Like many previously studied pension reforms, the reform studied here creates an incentive for women to decrease their labor supply through the traditional wealth effect. However, since pension receipt is conditional on work history, it also encourages women to increase their labor supply through an eligibility effect. Our results suggest that this eligibility effect is particularly powerful in bringing married women into the workforce.

We use an extended difference-in-differences specification that compares the pension receipt and labor supply of rural women to that of urban women (first difference), before and after the reform (second difference), to find a sustained increase in labor supply among rural women of nine percentage points. All cohorts of working-age women dramatically increased their labor supply immediately following the reform in 1991. Older women who were age-eligible for the pension at the time of the reform increased labor supply on the extensive margin by between 30 and 40 percentage points immediately following the reform, while younger women not yet age-eligible increased their labor supply at slightly smaller rates, between 10 and 30 percentage points on the extensive margin. These findings suggest that women who might not otherwise enter the labor force adjust their labor supply when the pension incentive is strong enough. Older women will work to gain eligibility, and younger women increase their labor supply in anticipation.

A second robust finding in the literature on labor supply responses to the architecture of public pensions is that people tend to retire at discontinuously higher rates when they reach the age of pension eligibility (Neumark & Song, 2013; Behaghel & Blau, 2012; Shu, 2018). Previous work has emphasized credit constraints to explain this behavior. We next use a difference-in-discontinuities specification to explore whether women living in rural areas in Brazil make labor supply choices that replicate this pattern. We find little evidence of a discontinuous decrease in labor supply at 55, the age at which women who work in agriculture become eligible for the rural pension, immediately after the reform. However, this labor supply response develops among younger cohorts of women; women who turn 55 in 2006, for example, are five percentage points less likely to work than they are at the marginally younger 54. These findings suggest that women who are aware of the pension eligibility age and work requirements at the beginning of their working life exhibit a discontinuous decrease in labor supply at the age of eligibility.

We also explore the various competing effects of this reform on female labor supply by building a model of labor supply decisions over the life-cycle. We model heterogeneity in preferences underlying labor market participation decisions. Our model suggests that there are four groups of people driven by countervailing effects. First, those who have strong productivity in home production are unlikely to increase labor-force participation and forgo accessing the pension. Second, a certain group of marginal workers will now choose to work more years so as to meet the work eligibility requirement and obtain the pension. Third, a group of marginal workers who would have worked more than the work requirement, may actually reduce labor supply to the required amount. Finally, a group of workers that would have worked many more years than required may reduce their labor supply somewhat (and still work more than required) given their extra expected wealth from pension. We use this model to compare lifetime labor supply decisions with and without the pension, and explore the transition response to the pension expansion among Brazilian women with a smoothing assumption.

Methodologically, many papers in this literature attribute the difference in labor supply between age-eligible individuals and non age-eligible adults to a wealth effect due to the pension (Bando et al., 2016; Duque, 2021; Shu, 2018; de Carvalho Filho, 2008). However, this parameter is confounded by labor supply responses among the non-age eligible as the non-age eligible may also decrease their lifetime labor supply. Evidence abounds that old-age pensions have spillover effects on non-age eligible adults: adult children make different migration decisions, may be more or less likely to work, and families invest more in education of young children (Eggleston & Fuchs, 2012; Duflo, 2003; Ambler, 2016). In our empirical specifications, we avoid the need to use slightly younger cohorts to control for time-specific effects by comparing the impact of the pension expansion on female labor supply to its impact on various other similarly-aged control groups.

2 Background

The Brazilian Constitution of 1988 initiated a dramatic expansion of old-age pensions to women in rural areas. The rural pension system in place prior to this reform, established in 1971 and referred to as PRORURAL, granted an old-age pension equal to 50% of the minimum wage to the head of all rural households upon turning 65, provided that the household head produced evidence of working in the rural sector in one of the previous three years. As heads of households were primarily men, most women were not eligible. Receipt of the rural pension was not means-or retirement tested. A separate social security system covered Brazilians living in urban areas, in which both men and women, regardless of whether they headed their household, were eligible to receive a pension at age 70, or after 30 years of work. The urban pension amount depended on a recipient's past years of work and recent labor earnings, but was bounded below by 90% of the minimum wage. Receipt of the urban pension required recipients to quit their current job, though they could continue working elsewhere.

The 1988 Brazilian Constitution committed to equalizing this discrepancy in rural and urban pensions. Law (*Lei*) #8212/8213, passed in 1991, stipulated the details by which that equality would be achieved (see Table 1). This law made minor changes to the urban pension scheme and substantial changes to the rural pension scheme. The law adjusted the urban pension scheme by increasing the minimum benefit amount to 100% of the minimum wage, initiating a tax on covered wages, and decreasing the work requirement to 25 years for women. In the rural pension scheme, *Lei* #8212/8213 expanded access to old-age pensions to household members other than the household head; increased the benefit amount to 100% of the minimum wage; and reduced the eligibility age from 65 for all recipients, to 60 for men and 55 for women. Further, the law increased the number of years of work required for pension eligibility: to receive the pension in 1991, rural individuals were required to produce evidence that they worked in a rural occupation for at least 5 years, though those years of work could be discontinuous and anecdotal evidence from local pension administrators suggest that there was a low bar for what constituted evidence of rural work. This work requirement increased gradually for subsequent cohorts, so that people who attained the age of pension eligibility in 2011 or later were required to have worked for at least 15 years in a rural occupation. As a result, millions of married women were newly eligible to receive an old-age pension at age 55, provided that they could produce evidence of rural work history.

This reform had different impacts on work incentives for rural men and women. Most rural male pension recipients had worked more than 15 years prior to the expansion, so the newly expanded work requirement was not binding for most men. As a result, the main impact of the pension expansion on rural men was to decrease the eligibility age from 65 to 60. This increased the value of future pension benefits for any man below age 65, and the value of current pension benefits for newly eligible men between ages 60 and 65. de Carvalho Filho (2008) uses a triple-difference approach to assess the impact of this positive income effect on the labor supply of newly eligible men. By comparing rural to urban men (first difference) and men aged 60-64 to those aged 55-59 or 65-69 (second difference), before and after the reform (third difference), she finds that newly eligible men decreased employment by 38 percentage points on the extensive margin and 22.5 hours per week on the intensive margin.

For married women in rural areas, on the other hand, the minimum work rural work requirement established with *Lei* #8212/8213 was more likely to be binding. Prior to the reform in 1987, only 36 percent of rural women aged 25-75 worked, while 91 percent of rural men did so. Unlike men, for whom the 1991 pension expansion primarily increased lifetime wealth and thus exerted negative pressure on labor supply, newly eligible women who were not considered household heads faced an incentive both to decrease labor supply due to an increase in lifetime wealth and and incentive to increase labor supply to attain pension eligibility. A cursory review of employment patterns among rural women shows that both the age-eligible and age-ineligible women increased their labor supply in 1991, suggesting that the latter eligibility incentive dominated the labor supply decisions for many women. The following sections explore this empirical result in detail.[1]

3 Model

We begin with model of lifetime labor supply decisions with non-contributory pensions to explore the mechanisms through which the pension expansion can influence labor

[1]The 1988 constitution essentially merged the urban and rural pensions schemes. In 1998, the full pension scheme was reformed in a way intended to increase labor supply (men and women had to meet both the age and the years of work requirement in urban sectors, and the option for early retirement with proportional pensions was removed). These reforms might encourage us to think that negative treatment effects presenting in the early 2000s might be due to the 1998 pension reform increasing labor supply in urban areas. However, our descriptive trends suggest little real difference in urban labor supply patterns over this time.

supply. Section 3.1 builds a steady-state model to explore how a pension reform with the characteristics of the Brazilian rural pension expansion theoretically influences lifetime labor supply. Section 3.2 builds on that steady-state model to explore how people would adjust their labor supply if the pension expansion was introduced at different points in their working lives. This second modeling step is designed to represent the transition period following the 1991 reform, and describes an average annual treatment effect on cohort-level labor supply along the extensive margin.

3.1 Life-cycle model of labor supply

The model begins by describing how people choose the number of years they plan to work over their lifetime. Assume that individual i from cohort c lives $\bar{a}_c$ years and receives utility from consumption of market goods, C, and of home goods, H, over their lifetime. Their consumption of home goods is inversely proportional to the number of years the individual spends on market work, L, with $H = \bar{a}_c - L$. We will consider L the individual's choice variable. Without the pension regime, individuals receive a market wage, w, that does not change over their lifetime.

Under the pension regime, the individual receives a pension with present discounted value of $\tilde{P}$ if they work at least $\tilde{L}_c$ years over their lifetime.[2] Assume that under the pension regime, people receive a market wage w_P, which may or may not be the market wage that prevails without the pension.

Individuals are heterogeneous in α_i, their relative preferences over market and home consumption. They maximize their utility subject to a lifetime budget constraint:

$$\max_{H} \ (1-\alpha_i) log\ C + \alpha_i log\ (\bar{a}_c - \ L)$$
$$s.t. \quad C \leq \begin{cases} wL & \text{without pension} \\ w_p L + \tilde{P} \times \mathbb{1}_{L \geq \tilde{L}_c} & \text{with pension} \end{cases}$$

The value of home goods, which also can be interpreted as the opportunity cost of market work, is captured by α_i and can be heterogeneous across people.

Any pension scheme, $\{\tilde{P}, \tilde{L}_C\}$, affects individuals differently according to their opportunity cost of market work, α_i. The solution, summarized in Figure 6 and detailed in Appendix A.1, identifies three types of workers: those who work regardless of whether the pension is offered (market workers), those who work exactly the number of years the pension requires for eligibility (compliers), and those for whom the pension does not influence the number of years they work (non-responders).

[2] Note the model abstracts from eligibility age for now. Under the assumption of zero discounting, people are indifferent regarding which years in their life they work. Introducing an eligibility age, as we do in section 3.2, encourages them to complete the work requirement before their eligibility age to maximize the present discounted value of their pension.

Figure 6 describes how the home production, labor supply, and value function of these groups vary according to their opportunity cost of market work.[3] People with a low value of home production who worked prior to the pension expansion, $\alpha_i \leq \alpha_1 = \frac{w_p(\bar{a}_c - \tilde{L}_c)}{\bar{a}_c w_P + \tilde{P}}$, reduce their labor supply when the pension is available, but continue to work more than the minimum number of years required to achieve pension eligibility. These individuals, who we refer to as "market workers," respond to the wealth effect created by the additional pension wealth and are not constrained by the pension's minimum work requirement. People with a slightly higher value of home production, $\alpha_i \in \left(\alpha_1, \alpha_2 = \frac{\bar{a}_c - \tilde{L}_c}{\bar{a}_c}\right)$ similarly reduce their labor supply when the pension is available, but are constrained by the minimum work requirement and thus work exactly $\tilde{L}_c$ years over their lifetime. These individuals, who we call "down-compliers," respond to the minimum work requirement as well as the wealth effect; they work less than they would have without the pension but more than they would have in absence of the work requirement. A second group of compliers, "up-compliers" with a slightly higher $\alpha_i \in (\alpha_2, \alpha_3)$, also works exactly $\tilde{L}_c$ years.[4] Up-compliers similarly respond to both the minimum-work requirement and the wealth effect, but work more under the pension regime than they would have without the pension. Finally, individuals with a high value of home production, $\alpha_i > \alpha_3$, who we call "non-responders," do not adjust the number of years they plan to work under the pension expansion.

3.2 Modeling average annual treatment effects by cohort

This section expands the static model of lifetime labor supply to predict people's labor supply responses to a pension expansion that occurs during their working lives. In so doing, we model the average annual treatment effect of pension expansion on extensive-margin labor supply within a cohort and explore the channels through which this effect operates. In this step, we add the assumption that people are eligible to receive the rural pension, provided that they have worked at least $\tilde{L}_c$ years, only when they reach eligibility age, $\tilde{a}_E$. The pension scheme is now described by the triple $\mathcal{P} = \{\tilde{L}, \tilde{P}, \tilde{a}_E\}$.

We assume that each member of a given cohort c has the same target retirement age and that $\alpha_i \sim G(\alpha)$ within a cohort, implying that the aggregate lifetime labor supply of cohort c under the no-pension regime is $L_C^{NP} = \int_\alpha L_{NP}^* dG(\alpha)$, where L_{NP}^* is the interior solution for lifetime labor supply under the no-pension regime in Section 3.1. At the cohort level, aggregate lifetime labor supply is smoothed across the years before the cohort reaches its target retirement date. Accordingly, the extensive margin labor supply within a cohort in a given year is $\frac{L_C^{NP}}{\bar{a}_c}$ if everyone within a cohort planned to retire only upon death (ie., the cohort's retirement age is $\bar{a}_c$).

Let $\bar{a}_R$ be the cohort's target retirement age under the no-pension regime, and $\tilde{a}_R$ be

[3]This figure assumes a lifespan of 80 years, that wages are the same with and without the pension, and that the pension scheme requires 15 years of work.

[4]The solution to α_3 is detailed in Appendix A.1

the cohort's target retirement age under the pension regime. Suppose that people are able to start working as soon as they are "born" so that their possible working life is $\bar{a}_R$ years under the no-pension regime and $\tilde{a}_R$ years under the pension regime.

Suppose a pension scheme $\mathcal{P}$ is introduced in year j, when cohort c is age $a_{cj} = j - c$ years of age. Prior to the pension introduction, cohort c planned to work L^*_{NP} years before retirement. At the cohort level, these years are smoothed out over the working life so that the cohort works $\frac{L^*_{NP}}{\bar{a}_R}$ per year. By year j, cohort c has worked $\frac{a_{cj}}{\bar{a}_R} L^*_{NP}$ years. Had the pension not been introduced, cohort c would have continued to work $\frac{1}{\bar{a}_R} L^*_{NP}$ per year until age $\bar{a}_R$. Define L^{NP}_{ct} to be cohort c's labor supply in period $t > j$ if the pension were never introduced:

$$L^{NP}_{ct} = \frac{1}{\bar{a}_R} \int_\alpha L^*_{NP} dG(\alpha) \tag{1}$$

We define the average annual treatment effect of the pension on cohort c to be $\Delta L_{ct} = L^P_{ct} - L^{NP}_{ct}$, where L^{NP}_{ct} is as defined in equation 1 and L^P_{ct} is the labor supply of cohort c in year $t > j$ after the pension has been introduced. The next step is to find an expression for L^P_{ct}. Under the pension regime, suppose that cohort c plans to work L_P years before age $\tilde{a}_R$. As of time j, they have already worked $\frac{a_{cj}}{\bar{a}_R} L^*_{NP}$ years. Accordingly, they must now work an additional $L_P - \frac{a_{cj}}{\bar{a}_R} L^*_{NP}$ years before age $\tilde{a}_R$, where L_P is their desired lifetime labor supply under the pension regime. At the cohort level, these years of work will be smoothed over the rest of the cohort's working life, which is $\tilde{a}_R - a_{cj}$ additional years. Therefore, the labor supply of cohort c in year $t > j$ after the pension has been introduced is:

$$L^P_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_\alpha L_P - \frac{a_{cj}}{\bar{a}_R} L^*_{NP} dG(\alpha) \tag{2}$$

The average treatment effect on extensive-margin labor supply in each year $t > j$ is:

$$\begin{aligned}
\Delta L_{ct} =& L^P_{ct} - L^{NP}_{ct} \\
\Delta L_{ct} =& \underbrace{\frac{1}{\tilde{a}_R - a_{cj}} \int_\alpha L_P - \frac{a_{cj}}{\bar{a}_R} L^*_{NP} dG(\alpha)}_{L^P_{ct}} - \underbrace{\frac{1}{\bar{a}_R} \int_\alpha L^*_{NP} dG(\alpha)}_{L^{NP}_{ct}} \\
=& \int_\alpha \frac{1}{\tilde{a}_R - a_{cj}} L_P - L^*_{NP} \left(\frac{a_{cj}}{\bar{a}_R} \frac{1}{\tilde{a}_R - a_{cj}} + \frac{1}{\bar{a}_R} \right) dG(\alpha) \\
=& \int_\alpha \frac{1}{\tilde{a}_R - a_{cj}} L_P - L^*_{NP} \left(\frac{a_{cj} + \tilde{a}_R - a_{cj}}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) dG(\alpha)
\end{aligned}$$

$$\Delta L_{ct} = \int_\alpha \frac{1}{\tilde{a}_R - a_{cj}} L_P - L^*_{NP} \left(\frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) dG(\alpha) \tag{3}$$

3.2.1 Decomposing into wealth and retirement-timing effect with no work requirement

Suppose for the moment that the pension scheme has no work requirement, $\tilde{L} = 0$, or that we are calculating the average annual treatment effect for a population that includes only market workers. In this case, $L_P = L_P^* = \bar{a}_c(1-\alpha_i) - \frac{\alpha_i \tilde{P}}{w_P}$ and $L_{NP}^* = (1-\alpha_i)\bar{a}_c$ (see Appendix A.1). The average annual treatment effect by cohort from equation 3 is:

$$\Delta L_{ct} = \int_\alpha \frac{1}{\tilde{a}_R - a_{cj}} \underbrace{\bar{a}_c(1-\alpha_i) - \frac{\alpha_i \tilde{P}}{w_P}}_{L_P = L_P^*} - \underbrace{(1-\alpha_i)\bar{a}_c}_{L_{NP}^*} \left(\frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) dG(\alpha)$$

$$\Delta L_{ct} = \int_\alpha (1-\alpha_i)\bar{a}_c \left(\frac{1}{\tilde{a}_R - a_{cj}} - \frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) - \frac{1}{\tilde{a}_R - a_{cj}} \frac{\alpha_i \tilde{P}}{w_P} dG(\alpha)$$

$$\Delta L_{ct} = \int_\alpha (1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) - \frac{1}{\tilde{a}_R - a_{cj}} \frac{\alpha_i \tilde{P}}{w_P} dG(\alpha)$$

$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_\alpha \underbrace{(1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R} \right)}_{\text{Retirement Timing Effect}} \underbrace{- \frac{\alpha_i \tilde{P}}{w_P}}_{\text{Wealth Effect}} dG(\alpha) \tag{4}$$

Note that, when there is no work requirement, the pension scheme influences the average annual treatment effect of the extensive-margin labor supply response through two channels:

- The retirement timing channel: If the pension scheme does not affect people's target retirement date, then $\bar{a}_R = \tilde{a}_R$ and the retirement timing effect is zero. If the pension scheme encourages people to decrease their target retirement age, then $\bar{a}_R > \tilde{a}_R$, and the retirement timing effect is positive until age $\tilde{a}_R$ and negative from age $\tilde{a}_R$ to $\bar{a}_R$. If the pension encourages people to increase their target retirement age, then $\tilde{a}_R > \tilde{a}_R$, and the retirement timing effect is negative until age $\bar{a}_R$ and positive from age $\bar{a}_R$ to $\tilde{a}_R$

- The wealth effect channel: cohort-level lifetime labor supply decreases by $\int_\alpha \frac{\alpha_i \tilde{P}}{w_P} dG(\alpha)$ due to a wealth effect that depends on the productivity of home-work, the lifetime value of the pension, and the wage the individual can receive under the pension regime.

- Overall, both effects are larger in magnitude if the reform happens closer to the desired retirement age under the pension scheme/ the cohort is closer to retirement age when the pension regime is in place; the average annual treatment effect by cohort should be closer to zero for cohorts that were younger (further from retirement age) when the reform was enacted.

3.2.2 Including the work requirement

Now, allow the pension scheme to include a work requirement: people from cohort c must work for at least $\tilde{L}_c$ years to receive pension eligibility. Introducing this requirement creates our second two groups of workers: compliers who work exactly $\tilde{L}_c$ years (some of whom work more than they would have without the pension and some of whom work less than they would have without the pension) and non-responders who choose to forgo the pension and, instead, work the same number of years they would have if the pension had not been introduced.

Down- or Up-Compliers work $\tilde{L}_c$ years under the pension scheme. We find the average annual treatment effect by cohort for this population with $\alpha_i \in (\alpha_1, \alpha_3]$, by setting $L_P = \tilde{L}_c$ in equation 3. Note that $\tilde{L}_c = \tilde{L}_c + L_P^* - L_P^*$, where L_P^* is lifetime labor supply under the pension regime when there is no work requirement, and equation 3 for the group of compliers becomes:

$$\Delta L_{ct} = \int_{\alpha_1}^{\alpha_3} \frac{1}{\tilde{a}_R - a_{cj}}(\tilde{L}_c + L_P^* - L_P^*) - L_{NP}^* \left(\frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) dG(\alpha)$$
$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_1}^{\alpha_3} \underbrace{L_P^* - L_{NP}^* \frac{\tilde{a}_R}{\bar{a}_R}}_{\mathcal{A}} + (\tilde{L}_c - L_P^*) dG(\alpha)$$

Note that $\mathcal{A}$ is the inside of the integral in equation 4. Accordingly, we see that the retirement-timing effect and the wealth effect are both active for compliers as well as market workers:

$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_1}^{\alpha_3} \underbrace{\underbrace{(1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R} \right)}_{\text{Retirement Timing Effect}} - \underbrace{\frac{\alpha_i \tilde{P}}{w_P}}_{\text{Wealth Effect}}}_{\mathcal{A}} + \underbrace{(\tilde{L}_c - L_P^*)}_{\text{Eligibility Effect}} dG(\alpha)$$

The average annual treatment effect for compliers is also influenced by a third channel, which we call the eligibility effect. Without the work requirement, compliers would have worked less than $\tilde{L}_c$ when the pension was introduced. However, these workers find the value of receiving the pension to be high enough that they are willing to work the required number of years to achieve eligibility. Thus they work an additional $\tilde{L}_c - L_P^*$ years more than the interior solution under an analogous pension regime with no work requirement. Plugging in the equation for L_P^* from Appendix A.1, we have:

$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_1}^{\alpha_2} \underbrace{(1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R}\right)}_{\text{Retirement Timing Effect}} - \underbrace{\frac{\alpha_i \tilde{P}}{w_P}}_{\text{Wealth Effect}} + \underbrace{\tilde{L}_c - (1-\alpha_i)\bar{a}_c + \frac{\alpha_i \tilde{P}}{w_P}}_{\text{Eligibility Effect}} dG(\alpha) \tag{5}$$

Non-responders do not adjust their lifetime labor supply when the pension regime is introduced. The contribution by the non-responders to the cohort-level average annual treatment effect depends on whether they adjust their retirement age in response to the pension expansion. If they do not, their contribution to the average annual treatment effect is:

$$\Delta L_{ct} = 0 \tag{6}$$

However, if non-responders work some small amount over the course of their lifetime and their retirement age adjusts along with the retirement age of the rest of their cohort, then their adjustment may contribute a retirement-timing effect only:

$$\Delta L_{ct} = \int_{\alpha_3}^{1} \frac{1}{\tilde{a}_R - a_{cj}} L^*_{NP} - L^*_{NP} \left(\frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})}\right) dG(\alpha)$$
$$\Delta L_{ct} = \int_{\alpha_3}^{1} L^*_{NP} \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})}\right) dG(\alpha)$$
$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_3}^{1} L^*_{NP} \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R}\right) dG(\alpha)$$
$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_3}^{1} (1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R}\right) dG(\alpha)$$

So then all members of the cohort respond with the retirement timing effect, everyone but non-responders are influenced by the wealth effect, and only the compliers respond to the eligibility effect. The average annual treatment effect for the whole cohort, including all three groups of workers, is:

$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \Bigg[\int_{\alpha} \underbrace{(1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R}\right)}_{\text{Retirement Timing Effect}} - \underbrace{\frac{\alpha_i \tilde{P}}{w_P}}_{\text{Wealth Effect}} dG(\alpha) + \int_{\alpha_1}^{\alpha_3} \underbrace{\tilde{L}_c - (1-\alpha_i)\bar{a}_c + \frac{\alpha_i \tilde{P}}{w_P}}_{\text{Eligibility Effect}} dG(\alpha) \Bigg] \tag{7}$$

3.3 Bringing model to the data

When we take this to the data, we argue that the average annual treatment affect by cohort on extensive-margin labor supply, $ATT_{ct} = \Delta L_{ct}$, is captured in the difference-in-differences specification we lay out in section 5.2.

Similarly, the change in total labor supply per year in the population is given by $\Delta L_t = \sum_c N_c \Delta L_{ct}$, where N_c is the population share in cohort c. The analogue in the data is a difference-in-differences coefficient on labor supply that is not cohort specific, but varies over time $ATT_t = \Delta L_t$.

And last, the change in lifetime labor supply for cohort c is $\Delta L_c = \sum_t \Delta L_{ct}$, and $ATT_c = \Delta L_c$. As such, our estimates of ATT_{ct} aggregated in the various ways tell us what would happen to overall labor supply in the population over time.

We also use a difference-in-discontinuity specification, described in section 5.3, to explore whether the pension expansion influenced cohorts' target retirement age.

4 Data Description

The *Pesquisa Nacional por Amostra de Domicilios*, or PNAD, is an annual, cross-sectional survey of approximately 100,000 households that began in 1967. This survey is nationally representative of the Brazilian population, age 14 and above, and emphasizes labor-market activity. The survey asks detailed questions about work and demographic aspects of household members. Importantly for this study, it contains information on household members' pension receipt and work status, including work in informal employment. This paper uses data compiled between 1981-2013, omitting years in which the PNAD was not conducted, and considers adults between age 25 and 74.

Table 2, Panel A describes the pension and labor force status of rural and urban residents in the PNAD, aged 25 to 74, between 1981 and 1991 (before the reform) and between 1993 and 2013 (after the reform). Women are substantially less likely than men to identify themselves as the household head in both rural and urban areas. The pension reform that expanded eligibility to non-household heads was associated with an increase in pension receipt among rural residents: from 28 to 66 percent among women aged 55 and older and from 40 to 55 percent among men aged 55 and older. Following the reform, 12 percent of rural women and men live in households receiving multiple pensions, increased from three and two percent, respectively, before the reform. Table 2, Panel B describes individual and household characteristics. Family size is comparable among rural and urban women, but rural women are more likely to be married and less likely to live a multi-generational household than their urban counterparts.

5 Empirical results

This section describes women's labor supply responses to the rural pension expansion. Consistent with previous studies, we find that aggregate labor supply discontinuously decreases at the age of eligibility. Yet, we document a set of new dynamics at other ages. We find *increases* in aggregate labor supply, driven by increases in labor force participation, for the three years following the expansion. This near-term adjustment is unique and differs substantially from that found in earlier work. This response varies by cohort: Women aged 45 through 59, around the age of eligibility when the expansion occurred, experienced a large increase in annual labor supply, while younger cohorts saw smaller increases. The following subsections use descriptive trends, a difference-in-differences specification, and a difference-in-discontinuities specification to describe these findings.

5.1 Descriptive Trends

We begin with a simple analysis of aggregate trends in married women's labor force participation by rural versus urban status, before going into a difference-in-differences analysis. As difference-in-differences estimates may hide which group of individuals are driving the changes, we believe that the simple descriptive trends transparently make the case that pension eligibility increases labor force participation among married women in rural areas.

Figure 2 describes patterns of pension receipt and labor supply among married and single women living in rural and urban areas in Brazil from 1981 through 2013. While there was an expansion in pension receipt among married women (red lines) living in both urban (light) and rural (dark) areas throughout this period, the expansion among married women in rural areas was particularly pronounced between 1991 and 1993 (Figure 2, Panel A).[5] Further, the rural workforce increased dramatically on both the extensive margin and in aggregate over that two-year period: the fraction of married women in rural areas that worked increased by ten percentage points (37 percent) and the average length of the workweek among all married women in rural areas increased by two hours (15 percent). The average length of the workweek among those who worked, however, declined by four and a half hours (14 percent) between 1991 and 1993.

Labor supply remained elevated on the extensive margin among married women in rural areas in the decades following the pension expansion, but aggregate hours worked flattened out shortly after 1993. This aggregate trend was influenced by a steady decrease along the intensive margin, measured as hours worked among the working, throughout the 2000s. These trends are particularly pronounced in comparison to labor supply trends among married women in urban areas, who experienced steady aggregate growth in labor

[5] This is consistent with de Carvalho Filho (2008), who shows that the Brazilian government took roughly two years to expand the rural pension system to reach the newly eligible.

supply, with steady increases along the extensive margin and very little change on the intensive margin.

Figure 2, Panels B and C, describe how different cohorts of women adjusted their labor supply following the rural pension expansion. Panel B includes only women who were younger than 50 in 1991 (pre-retirement age) and Panel C includes only women who were older than 50 (retirement age) in 1991. Rural married women who were younger than retirement age increased employment on the extensive margin by ten percentage points, and sustained this increase throughout most of their careers. Rural married women close to or in retirement, between ages 50 and 74 in 1991, similarly increased labor supply by around ten percentage points; this large peak was short-lived, but married retirement-age women in rural areas continued to work more than their counterparts in urban areas for many years following the reform. Among both cohorts, the increase on the extensive margin was short-lived, but the decline on the intensive margin continued throughout the 2000s. These patterns are again particularly pronounced in comparison to labor supply trends among married women in urban areas.

The pension expansion allowing multiple pensions per household increased the pension access of married women much more than that of single women or men. This differential impact is evident in Figure 2, Panel A, where pension receipt increased by almost seven percentage points among married rural women between 1991 and 1993, but by only one and a half percentage points among single rural women. In that same period, rural men experienced a similarly small increase in pension receipt of two percentage points. Unlike married women in rural areas, neither single women nor men living in rural areas noticeably increased their labor supply on the extensive margin or in aggregate over this period. Both single women and men, however, decreased labor supply on the intensive margin: hours worked among the working decreased by four percentage points (ten percent) among single women between 1990 and 1993, a decline similar in magnitude to that among married women. Rural men experienced a less precipitous decline in intensive-margin labor supply, but still pronounced relative to urban men, and a steady decline in aggregate labor supply throughout the 2000s.

5.2 Difference-in-differences Strategy

We identify the impact of the pension expansion on labor supply by comparing labor supply outcomes of people living in rural areas to those of people living in urban areas (first difference), in years before and after the reform (second difference). The following equation describes the extended difference-in-differences specification:

$$y_{irst} = \alpha D_{irs} + \sum_{j=1981}^{1987} \beta_j^{pre} D_{irs} + \sum_{j=1988}^{2013} \beta_j^{post} D_{irs} + \delta_t + \mu_s + \Gamma'_{ist} X_{irst} \tag{8}$$

The outcome variable of interest, y_{irst}, is measured for individual i living in geographical area r of state s in year t. The variable D_{irs} indicates the individual's treatment status, equal to one for individuals living in rural areas who could benefit from the newly expanded rural pension system, and zero for individuals living in urban areas. The coefficients δ_t and μ_s represent year and state fixed-effects. The vector of controls, X_{ist}, consists of an indicator of whether a spouse is present in the household and the number of other household members: household characteristics that may vary over time and are correlated with the outcome. We run this specification on various samples of people between ages 25 and 74, in the years 1981 to 2013. The omitted year is the year 1987, immediately before the constitutional reform.

5.2.1 Difference-in-Differences: Results

Our main estimates focus on married women living in rural areas. Figure 3, Panel A presents the coefficient estimates and 95% confidence intervals found by running equation 8 on the sample of married women in rural and urban areas, using pension receipt and three measures of labor supply as the outcome variables. We find that pension receipt among married women in rural areas (graph Ai) increased by four percentage points relative to their urban counterparts within two years of the pension expansion, and by ten percentage points relative to their urban counterparts by 2013. The fraction of married women in rural areas who worked (Aii: extensive margin) similarly increased relative to its urban counterpart immediately after the reform, by nine percentage points (26 percent) between 1991 through 1993, and remained high until 2009. The average length of the workweek among working married women in rural areas (Aiii: intensive margin), however, declined by two hours in 1992, by six hours in 2009, and remained at this low level through 2013.

These patterns are consistent with two explanations: either the length of the work week declined for all women after the pension expansion, or women who entered the workforce after the expansion were more likely to work part time. Appendix B provides evidence supporting the latter explanation. Graph A.iv. shows that the increase in labor supply along the extensive margin dominated the decrease along the intensive margin in the early years: the average length of the workweek among all women increased by approximately two hours (13 percent) from 1991 though 1993. However, the overall treatment effect fell to zero within five years, and below zero by 2009.

Figure 3, Panels B and C present the primary estimates from specification 8 separately for women in pre-retirement and retirement-age cohorts. As expected, pension receipt increases quickly among age-eligible married rural women. The largest increases in labor supply along the extensive margin are among married women who are near age-eligible for the pension. Married women in rural areas who were between 60 and 65 were 16 percentage points more likely to work, while those who between 55 and 65 were 20 percentage points more likely to work in the year following the enactment of Law #8212/8213. This increase in labor supply, though smaller initially, for younger cohorts is more persistent than that for older cohorts. Despite the decline in the average length of the workday for most cohorts, overall labor supply increased for middle-age cohorts throughout the period considered.

While our focus has been on married women's labor force participation, we may also expect rural single women and rural men to respond to aspects of the rural pension expansion. Single women and men who were expecting to draw on the rural pension prior to the reform saw their eligibility age decline by ten and five years, respectively, and their benefits increase from 50 percent to 100 percent of the minimum wage. Figure 2, Panel A, and Figure 4, Panel A, compare descriptive trends in pension receipt, work status, and hours worked for single women and men, to those of married women, in urban and rural areas. These figures confirm that the starkest increase in pension receipt was among married women in rural areas immediately following the reform. However, pension receipt also increased discontinuously for rural men and, to a lesser extent, single women in that time period. The descriptive trends in labor supply measures, however, suggest that the primary adjustments in labor supply immediately following the reform were among married women in rural areas while longer-term declines in labor supply also occurred among rural single women and rural men. Figure 4 compares these patterns more formally by presenting the difference-in-difference specification on married women, first shown in Panel A of Figure 3, beside those found by running that same specification on men (Panel B) and single women (Panel C). Once again, these specifications compare rural and urban (first difference) over time (second difference).

5.2.2 Difference-in-differences: Identification and Robustness

Two identifying assumptions underlie this specification. First, the parallel trends assumption requires that rural and urban labor supply would move in parallel in absence of the expansion in the rural pension system. The point estimates of the pre-trend coefficients, β_j^{pre} $\forall j \in [1981, 1989]$, are not far from nor statistically different from zero, which alleviates the concern that this assumption is violated. Second, the exogeneity assumption requires that no other changes occurred simultaneously with the pension reform in 1988, besides the policy change of interest, that influence rural and urban labor supply choices in different ways. Under these identifying assumptions, the coefficients of interest β_j^{post}, $\forall j \in [1988, 2013]$, measure the impact of the pension expansion on rural labor supply.

One potential threat to the exogeneity assumption would be coincident changes in the urban pension system. The constitutional reform of 1988 and subsequent Law #8212/9213 made minor reforms to the urban pension scheme that may have influenced the labor supply of the control group: a requirement for urban workers to quit their current job in order to claim pensions was removed, the minimum benefit increased and working wages taxed, and the work requirement for urban women to gain pension eligibility reduced from 30 to 25 years. The first two of these reforms in the urban scheme bias our difference-in-differences estimates toward zero, but the third introduces a positive bias. The descriptive analysis in the previous subsection alleviates this concern somewhat, since it shows quite starkly that were there were no substantial changes in pension provision or labor supply among married women in urban areas, while there were sharp changes to married women's labor supply in rural areas after the pension expansion in 1991.

The estimates presented in Figure 4 further alleviate concerns about the exogeneity assumption. By comparing different groups in rural areas – married women, single women, and men – this exercise allows us to explore potential confounding factors that affect rural areas more broadly, in comparison with urban areas. That is, if married women's labor supply in rural areas happened to be influenced by aggregate labor market shocks that were absent from urban areas, the labor supply of single women and men in rural areas would likely be differentially affected as well. While we visually compare the estimates for married women, single women, and men in the main text, Appendix B.1 runs more structural difference-in-difference estimates across these groups. These exercises confirm that the labor supply of rural married women is more responsive to the rural pension expansion than that of single women or men.

5.3 Difference-in-discontinuities

We also examine whether introducing a pension eligibility age at 55 influenced women's target retirement age. To do so, we use a difference-in-discontinuities specification, and estimate a discontinuity in various outcomes at age 55, over time. Figure 5 shows the discontinuity in pension receipt and labor supply at age 55 among rural women in each year in the three decades surrounding the reform. The first panel shows the stark jump in pension receipt at age 55, after the reform. The subsequent panels look at the probability that women worked, and the hours worked.

Prior to the reform in 1991, there was negligible difference in the probability that a rural women was working at age 55 versus age 54. However, by 1995, women were five percentage points less likely to work at age 55 than 54, and that difference increased marginally as the years progressed. This suggests, as we describe in the model below, that individuals who had less than the required years of work experience tried to attain the required years by the age of 55. In Appendix B.2, we test the robustness of this discontinuity by running analogous specifications using ages other than the age of eligibility – 50, 60, and 65 – and find no evidence of a discontinuous decrease in labor supply at those ages in any year between 1981 and 2006.

6 Discussion

The evidence here suggests that expanding a pension with an informal work requirement substantially increased labor supply along the extensive margin among people who may not have otherwise entered the workforce. We find clear evidence of a temporary response on the part of immediately eligible workers, and a more sustained response among future-eligible workers. The model presented in Section 3 sheds light on the mechanisms underlying these empirical adjustments.

According to our lifetime model of labor supply, the pension expansion encourages people with lower home productivity, α_i, to decrease the number of years they work over their lifetime and those with slightly higher home productivity to increase the number of years they work. In Figure 6, market workers with $\alpha_i \in (0, \alpha_1]$ and down-compliers with $\alpha_i \in (\alpha_1, \alpha_2]$ would have worked more than the pension reform requires to achieve eligibility in absence of the reform; the pension reform creates a wealth effect encouraging them to decrease their labor supply. Up-compliers, on the other hand, have slightly higher home productivity with $\alpha_i \in (\alpha_2, \alpha_3]$ and would not have worked as many years as the pension requires for eligibility in absence of the reform. The pension thus encourages them to work more years over their lifetime to achieve eligibility. Our empirical estimates in section 5 suggest an aggregate increase in years worked over the lifetime, implying that the increase in years worked among up-compliers outweighs the decrease in years worked among market workers and down-compliers.

Model equation 7, repeated below for convenience, captures the annual extensive-margin adjustments in labor supply by cohort to the pension expansion. Under the assumption that lifetime labor supply is smoothed within cohort over the working life, the difference-in-difference estimates found by running specification 8 on an indicator for whether an individual from cohort c worked in the previous week, when surveyed in year t, are the empirical analogue to ΔL_{ct}:

$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \Bigg[\int_\alpha \underbrace{(1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a_R}}{\bar{a}_R} \right)}_{\text{Retirement Timing Effect}} - \underbrace{\frac{\alpha_i \tilde{P}}{w_P}}_{\text{Wealth Effect}} \, dG(\alpha) + \int_{\alpha_1}^{\alpha_3} \underbrace{\tilde{L}_c - (1-\alpha_i)\bar{a}_c + \frac{\alpha_i \tilde{P}}{w_P}}_{\text{Eligibility Effect}} dG(\alpha) \Bigg]$$

Accordingly, each annual cohort-level treatment effect captures a wealth effect, eligibility effect, and retirement-timing effect. The wealth and eligibility effects first arise in our lifetime model; their sum is negative within year for market-workers and down-compliers, and positive within year for up-compliers. The retirement-timing effect arises if the pension expansion influences a cohort's target retirement age, or $\tilde{a}_R \neq \bar{a}_R$. The difference-in-discontinuities specification in section 5.3 suggests that this is indeed the case: a target retirement age seems to develop at the new pension eligibility age of 55. The retirement-timing effect does not result in a larger number of years worked over the lifetime; rather it redistributes working years across the lifetime. If the target retirement age decreases due to the pension expansion, people will reallocate the years they planned to work after the new target retirement date to years immediately after the reform and before their new target retirement date.

[[Figure 5 shows responses smaller in magnitude for younger cohorts of women, which is consistent with the model prediction coming from the above equation. Younger women who are further from their retirement age when the reform is introduced (ie., larger $\tilde{a}_R - a_{cj}$) have more years across which to spread out their labor supply adjustment. Accordingly, each annual treatment effect will be smaller in magnitude for younger cohorts.]]

Over the course of the lifetime, the retirement timing effect should have no impact on overall labor supply, while the wealth effect would decrease extensive-margin labor supply and the eligibility effect would increase it. To explore whether the short-lived increases in extensive margin labor supply are due to the eligbility effect or the retirement-timing effect, we calculate the cohort-level average treatment effect as $\Delta L_C = \sum_t \Delta L_{ct}$. Table 3 presents these estimates for cohorts grouped into five-year bins, that were between the age of 25 and 69 in 1991. Extensive-margin labor supply increased by between one and seven years per worker across cohorts among women, with percentage increases in the number of years worked over the lifetime between four and 26 percent.

To calculate these lifetime adjustments in labor supply by cohort, we use the annual cohort-level difference-in-difference estimates to predict the number of workers that work in each year in the actual (with the pension expansion) and counterfactual (predicted if there had been no pension expansion) scenarios. The lifetime change in worker-years due to the pension expansion is then calculated as the difference between the actual number of worker-years within the cohort and the predicted number of worker-years within the cohort from 1991 through 2013. The cohort aged 25 through 29 in 1991, for example, worked an additional six months per person and 1.2 years per worker due to the pension expansion, leading to an calculated increase in lifetime labor supply of 4.3 percent.

Table 3 shows a steady pattern of larger impacts of the pension expansion on lifetime labor supply for old cohorts. Women under 44 when the reform occurred increased lifetime labor supply on the order of four percent, while women older than that age increased lifetime labor supply between ten and 26 percent. This increasing pattern could be explained by changes in the composition of the workforce. Note that the work requirement, referred to as $\tilde{L}_c$ in section 3, was eased in gradually, so that women who were 55 and older only needed to work five years to achieve pension eligibility while younger women were required to between 5 up to 15 years, depending on their cohort.[6] The α_i threshold at which workers transition from an "down-complier," who decreases labor supply facing the pension expansion, to an "up-complier", who increases labor supply facing the pension expansion falls with $\tilde{L}_c$. Facing the lower worker requirement $\tilde{L}_c$, therefore, older cohorts were more likely to have an α_i such that they were up-compliers.

The model does not directly capture the intensive-margin impacts on working, but the empirical work clearly shows a decrease in the number of hours worked among the working for all groups considered, which dampens the rise in total labor supply among rural women. However, the model does provide some intuition on what might be causing this decrease. On one hand, this could be due to the wealth effect: We've argued above that the positive eligibility effect strongly counteracts the negative wealth effect with regards to the extensive-margin labor supply. People may be reacting to this wealth effect not by cutting back on years worked, but by cutting back on hours. On the other hand, this could be a composition effect – "up-compliers" with high productivity of home work, α_i, who are entering the workforce may choose to work fewer hours than the traditional market workers with a lower productivity of work at home.[7]

The model also sheds some useful light on the comparison between the impact on labor supply for women and men. Single women and men reveal themselves to have a lower α. Prior to the reform, a good majority of them worked for at least 15 years. Further, the design of the reform would have meant that the wealth effect was not as large for them as it was for married women who were not previously eligible. Even among single women and men, we see a slight increase on the intensive margin (which could be eligibility effect or retirement timing) and a decrease in hours worked along the intensive margin. While the patterns of aggregate hours worked are similar in magnitude across the three groups, both of those changes are smaller in magnitude for single women and men. Tables 4 and 6 calculate the lifetime change in labor supply for these groups.

7 Conclusion

Low female labor-force participation is endemic in the developing world. Cultural, norm-based and market-based frictions that restrict access to the labor market for half the country's population hinders unleashing its potential for growth and development. Policies that, with or without intent, expand female labor force participation at such an enormous rate are difficult to find. We document a substantial shift in women's participation in the labor market in response to the pension scheme.

This paper has shed light on the willingness and the ability of workers to react to retirement incentives in a forward-looking manner. The results regarding the immediately eligible cohort indicate that elderly workers have the ability to increase their labor supply

[6]Table 3 details these work requirements by cohort.

[7]Expand on the appendix that breaks down by full- and part-time workers.

given the right incentives, and the results regarding the younger cohorts indicate that retirement policies enacted today may have unforeseen effects among those who are not currently eligible for benefits, but will be in the future. While the responses seem to be much larger than what has been documented in other contexts (or might seem sensible from another perspective), the pensions were indeed sizeable. Given how important the equivalent of an additional minimum wage might have been to a low-income rural family, it may be more reasonable to expect that the work requirements of the pension could dominate the wealth effect on labor supply.

Our study looks at the impact of the pension expansion and coincident rural work requirement on *any* work by a woman living in rural areas. It would be interesting to further explore whether it was only rural work that increased, or if people were more likely to hire people as domestic workers as women did less domestic work to engage in paid rural work outside of the house. There is also evidence that an expansion of rural pensions in other countries influence, for example, the labor supply decisions of adult children or the education support of younger children. We would like to explore these impacts in the case of Brazil.

This study adds more broadly to the literature regarding retirement policies in the developing world. Reforms of benefits and social security often demand an analysis of the associated labor supply responses among the eligible cohort. However, this paper shows that an expansion of benefits can, under some circumstances, *increase* labor supply if qualifications are properly managed.

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Table 1. The Brazilian Social Security System for Men and Women, before and after reform

Women	Rural	Urban
Pre Reform		
Eligibility status	* Women who are household heads * Age 65 and above	* All women * Age 70 and above, or 30 years of work
Benefit amount	* 50% of minimum wage	* Min. benefit: 90% of minimum wage * Rises with work and earnings
Work requirement	* Must document rural work for at least 1 of past 3 years	* Must quit job to receive benefits
Contribution requirement	* None	* None
Post Reform		
Eligibility status	* All women * Age 55 and above	* All women * Age 70 and above, or 25 years of work
Benefit amount	* 100% of minimum wage	* Min. benefit: 100% of minimum wage * Rises with work and earnings
Work requirement	* Min. work requirements increase from 5 years in 1991 to 15 years in 2011	* No requirement to quit current job to receive benefits
Contribution requirement	None	* Working wages are taxed

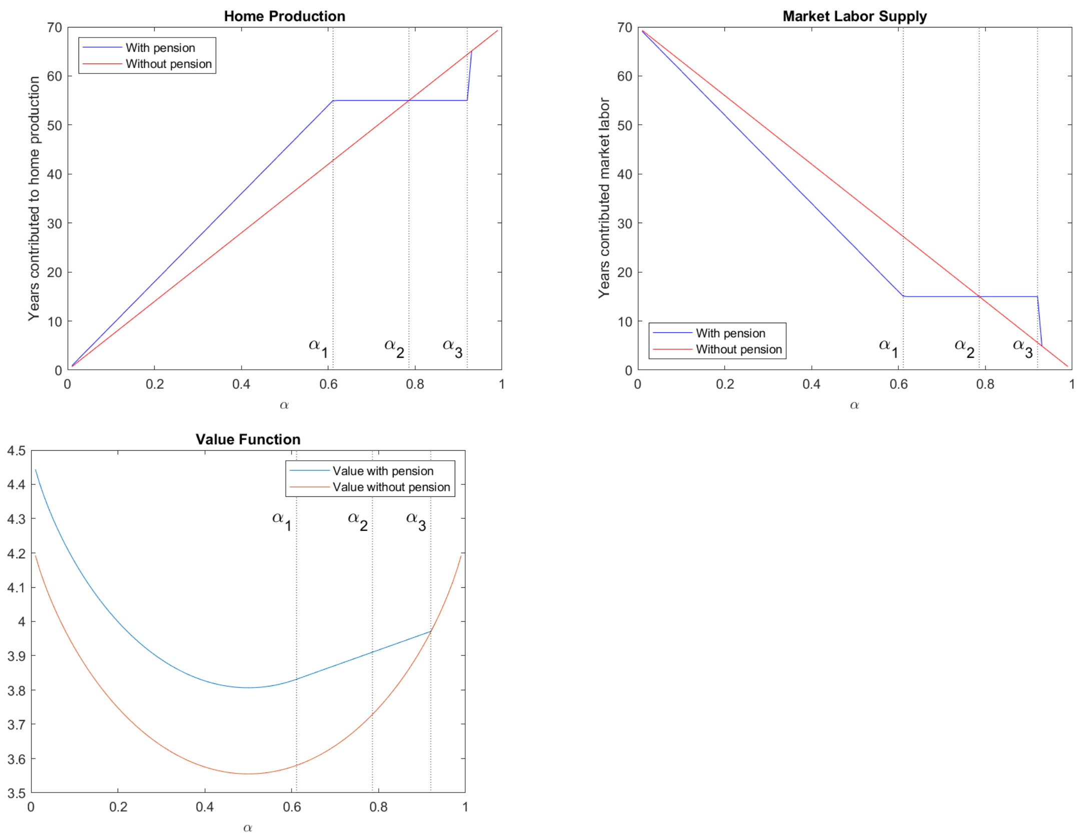
Men	**Rural**	**Urban**
Pre-reform		
Eligibility status	* Men who are household heads * Age 65 and above	* All men, regardless of household status * Age 70 and above, or 30 years of work
Benefit amount	* 50% of minimum wage	* Min. benefit: 90% of minimum wage * Rises with work and earnings
Work requirement	* Must document rural work for 1 of past 3 years	* Must quit job to receive benefits
Contribution requirement	* None	* None
Post reform		
Eligibility status	* All men, regardless of household status * Age 60 and above	* All men, regardless of household status * Age 70 and above, or 30 years of work
Benefit amount	* 100% of minimum wage	* Min. benefit: 100% of minimum wage * Rises with work and earnings
Work requirement	* Min. work requirements increase from 5 years in 1991 to 15 years in 2011	* No requirement to quit job to receive benefits
Contribution requirement	None	* Working wages are taxed

Table 2: Characteristics of Urban and Rural Women and Men, before and after the reform

	Women				Men			
	Rural		Urban		Rural		Urban	
	Before	After	Before	After	Before	After	Before	After
A. Pension and Labor Force Status								
% identifying as HH head	10	15	18	29	87	81	85	74
% of population receiving pension	7	17	8	11	11	15	14	14
% of population 55+ receiving pension	28	66	30	40	40	55	56	57
% of population 65+ receiving pension	52	79	44	55	78	88	83	85
% living in HH receiving $\geq$ 1 pen	3	12	4	6	2	12	3	6
% Worked in reference week	34	50	40	51	91	88	82	79
Average hours worked per week	13	15	16	19	45	39	39	36
B. Individual and Household Characteristics								
Average Age	43	44	42	44	43	44	42	43
% Married with spouse present	77	76	65	61	80	75	79	72
% living in Multigenerational HH	24	25	30	29	20	21	24	24
Avg Number of HH members	5	4	5	4	5	4	5	4
Avg Number of children in HH	3	2	2	2	3	2	2	2
N Observations	146,205	243,884	620,790	1,554,854	155,452	265,316	551,606	1,354,705

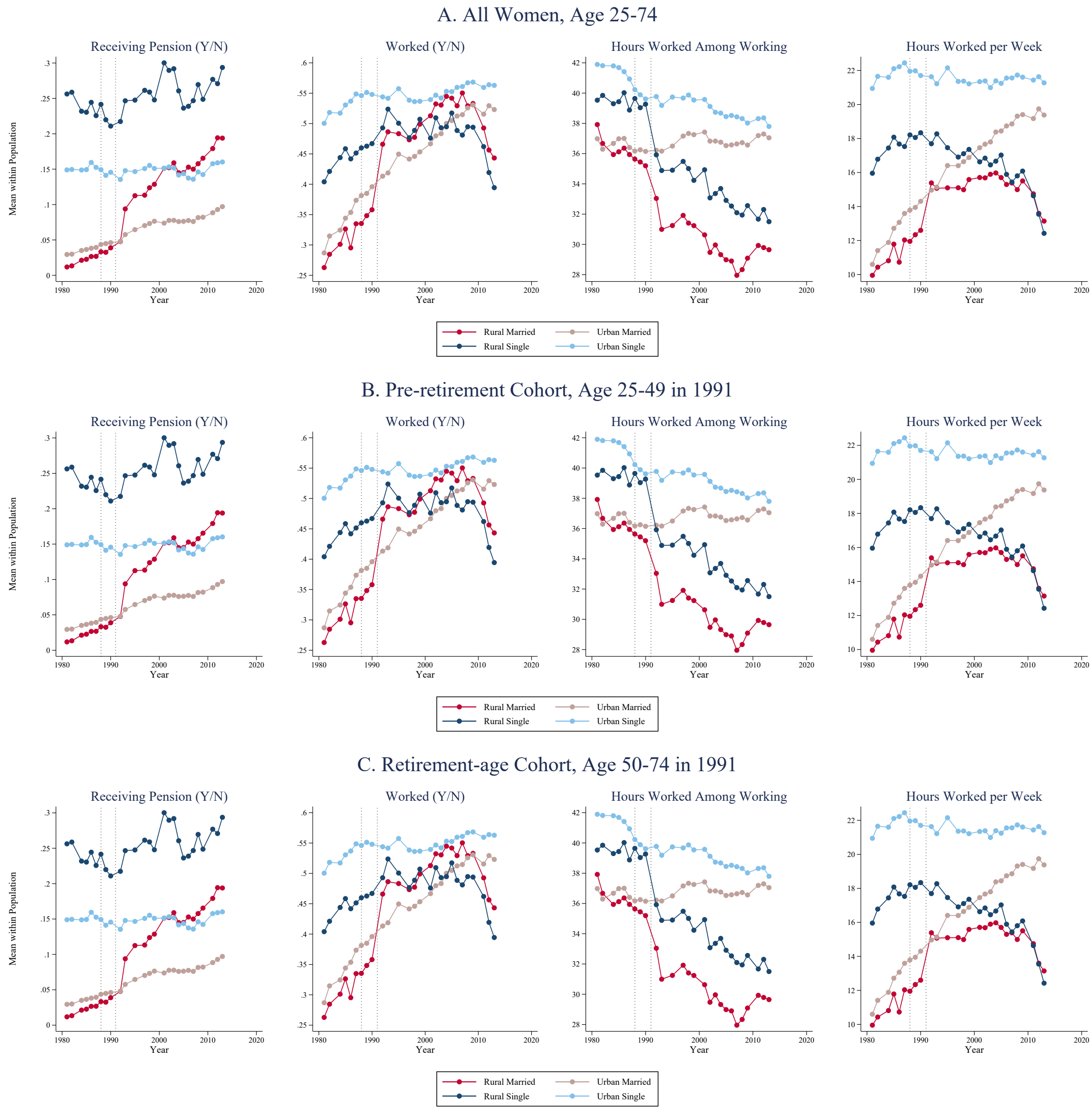
Notes. Sample contains all PNAD respondents between ages 25 and 75. A respondent is classified as rural if they live in a rural village, and urban otherwise. Columns labeled "Before" include years between 1981 and 1992; columns labeled "After" include years between 1992 and 2013.

Figure 1: Heterogeneous response to pension system with $\bar{L}_c = 15$ and $\bar{a}_c = 70$



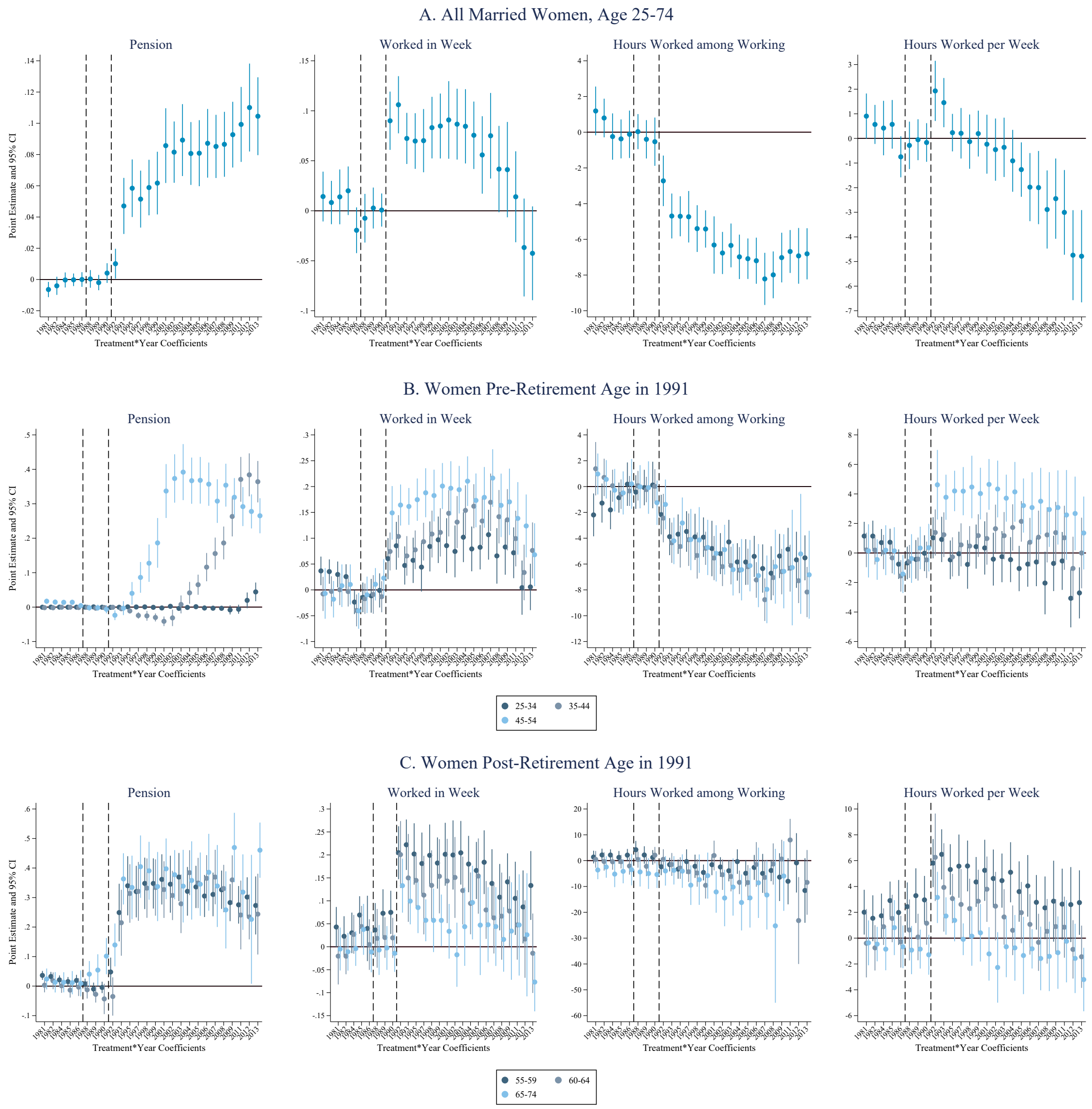
Notes. The model predicts ...Distinguishes the people who decrease labor supply due to a wealth effect, the "constrained" market workers, and the "compliers".

Figure 2: Women's Pension and Work Status in Rural and Urban Areas by Marital Status



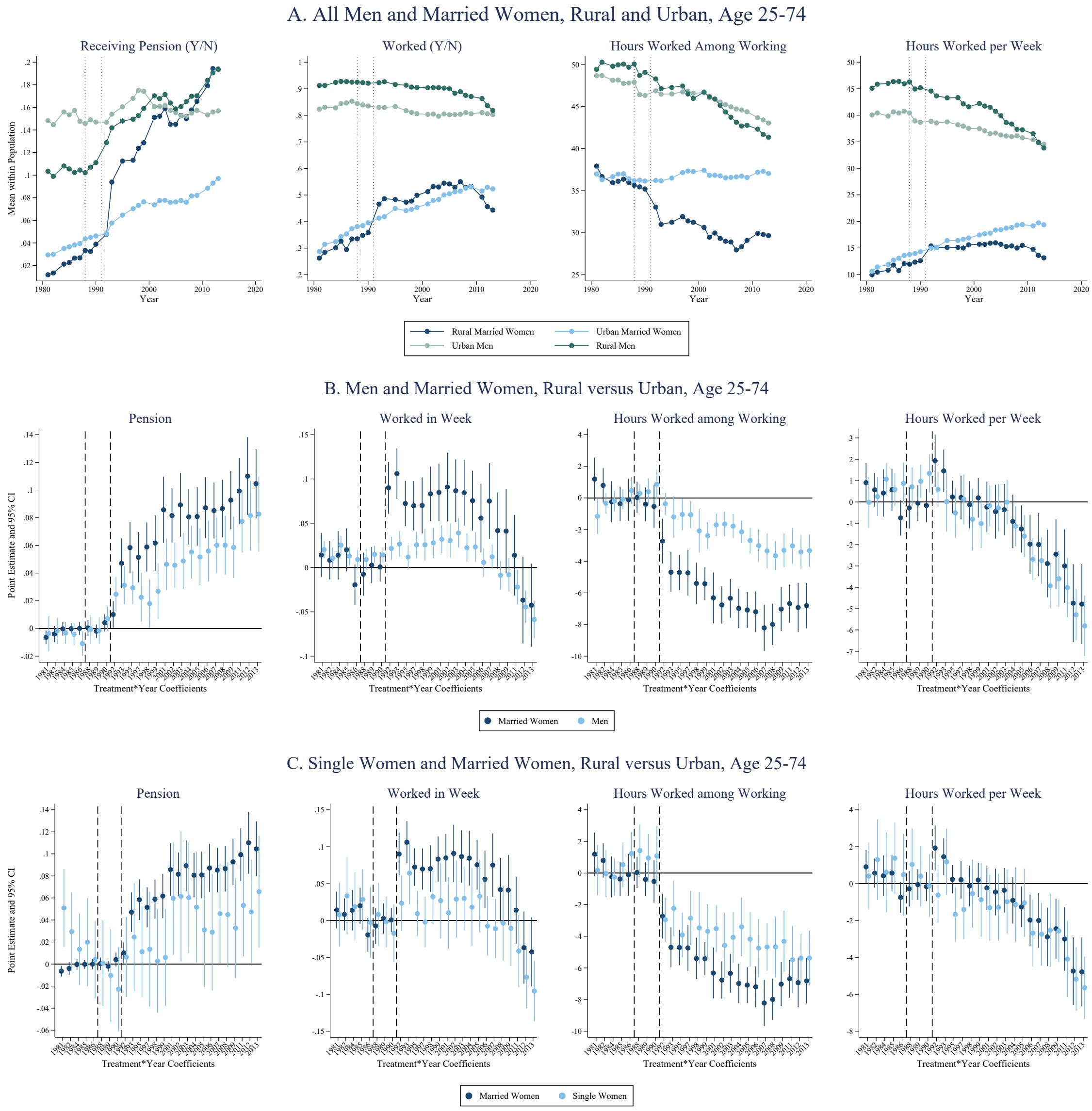
Notes. Panel A shows pension and labor force status among married (red lines) and single (blue lines) women, ages 25-74, in rural areas (dark lines) and urban areas (light lines) from 1981 through 2013. Panel B shows pension and labor force status among married (red lines) and single (blue lines) women who were between ages 25 and 49 when the law passed in 1991, in rural areas (dark lines) and urban areas (light lines). Panel C shows pension and labor force status among married (red lines) and single (blue lines) women who were between ages 50 and 74 when the law passed in 1991, in rural areas (dark lines) and urban areas (light lines). "Pension" refers to the fraction of the population that received a pension in each year. "Worked" refers to the fraction of the population that worked in the reference week in each year. "Hours worked among working" refers to the average number of hours worked per week among people who worked in the reference week. "Hours worked per week" refers to the average hours worked per person among the full population, working and not working, in each year.

Figure 3: Pension and Work Status in Rural versus Urban Areas among Married Women, Difference-in-Difference Estimates



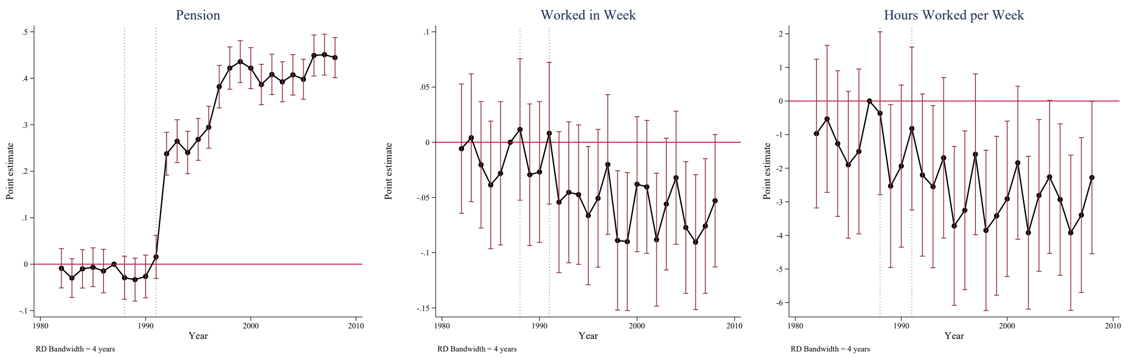
Notes. Panel A shows pension and labor force status among married women, ages 25-74, in rural areas (dark lines) and urban areas (light lines) from 1981 through 2013. Panel B shows pension and labor force status among women, ages 25-74, in rural areas (dark lines) and urban areas (light lines) from 1981 through 2013. “Pension” refers to the percent of the population aged 25-74 that receives a pension in each year. “Worked in Week” refers to the percent of the population aged 25-74 that worked in the reference week in each year. “Hours worked per week” refers to the average hours worked per person among the population aged 25-74 in each year. Each panel shows the β coefficient estimates and 95% confidence intervals on each year from an extended difference in difference regression of the form $y_{ist} = \alpha \times D_{ist} + \sum_{j=1981}^{1988} \beta_j^{pre} \times D_{isj} + \sum_{j=1989}^{2013} \beta_j^{post} \times D_{isj} + \delta_t + \mu_s + \Gamma'_{ist} X_{ist}$, where y_{it} is the outcome variable of interest and $D = 1$ if the individual lives in a rural area. Panel A includes all married women age 25-74 within the year plotted. Panel B includes three different cohorts of married women who were younger than the retirement age of 55 when the law was passed in 1991. Panel C includes three different cohorts of married women who were older than the retirement age of 55 when the law passed in 1991. Coefficients are estimated relative to 1987, the year before the constitutional amendment announcing expansion of the rural pension scheme.

Figure 4: Comparison of treatment effects: Married women, Men, and Single Women



Notes. This figure compares the impact of the 1991 expansion on married women to that on two other groups of workers that had access to the rural pension prior to the reform – men and single women. Panel A compares the descriptive patterns in pension receipt and labor supply for men to those for married women (shown in Figure 1). Panel B compares the difference-in-differences estimates derived from running Equation (1) on Men the main difference-in-differences estimates derived from running equation 1 on married women. Panel C compares the difference-in-differences estimates derived from running equation 1 on single women to the main difference-in-difference estimates. This figure excludes dependent children or other relatives.

Figure 5: Difference in Discontinuity at Age 55



Notes. These graphs show the difference in discontinuity at age 55 in the three variables listed, using a bandwidth of 4 years.Figure shows the discontinuity estimate at age 55 and 95% confidence intervals for RDs run in each year, using a bandwidth of 4 years. Sample is restricted to women living in rural areas, and the graph shows a discontinuous decrease in employment that develops at age 55 a few years after the reform.

Table 3: Actual and Predicted Changes in Lifetime Labor Supply by Cohort: All Rural Women

Age in 1991	Extra Years per person	Extra Years per worker	% Change in Lifetime	Yrs of Work Req. for eligibility	Age eligible for new entrants
25-29	.52	1.2	4.3	15	55
30-34	.57	1.3	4.7	15	55
35-39	.49	1.1	4.1	13-14.5	55
40-44	.49	1.2	4.3	10.5-12.5	55
45-49	1	2.7	10	8-10	55-56.5
50-54	1.1	3.4	13	5-7.5	57.5-60
55-59	1	3.8	14	5	60-64
60-64	1.3	6.3	23	5	65-69
65-69	1.2	7	26	5	70-74
70-74	.56	4.4	16	5	75-80

Table 4: Actual and Predicted Changes in Lifetime Labor Supply by Cohort: Rural Men

Age in 1991	Extra Years per person	Extra Years per worker	% Change in Lifetime	Yrs of Work Req. for eligibility	Age eligible for new entrants
25-29	.35	.38	1.4	15	60
30-34	.052	.055	.2	15	60
35-39	.19	.21	.77	13-14.5	60
40-44	.38	.43	1.6	10.5-12.5	60
45-49	.34	.39	1.4	8-10	60
50-54	.89	1.1	4	5-7.5	60
55-59	.96	1.2	4.6	5	60-64
60-64	1.8	2.5	9.4	5	65-69
65-69	2.2	3.5	13	5	70-74
70-74	1.9	3.4	13	5	75-79

Table 5: Adjustments in Lifetime Labor Supply: Rural Married Women

Age in 1991	Extra Years per person	Extra Years per worker	% Change in Lifetime	Yrs of Work Req. for eligbility	Age eligible for new entrants
25-29	1.2	3	11	15	55
30-34	.81	2	7.5	15	55
35-39	.47	1.1	4.2	13-14.5	55
40-44	.45	1.1	4.1	10.5-12.5	55
45-49	1.2	3.5	13	8-10	55-56.5
50-54	1.4	4.5	17	5-7.5	57.5-60
55-59	.51	1.8	6.7	5	60-64
60-64	1.3	6	22	5	65-69
65-69	1.1	7	26	5	70-74
70-74	.56	4.2	16	5	75-79

Table 6: Actual and Predicted Changes in Lifetime Labor Supply by Cohort

Age in 1991	Extra Years per person	Extra Years per worker	% Change in Lifetime	Yrs of Work Req. for eligbility	Age eligible for new entrants
25-29	.21	.41	1.5	15	55
30-34	.51	.92	3.4	15	55
35-39	.98	1.8	6.8	13-14.5	55
40-44	.75	1.5	5.6	10.5-12.5	55
45-49	.96	2.3	8.4	8-10	55-56.5
50-54	.76	2.1	7.9	5-7.5	57.5-60
55-59	1.6	5.9	22	5	60-64
60-64	1.4	6.5	24	5	65-69
65-69	1.3	7.9	29	5	70-74
70-74	.48	3.8	14	5	75-79

A Model Appendix: Derivations

A.1 Life-cycle model of labor supply (comparing steady states)

The model begins by describing how people choose the number of years they plan to work over their lifetime. Assume that individual i from cohort c lives $\bar{a}_c$ years and receives utility from consumption of market goods, C, and of home goods, H, over their lifetime. Their consumption of home goods is inversely proportional to the number of years the individual spends on market work, L, with $H = \bar{a}_c - L$. We will consider L the individual's choice variable. Without the pension regime, individuals receive a market wage, w, that does not change over their lifetime.

Under the pension regime, the individual receives a pension with present discounted value of $\tilde{P}$ if they work at least $\tilde{L}_c$ years over their lifetime.[8] Assume that under the pension regime, people receive a market wage w_P, which may or may not be the market wage that prevails without the pension.

The optimization problem is then:

$$\max_{H} \; (1-\alpha_i)log\text{C} \; + \alpha_i log\text{H}$$

$$s.t. \quad C = \sum_t c_t, \quad L = \sum_t \ell_t, \quad H = \bar{a}_c - L$$

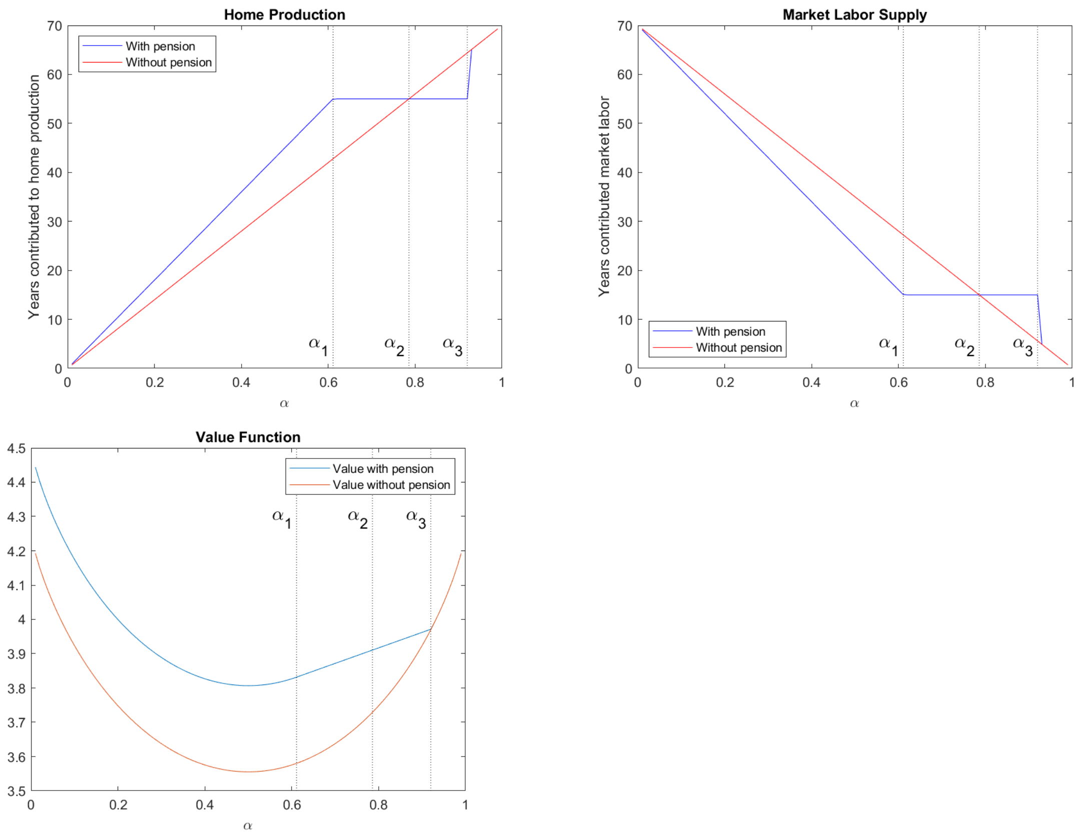
$$C \leq \begin{cases} w(\bar{a}_c - H) & \text{without pension} \\ w_p(\bar{a} - H) + \tilde{P} \times \mathbb{1}_{L \geq \tilde{L}_c} & \text{with pension} \end{cases}$$

The value of home goods, which also can be interpreted as the opportunity cost of market work, is captured by α_i and can be heterogeneous across people.

Any pension scheme, $\{\tilde{P}, \tilde{L}_C\}$, affects individuals differently according to their opportunity cost of market work, α_i. The solution, detailed below identifies three types of workers: those who work regardless of whether the pension is offered (market workers), those who work exactly the number of years the pension requires for eligibility (compliers), and those who never worker regardless of whether the pension is offered (non-market workers). Figure 6 describes how these groups vary according to their opportunity cost of market work, with an assumed lifespan of 80 years and under the introduction of a pension scheme that required 15 years of work.

[8] Note this abstracts from the eligibility age for now. Since we assume zero discounting, people are indifferent regarding which year in their life they work, so they will work before any eligibility age to maximize the present discounted value of their pension.

Figure 6: Heterogeneous response to pension system with $\bar{L}_c = 15$ and $\bar{a}_c = 70$



Notes. The model predicts ...Distinguishes the people who decrease labor supply due to a wealth effect, the "constrained" market workers, and the "compliers".

A.1.1 Interior solutions

The interior solution to the individual optimization problem without a pension is:

$$\begin{aligned} C^*_{NP} =& (1-\alpha_i)w\bar{a}_c \\ L^*_{NP} =& (1-\alpha_i)\bar{a}_c \end{aligned} \tag{9}$$

The interior solution under the pension regime is:

$$\begin{aligned} L^*_P =& (1-\alpha_i)\bar{a}_c - \frac{\alpha_i \tilde{P}}{w_P} \\ C^*_P =& (1-\alpha_i)(w_p\bar{a}_c + \tilde{P}) \end{aligned} \tag{10}$$

A.1.2 Types of workers

The group identified as "market workers" will choose the interior solution under both the no-pension and the pension regime, L^*_{NP} and L^*_P, respectively. The group defined as "compliers" will choose to work at the interior solution, L^*_{NP}, under the no-pension regime and exactly $\tilde{L}_c \neq L^*_P$ years under the pension regime. The group defined as non-market workers will work L^*_{NP} years regardless of whether a pension regime is in place.

Market workers are people with a low value of home production who choose to work more than $\tilde{L}_c$ when pensions are offered: $L^*_P \geq \tilde{L}_c$, or $(1-\alpha_i)\bar{a}_c - \frac{\alpha_i \tilde{P}}{w_P} \geq \tilde{L}_c$. This is true for all individuals with preferences such that $\alpha_i \leq \frac{w_p(\bar{a}_c - \tilde{L}_c)}{\bar{a}_c w_P + \tilde{P}} \equiv \alpha_1$.

Compliers are people with a slightly higher value of home production who work exactly the number of years required for pension eligibility. Compliers can be separated into two groups:

- People who work $\tilde{L}_c$ years under the pension regime and *less* than they would have if no pension were offered. This group has preferences such that:

$$\begin{gathered} L^*_{NP} \geq \tilde{L}_c \geq L^*_P \\ \bar{a}_c(1-\alpha_i) \geq \tilde{L}_c \geq (1-\alpha_i)\bar{a}_c - \frac{\alpha_i \tilde{P}}{w_P} \end{gathered} \tag{11}$$

  This is true for $\alpha_i \in \left(\frac{w_p(\bar{a}_c - \tilde{L}_c)}{\bar{a}_c w_P + \tilde{P}}, \frac{\bar{a}_c - \tilde{L}_c}{\bar{a}_c}\right)$. Defined $\alpha_2 = \frac{\bar{a}_c - \tilde{L}_c}{\bar{a}_c}$.

- People who work $\tilde{L}_c$ years under the pension regime and *more* than they would have if no pension is offered. They do so if the value of working $\tilde{L}_c$ and receiving a pension is larger than the value of working $\tilde{L}^*_{NP}$ and not receiving a pension. This group has preferences such that:

$$L^*_{NP} \leq \tilde{L}_c \tag{12}$$

  and

$$V^*_P(\tilde{L}) > V^*_{NP}(L^*_{NP}) \tag{13}$$

  In the below proposition, we show that for the group of compliers, α_i is bounded above by a finite value α_3, and that $\alpha_3 > \frac{\bar{a}_c - \tilde{L}_c}{\bar{a}_c}$ for any $\tilde{P} > 0$, implying that compliers value non-market work at level:

$$\alpha_i \in \left(\frac{\bar{a}_c - \tilde{L}}{\bar{a}_c}, \alpha_3\right] \tag{14}$$

Proposition 1: Existence and Description of Compliers The conditions for an individual to be a complier:

$$L^*_P < \tilde{L}_c \iff \alpha_i > \frac{\bar{a}_c - \tilde{L}}{\bar{a}_c} \quad AND \quad V^*_P(\bar{H}) > V^*_{NP}(H^*_{NP}) \tag{15}$$

The constraint $V_P^*(\bar{H}) > V_{NP}^*(H_{NP}^*)$ stipulates that the individual prefers to engage in more market work and receive the pension, rather than maintaining lower levels of market work and not receiving the pension. We can solve this constraint to find the maximum value of α for which the pension scheme encourages the individual to engage in more market work. We will use the combination of the above two conditions to find this. First, let us document:

$$V_{NP}^*(L_{NP}^*) = (1-\alpha)log\{w(H-\alpha H)\} + \alpha log \alpha H \tag{16}$$

And

$$V_P^*(\bar{L}) = (1-\alpha)log\{w(H-\bar{L}) + P\} + \alpha log \bar{L} \tag{17}$$

So, for $V_P^*(\bar{L}) > V_{NP}^*(L_{NP}^*)$, we must have

$$(1-\alpha)log\frac{\{w(H-\bar{L}) + P\}}{\{wH(1-\alpha)\}} > \alpha log\frac{\alpha H}{\bar{L}} \tag{18}$$

Or

$$log\frac{\{w(H-\bar{L}) + P\}}{wH} > log(1-\alpha) + \frac{\alpha}{(1-\alpha)}log\left(\frac{\alpha H}{\bar{L}}\right) \tag{19}$$

The right-hand side of the inequality is monotonically increasing in α, so there exists an $\tilde{\alpha}$ such that compliers exist in the range: $\frac{\bar{L}}{H} < \alpha < \tilde{\alpha}$.

We can further derive that α is bounded above by a finite value $\tilde{\alpha}$, and that $\tilde{\alpha} > \frac{\bar{L}}{H}$ for any $P > 0$.

Never market workers have a high value of home production: even when a pension is available, they choose to work less than $\tilde{L}_c$ and, therefore, do not receive the pension. That is, they meet two conditions:

$$L_{NP}^* < \tilde{L}_c \iff \alpha_i > \frac{\bar{a}_c - \tilde{L}_c}{\tilde{L}_c} \quad AND \quad V_P^*(\tilde{L}) \leq V_{NP}^*(L_{NP}^*) \tag{20}$$

Accordingly, non-market workers place high value in non-market activity, with $\alpha_i > \alpha_3$

Figure 6 summarizes these results. Let $\alpha_1 = \frac{w(\bar{a}_c - \tilde{L}_c)}{w\bar{a}_c + P}$, $\alpha_2 = \frac{\bar{a}_c - \tilde{L}}{\bar{a}_c}$, and α_3 be the cut-off described in proposition 1. From 0 to α_1, we see people who respond only to the wealth effect – they work less over their lifetime (unconstrained market workers). Then from α_1 to α_2, both the wealth and the eligibility effect are active (constrained market workers); the wealth effect of the pension encourages them to work less, but the eligibility effect prevents them from decreasing their labor supply below $\tilde{L}_c$. Finally, with $\alpha > \alpha_2$, people are working more to receive the pension (compliers).

A.2 "Decomposing" the diff-in-diff estimates by cohort

Now, we add a pension eligibility age, $\tilde{a}_E$, to our pension scheme so that the pension scheme is described by the triple $\mathcal{P} = \{\tilde{L}, \tilde{P}, \tilde{a}_E\}$.

The model in Section 1 describes how people choose the number of years they work over their lifetime. To capture the difference-in-difference estimates of the extensive-margin labor supply – the decision of interest in the difference-in-differences estimates – we focus on the lifetime labor supply within a cohort. We assume that $\alpha_i \sim G(\alpha)$ within a cohort, implying that the lifetime labor supply of cohort c under the no-pension regime is $L_C^{NP} = \int_\alpha L_{NP}^* dG(\alpha)$, and that each member of a given cohort c has the same target retirement age. At the cohort level, then, labor supply is smoothed across the years before the cohort reaches the target retirement date. Accordingly, the extensive margin labor supply within a cohort in a given year is $\frac{L_C^{NP}}{\bar{a}_c}$ if everyone within a cohort never retired (ie., the cohort's retirement age is $\bar{a}_c$.

Let $\bar{a}_R$ be the target retirement age under the no-pension regime, and $\tilde{a}_R$ be the target retirement age under the pension regime. Suppose that people are able to start working as soon as they are "born" so that their possible working life is $\bar{a}_R$ years under the no-pension regime, and $\tilde{a}_R$ years under the pension regime. More on how $\tilde{a}_R$ relates to the eligibility age later.

Suppose a pension scheme $\mathcal{P}$ is introduced in year j, when cohort c is age $a_{cj} = j - c$ years of age. Prior to the pension introduction, cohort c's planned lifetime labor supply was L_{NP}^*. At the cohort level, these years are smoothed out over the working life so that the cohort works $\frac{L_{NP}^*}{\bar{a}_R}$ per year. By year j, cohort c has worked $\frac{a_{cj}}{\bar{a}_R} L_{NP}^*$ years. Had the pension not been introduced, cohort c would have continued to work $\frac{a_{cj}}{\bar{a}_R} L_{NP}^*$ per year until age $\bar{a}_R$.

Define L_{ct}^{NP} to be cohort c's labor supply in period $t > j$ if the pension were never introduced:

$$L_{ct}^{NP} = \frac{1}{\bar{a}_R} \int_\alpha L_{NP}^* dG(\alpha) \tag{21}$$

Our difference-in-difference estimate will be $\Delta L_{ct} = L_{ct}^P - L_{ct}^{NP}$, where L_{ct}^{NP} is as defined in equation 1 and L_{ct}^P is the labor supply of cohort c in year $t > j$ after the pension has been introduced. The next step is to find an expression for L_{ct}^P. Under the pension regime, suppose that cohort c will work L_P years before age $\tilde{a}_R$. As of time j, they have already worked $\frac{a_{cj}}{\bar{a}_R} L_{NP}^*$ years. Accordingly, they must now work an additional $L_P - \frac{a_{cj}}{\bar{a}_R} L_{NP}^*$ years before age $\tilde{a}_R$. At the cohort level, these years of work will be smoothed out over the rest of the cohort's working life, which will be $\tilde{a}_R - a_{cj}$. Therefore, the labor supply of cohort c in year $t > j$ after the pension has been introduced is:

$$L_{ct}^P = \frac{1}{\tilde{a}_R - a_{cj}} \int_\alpha L_P - \frac{a_{cj}}{\bar{a}_R} L_{NP}^* dG(\alpha) \tag{22}$$

The difference-in-difference estimate in each year $t > j$ is:

$$
\begin{aligned}
\Delta L_{ct} =& L_{ct}^{P} - L_{ct}^{NP} \\
\Delta L_{ct} =& \underbrace{\frac{1}{\tilde{a}_R - a_{cj}} \int_\alpha L_P - \frac{a_{cj}}{\bar{a}_R} L_{NP}^* dG(\alpha)}_{L_{ct}^P} - \underbrace{\frac{1}{\bar{a}_R} \int_\alpha L_{NP}^* dG(\alpha)}_{L_{NP}^*} \\
=& \int_\alpha \frac{1}{\tilde{a}_R - a_{cj}} L_P - L_{NP}^* \left(\frac{a_{cj}}{\bar{a}_R} \frac{1}{\tilde{a}_R - a_{cj}} + \frac{1}{\bar{a}_R} \right) dG(\alpha) \\
=& \int_\alpha \frac{1}{\tilde{a}_R - a_{cj}} L_P - L_{NP}^* \left(\frac{a_{cj} + \tilde{a}_R - a_{cj}}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) dG(\alpha)
\end{aligned}
$$

$$
\Delta L_{ct} = \int_\alpha \frac{1}{\tilde{a}_R - a_{cj}} L_P - L_{NP}^* \left(\frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) dG(\alpha) \tag{23}
$$

A.2.1 Decomposing into wealth and retirement timing effect with no work requirement

Suppose for the moment that the pension scheme has zero work requirement, $\tilde{L} = 0$, or that we are calculating the difference-in-difference for a population that includes only market workers. In this case, $L_P = L_P^* = \bar{a}_c(1 - \alpha_i) - \frac{\alpha_i \tilde{P}}{w_P}$ and $L_{NP}^* = (1 - \alpha_i)\bar{a}_c$. The difference-in-diffences estimate from equation 3 is:

$$
\begin{aligned}
\Delta L_{ct} =& \int_\alpha \frac{1}{\tilde{a}_R - a_{cj}} \underbrace{\bar{a}_c(1 - \alpha_i) - \frac{\alpha_i \tilde{P}}{w_P}}_{L_P = L_P^*} - \underbrace{(1 - \alpha_i)\bar{a}_c}_{L_{NP}^*} \left(\frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) dG(\alpha) \\
\Delta L_{ct} =& \int_\alpha (1 - \alpha_i)\bar{a}_c \left(\frac{1}{\tilde{a}_R - a_{cj}} - \frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) - \frac{1}{\tilde{a}_R - a_{cj}} \frac{\alpha_i \tilde{P}}{w_P} dG(\alpha) \\
\Delta L_{ct} =& \int_\alpha (1 - \alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a_R}}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) - \frac{1}{\tilde{a}_R - a_{cj}} \frac{\alpha_i \tilde{P}}{w_P} dG(\alpha)
\end{aligned}
$$

$$
\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_\alpha \underbrace{(1 - \alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a_R}}{\bar{a}_R} \right)}_{\text{Retirement Timing Effect}} - \underbrace{\frac{\alpha_i \tilde{P}}{w_P}}_{\text{Wealth Effect}} dG(\alpha) \tag{24}
$$

Note that, when there is no work requirement, the pension scheme influences the difference-in-difference estimate of the extensive-margin labor supply response through two channels:

- The retirement timing channel: If the pension scheme does not affect people's target retirement date, then $\bar{a}_R = \tilde{a}_R$ and the retirement timing effect is zero. If the pension scheme encourages people to decrease their target retirement age, then

$\bar{a}_R > \tilde{a}_R$, and the retirement timing effect is positive until age $\tilde{a}_R$ and negative from age $\tilde{a}_R$ to $\bar{a}_R$. If the pension encourages people to increase their target retirement age, then $\tilde{a}_R > \tilde{a}_R$, and the retirement timing effect is negative until age $\bar{a}_R$ and positive from age $\bar{a}_R$ to $\tilde{a}_R$

- The wealth effect channel: cohort-level labor supply decreases by $\int_\alpha \frac{\alpha_i \tilde{P}}{w_P} dG(\alpha)$ due to a wealth effect that depends on the productivity of home-work, the lifetime value of the pension, and the wage the individual can receive under the pension regime.

- Overall, both effects are larger in magnitude if the reform happens closer to the desired retirement age under the pension scheme/ the cohort is closer to retirement age when the pension regime is in place; the difference-in-difference estimate should be closer to zero for cohorts that were younger (further from retirement age) when the reform was enacted.

A.2.2 Including the work requirement

Now, allow the pension scheme to include a work requirement: people from cohort c must work for at least $\tilde{L}_c$ years to receive pension eligibility. Introducing this requirement creates our second two groups of workers: compliers who work exactly $\tilde{L}$ years (some of whom work more than they would have without the pension and some of whom work less than they would have without the pension) and non-market workers who choose to forgo the pension and, instead, work the same number of years they would have worked if the pension had never been introduced.

Compliers work $\tilde{L}_c$ years under the pension scheme. We can write the difference-in-difference estimate for this population with $\alpha_i \in (\alpha_1, \alpha_3]$, by setting $L_P^* = \tilde{L}$ in equation 3. Note that $\tilde{L}_c = \tilde{L}_c + L_P^* - L_P^*$, and equation 3 for the group of compliers becomes:

$$\Delta L_{ct} = \int_{\alpha_1}^{\alpha_2} \frac{1}{\tilde{a}_R - a_{cj}} (\tilde{L}_c + L_P^* - L_P^*) - L_{NP}^* \left(\frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})} \right) dG(\alpha)$$
$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_1}^{\alpha_2} \underbrace{L_P^* - L_{NP}^* \frac{\tilde{a}_R}{\bar{a}_R}}_{\mathcal{A}} + (\tilde{L}_c - L_P^*) dG(\alpha)$$

Note that $\mathcal{A}$ is the inside of the integral in equation 4. Accordingly, we see that the retirement-timing effect and the wealth effect are both active for compliers as well as market workers:

$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_1}^{\alpha_2} \underbrace{\underbrace{(1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a_R}}{\bar{a}_R}\right)}_{\text{Retirement Timing Effect}} - \underbrace{\frac{\alpha_i \tilde{P}}{w_P}}_{\text{Wealth Effect}}}_{\mathcal{A}} + \underbrace{(\tilde{L}_c - L_P^*)}_{\text{Eligibility Effect}} \, dG(\alpha)$$

The difference-in-difference estimate of compliers is influenced by a third channel, which we call the eligibility effect. Without the work requirement, compliers would have worked less than $\tilde{L}_c$ when the pension was introduced. However, these workers find the value of receiving the pension to be high enough that they are willing to work the required number of years to achieve eligibility. Thus they work an additional $\tilde{L}_c - L_P^*$ years more than the "interior solution" under the pension regime. Plugging in the equation for L_P^*, we have:

$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_1}^{\alpha_2} \underbrace{(1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a_R}}{\bar{a}_R}\right)}_{\text{Retirement Timing Effect}} - \underbrace{\frac{\alpha_i \tilde{P}}{w_P}}_{\text{Wealth Effect}} + \underbrace{\tilde{L}_c - (1-\alpha_i)\bar{a}_c + \frac{\alpha_i \tilde{P}}{w_P}}_{\text{Eligibility Effect}} dG(\alpha) \tag{25}$$

Non-market workers do not adjust their labor supply when the pension regime is introduced. Accordingly, the contribution of the non-market workers to the difference-in-differences estimate is:

$$\Delta L_{ct}^{nm} = 0 \tag{26}$$

- Do non-market workers have the same target retirement age as the rest of their cohort? If so...

$$\Delta L_{ct} = \int_{\alpha_3}^{1} \frac{1}{\tilde{a}_R - a_{cj}} L_{NP}^* - L_{NP}^* \left(\frac{\tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})}\right) dG(\alpha)$$
$$\Delta L_{ct} = \int_{\alpha_3}^{1} L_{NP}^* \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R(\tilde{a}_R - a_{cj})}\right)$$
$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_3}^{1} L_{NP}^* \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R}\right) dG(\alpha)$$
$$\Delta L_{ct} = \frac{1}{\tilde{a}_R - a_{cj}} \int_{\alpha_3}^{1} (1-\alpha_i)\bar{a}_c \left(\frac{\bar{a}_R - \tilde{a}_R}{\bar{a}_R}\right) dG(\alpha)$$

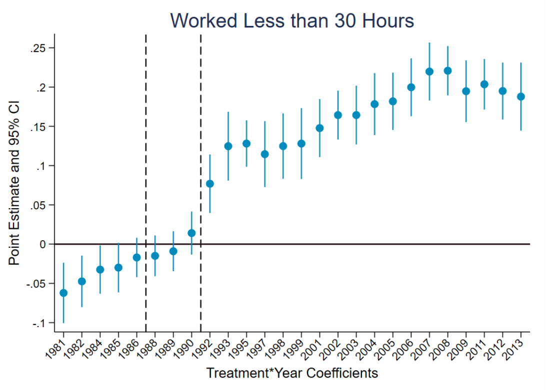
- So then everyone would have the retirement timing effect, everyone but non-market workers would have the wealth effect, and only the compliers would have the eligibility effect.

- (this bullet is brainstorming, not in the model): married women would have a wealth effect from their partners' pensions.

B Empirical Results, Robustness

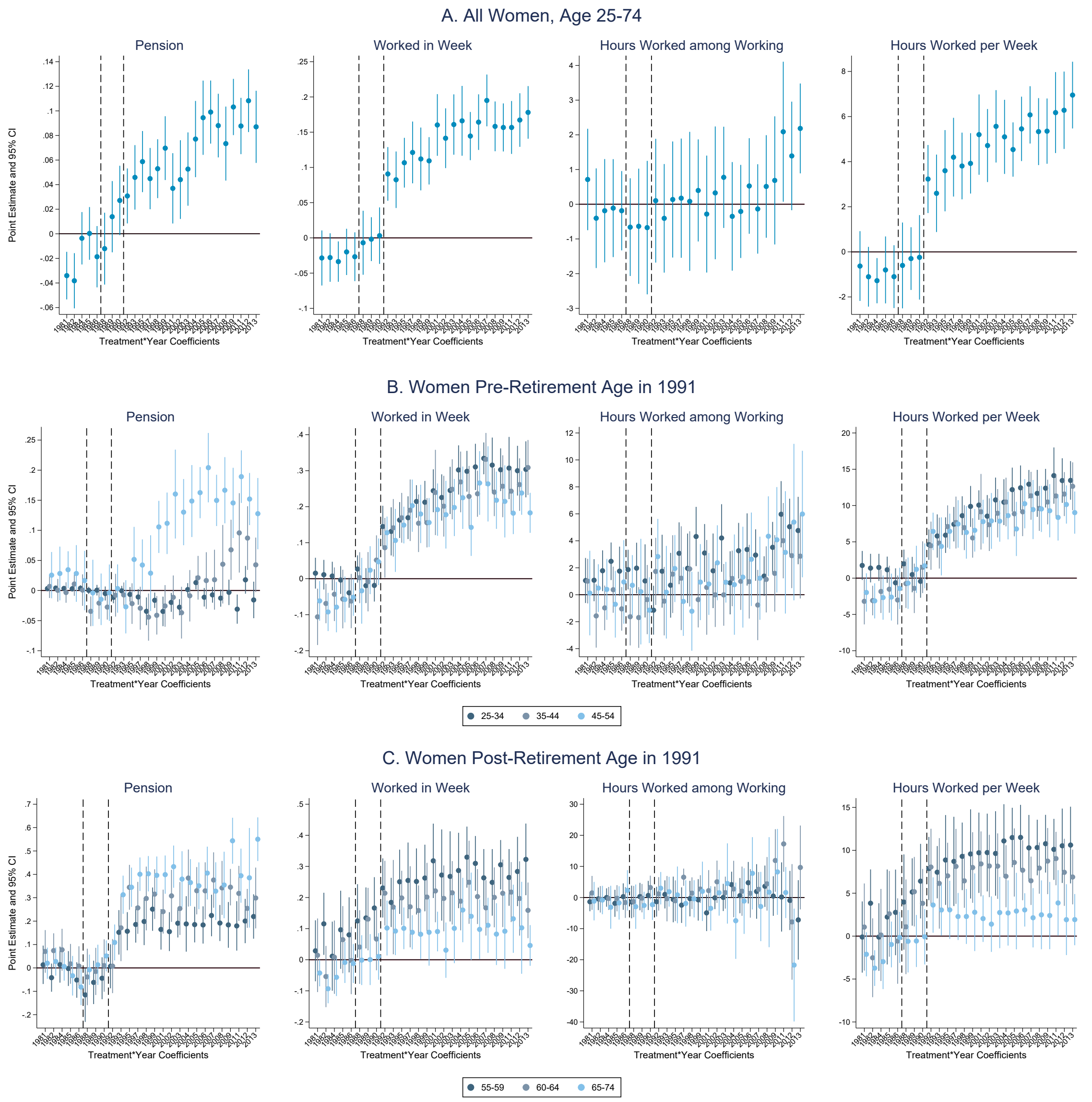
B.1 Robustness: Difference-in-differences

Figure 7: Part-time Work Status in Rural versus Urban Areas, Difference-in-Difference Estimates



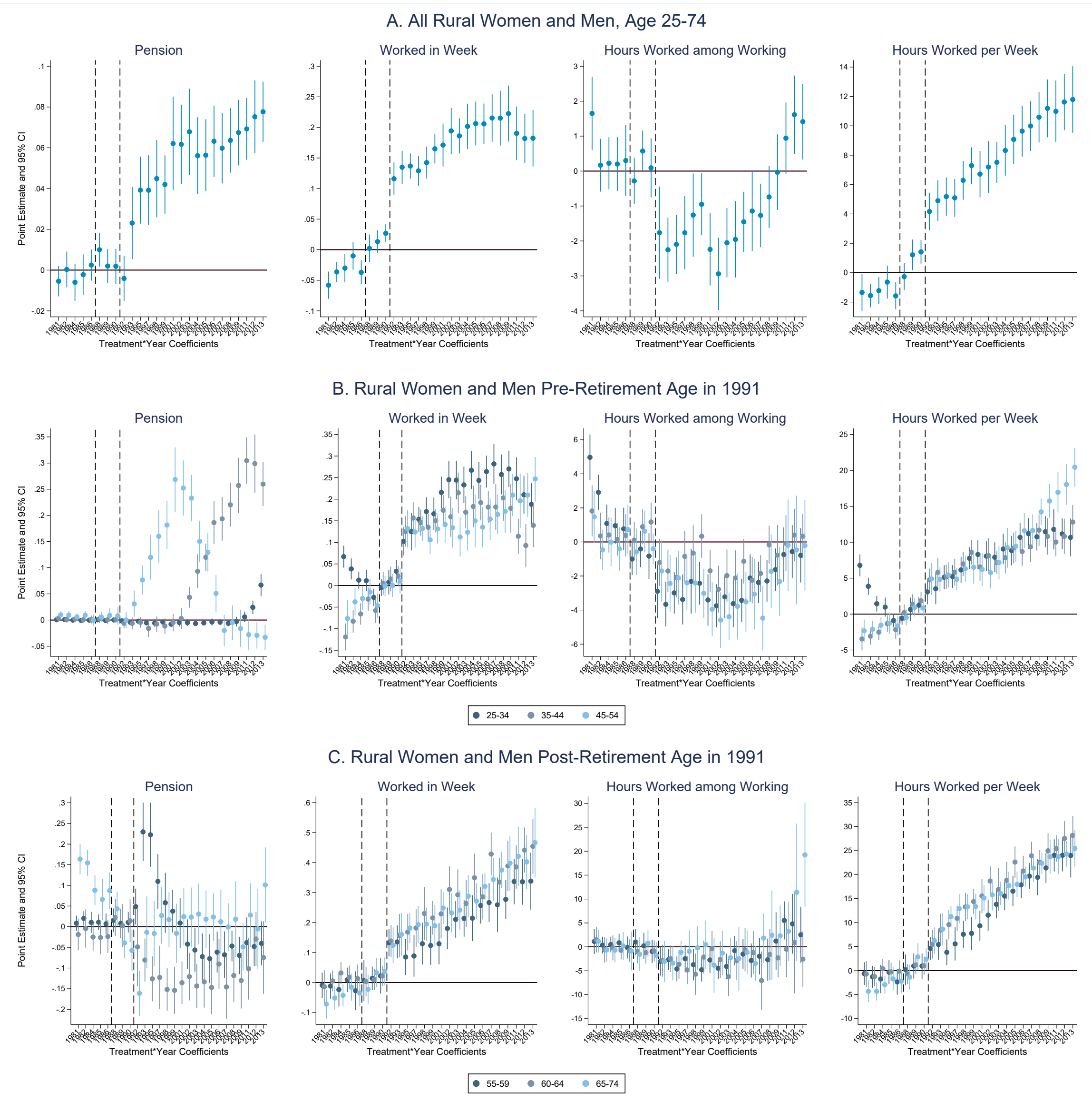
Notes. "Worked less than 30 hours" equals to one if the average hours worked per person is less than 30 hours. Each panel shows the β coefficient estimates and 95% confidence intervals on each year from an extended difference in difference regression of the form $y_{ist} = \alpha \times D_{ist} + \sum_{j=1981}^{1988} \beta_j^{pre} \times D_{isj} + \sum_{j=1989}^{2013} \beta_j^{post} \times D_{isj} + \delta_t + \mu_s + \Gamma_{ist}' X_{ist}$, where y_{it} is the outcome variable of interest and $D = 1$ if the individual lives in a rural area.

Figure 8: Pension and Work Status in Rural Married Women and Rural Single Women, Difference-in-Difference Estimates



Notes. Panel A shows pension and labor force status among women in rural areas, ages 25-74, who are married (dark lines) and who are single (light lines) from 1981 through 2013. Panel B shows pension and labor force status among women in rural areas, ages 25-74, who are married (dark lines) and who are single (light lines) from 1981 through 2013. "Pension" refers to the percent of the population aged 25-74 that receives a pension in each year. "Worked in Week" refers to the percent of the population aged 25-74 that worked in the reference week in each year. "Hours worked per week" refers to the average hours worked per person among the population aged 25-74 in each year. Each panel shows the β coefficient estimates and 95% confidence intervals on each year from an extended difference in difference regression of the form $y_{ist} = \alpha \times D_{ist} + \sum_{j=1981}^{1988} \beta_j^{pre} \times D_{isj} + \sum_{j=1989}^{2013} \beta_j^{post} \times D_{isj} + \delta_t + \mu_s + \Gamma'_{ist} X_{ist}$, where y_{it} is the outcome variable of interest and $D = 1$ if the individual is married. Panel A includes all women age 25-74 within the year plotted. Panel B includes three different cohorts of women who were younger than the retirement age of 55 when the law was passed in 1991. Panel C includes three different cohorts of women who were older than the retirement age of 55 when the law passed in 1991. Coefficients are estimated relative to the year before the constitutional amendment announcing expansion of the rural pension scheme, 1987.This figure includes only people who were younger than any pension claiming age – that is, younger than 55 – in 1991, the year in which *lei*#8212/8213 was passed.

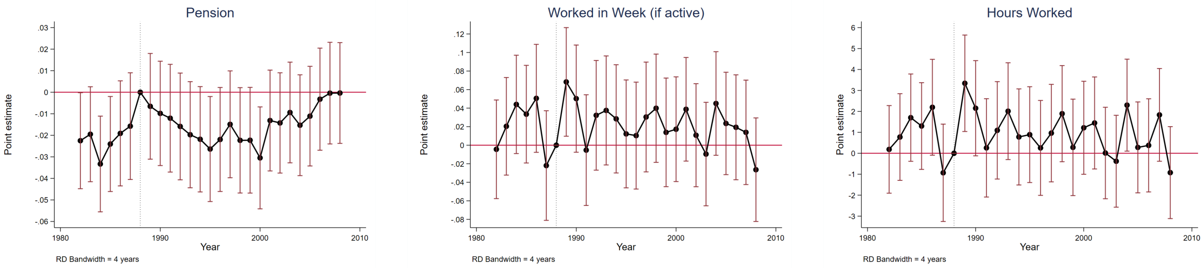
Figure 9: Pension and Work Status in Rural and Urban Areas, Difference-in-Differences



Notes. Panel A shows pension and labor force status among women, ages 25-74, in rural areas (dark lines) and urban areas (light lines) from 1981 through 2013. Panel B shows pension and labor force status among women, ages 25-74, in rural areas (dark lines) and urban areas (light lines) from 1981 through 2013. "Pension" refers to the percent of the population aged 25-74 that receives a pension in each year. "Worked in Week" refers to the percent of the population aged 25-74 that worked in the reference week in each year. "Hours worked per week" refers to the average hours worked per person among the population aged 25-74 in each year. Each panel shows the β coefficient estimates and 95% confidence intervals on each year from an extended difference in difference regression of the form $y_{ist} = \alpha \times D_{ist} + \sum_{j=1981}^{1988} \beta_j^{pre} \times D_{isj} + \sum_{j=1989}^{2013} \beta_j^{post} \times D_{isj} + \delta_t + \mu_s + \Gamma'_{ist} X_{ist}$, where y_{it} is the outcome variable of interest and $D = 1$ if the individual lives in a rural area. Panel A includes all women age 25-74 within the year plotted. Panel B includes three different cohorts of women who were younger than the retirement age of 55 when the law was passed in 1991. Panel C includes three different cohorts of women who were older than the retirement age of 55 when the law passed in 1991. Coefficients are estimated relative to the year before the constitutional amendment announcing expansion of the rural pension scheme, 1987.This figure includes only people who were younger than any pension claiming age – that is, younger than 55 – in 1991, the year in which *lei*#8212/8213 was passed.

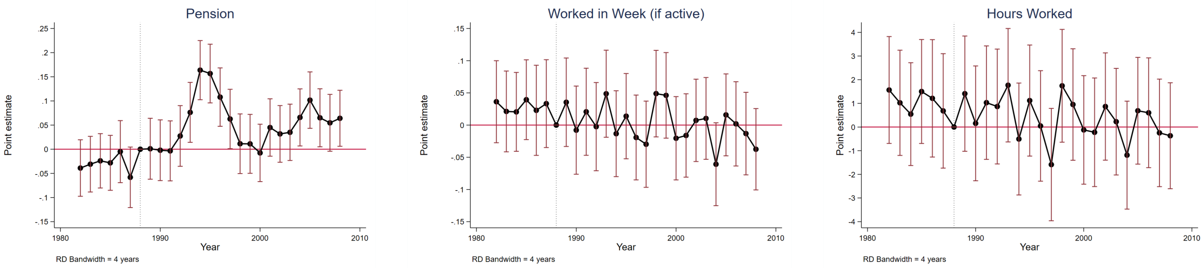
B.2 Robustness: Difference-in-discontinuities

Figure 10: Difference in Discontinuity at Age 50 (Women)



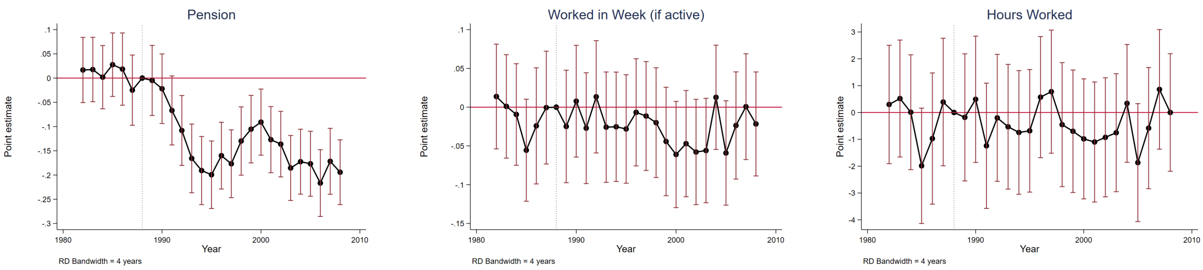
Notes. These graphs show the difference in discontinuity at age 50 in the three variables listed, using a bandwidth of 4 years.Figure shows the discontinuity estimate at age 50 and 95% confidence intervals for RDs run in each year, using a bandwidth of 4 years. Sample is restricted to women living in rural areas.

Figure 11: Difference in Discontinuity at Age 60 (Women)



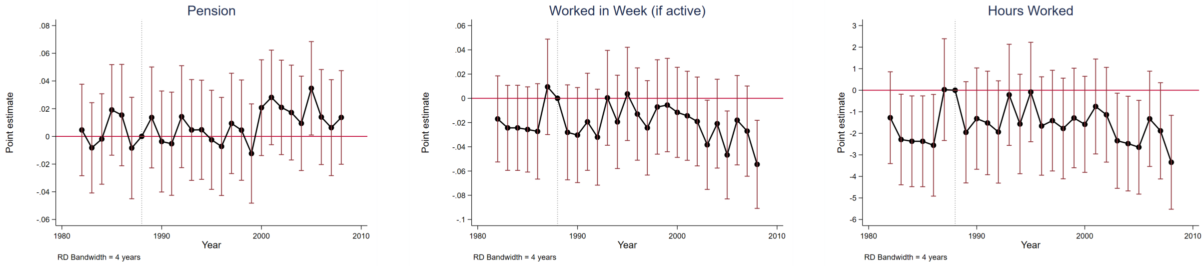
Notes. These graphs show the difference in discontinuity at age 60 in the three variables listed, using a bandwidth of 4 years.Figure shows the discontinuity estimate at age 60 and 95% confidence intervals for RDs run in each year, using a bandwidth of 4 years. Sample is restricted to women living in rural areas.

Figure 12: Difference in Discontinuity at Age 65 (Women)



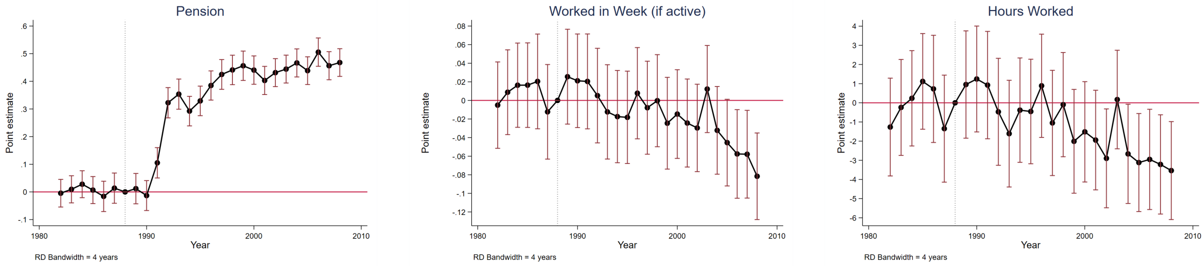
Notes. These graphs show the difference in discontinuity at age 65 in the three variables listed, using a bandwidth of 4 years.Figure shows the discontinuity estimate at age 65 and 95% confidence intervals for RDs run in each year, using a bandwidth of 4 years. Sample is restricted to women living in rural areas.

Figure 13: Difference in Discontinuity at Age 55 (Men)



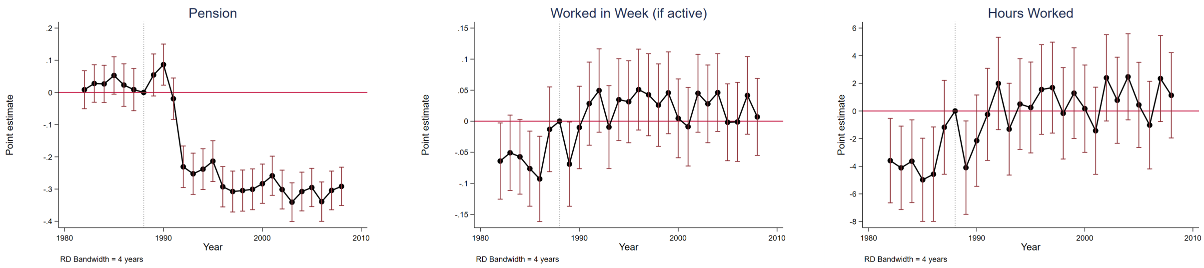
Notes. These graphs show the difference in discontinuity at age 55 in the three variables listed, using a bandwidth of 4 years.Figure shows the discontinuity estimate at age 55 and 95% confidence intervals for RDs run in each year, using a bandwidth of 4 years. Sample is restricted to men living in rural areas.

Figure 14: Difference in Discontinuity at Age 60 (Men)



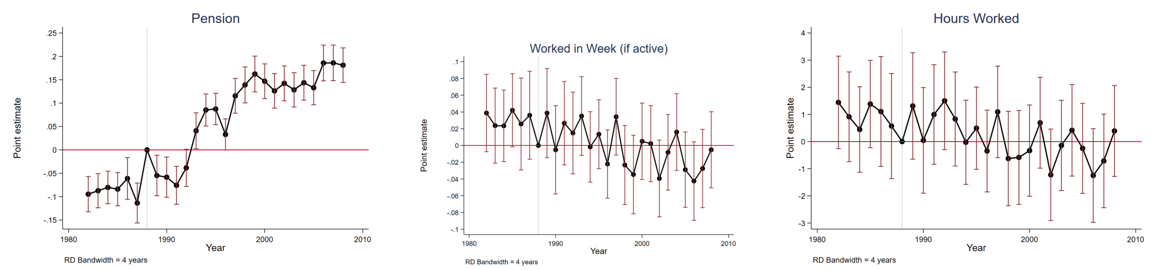
Notes. These graphs show the difference in discontinuity at age 60 in the three variables listed, using a bandwidth of 4 years.Figure shows the discontinuity estimate at age 60 and 95% confidence intervals for RDs run in each year, using a bandwidth of 4 years. Sample is restricted to men living in rural areas.

Figure 15: Difference in Discontinuity at Age 65 (Men)



Notes. These graphs show the difference in discontinuity at age 65 in the three variables listed, using a bandwidth of 4 years.Figure shows the discontinuity estimate at age 65 and 95% confidence intervals for RDs run in each year, using a bandwidth of 4 years. Sample is restricted to men living in rural areas.

Figure 16: Difference in Discontinuity at Age that Varies across Cohort (Women)



Notes. These graphs show the difference in discontinuity at age 65 in the three variables listed, using a bandwidth of 4 years.Figure shows the discontinuity estimate at age 65 and 95% confidence intervals for RDs run in each year, using a bandwidth of 4 years. Sample is restricted to men living in rural areas.

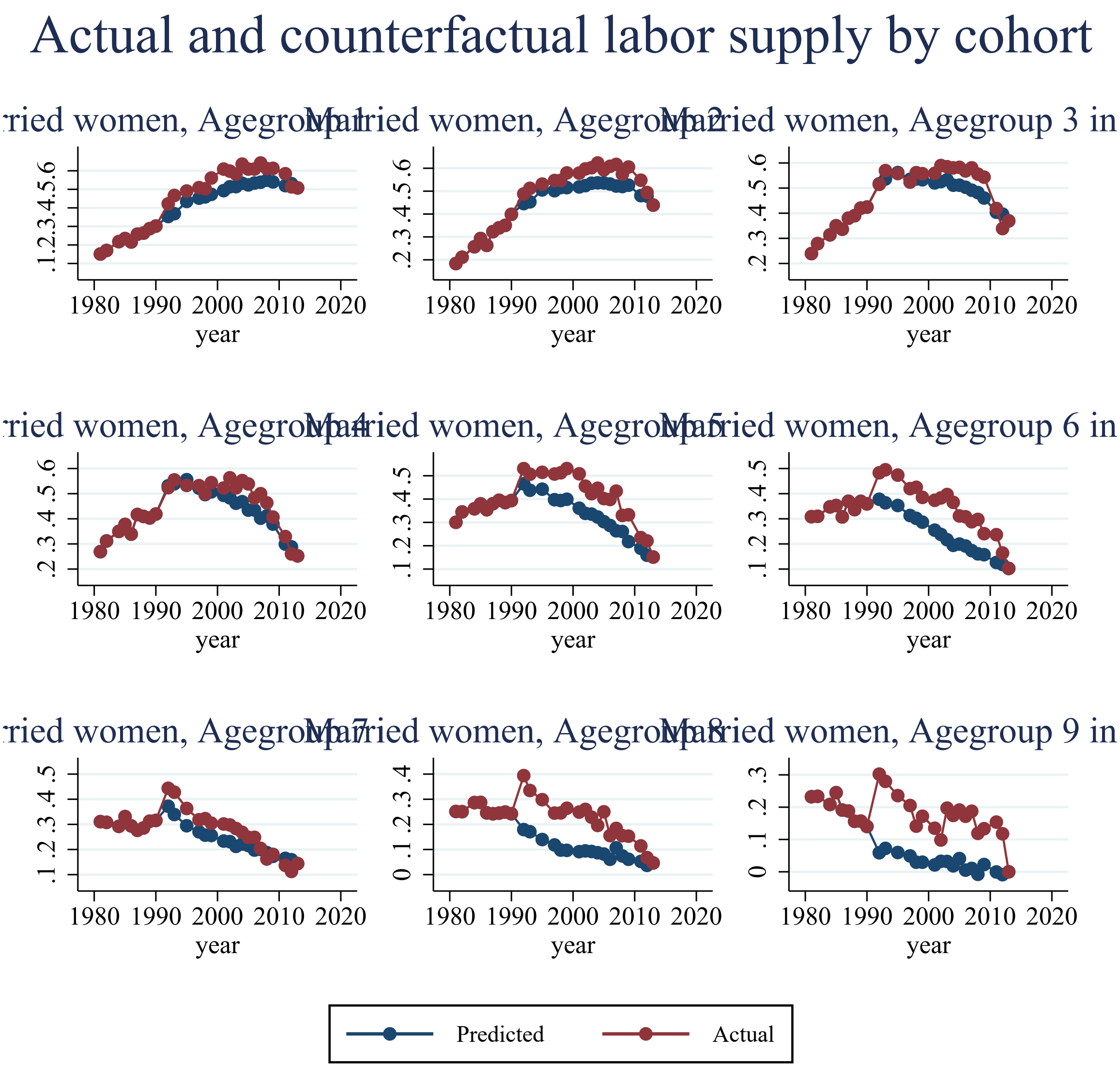


Figure 17: Impact on Lifetime Labor Supply For Rural Married Women

C Calculating Changes in Lifetime Labor Supply

Table 7: Adjustments in Lifetime Labor Supply: Rural Married Women

Age in 1991	Extra Years per person	Extra Years per worker	% Change in Lifetime	Yrs of Work Req. for eligbility	Age eligible for new entrants
25-29	1.2	3	11	15	55
30-34	.81	2	7.5	15	55
35-39	.47	1.1	4.2	13-14.5	55
40-44	.45	1.1	4.1	10.5-12.5	55
45-49	1.2	3.5	13	8-10	55-56.5
50-54	1.4	4.5	17	5-7.5	57.5-60
55-59	.51	1.8	6.7	5	60-64
60-64	1.3	6	22	5	65-69
65-69	1.1	7	26	5	70-74
70-74	.56	4.2	16	5	75-79

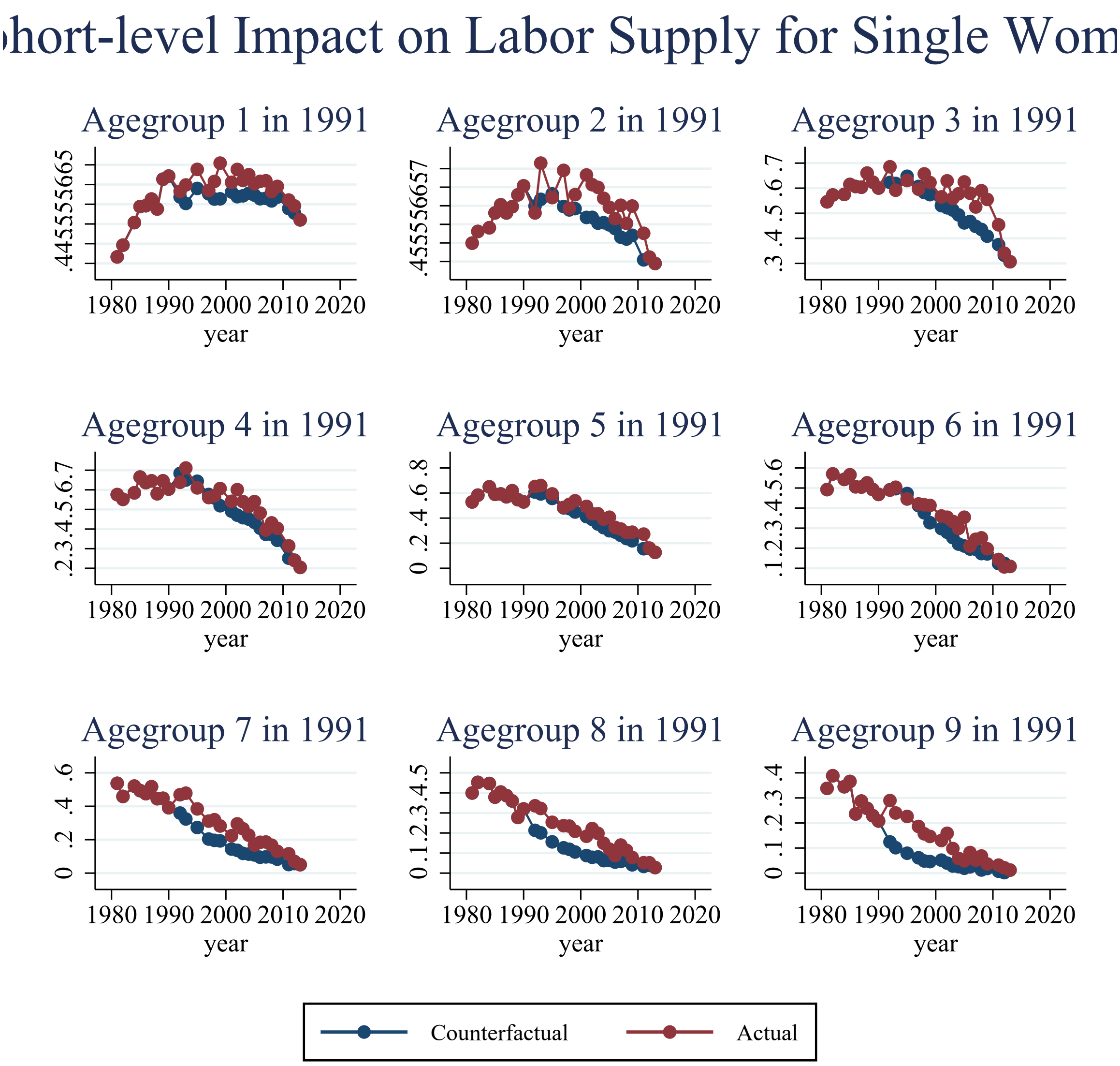


Figure 18: Impact on Lifetime Labor Supply For Rural Single Women

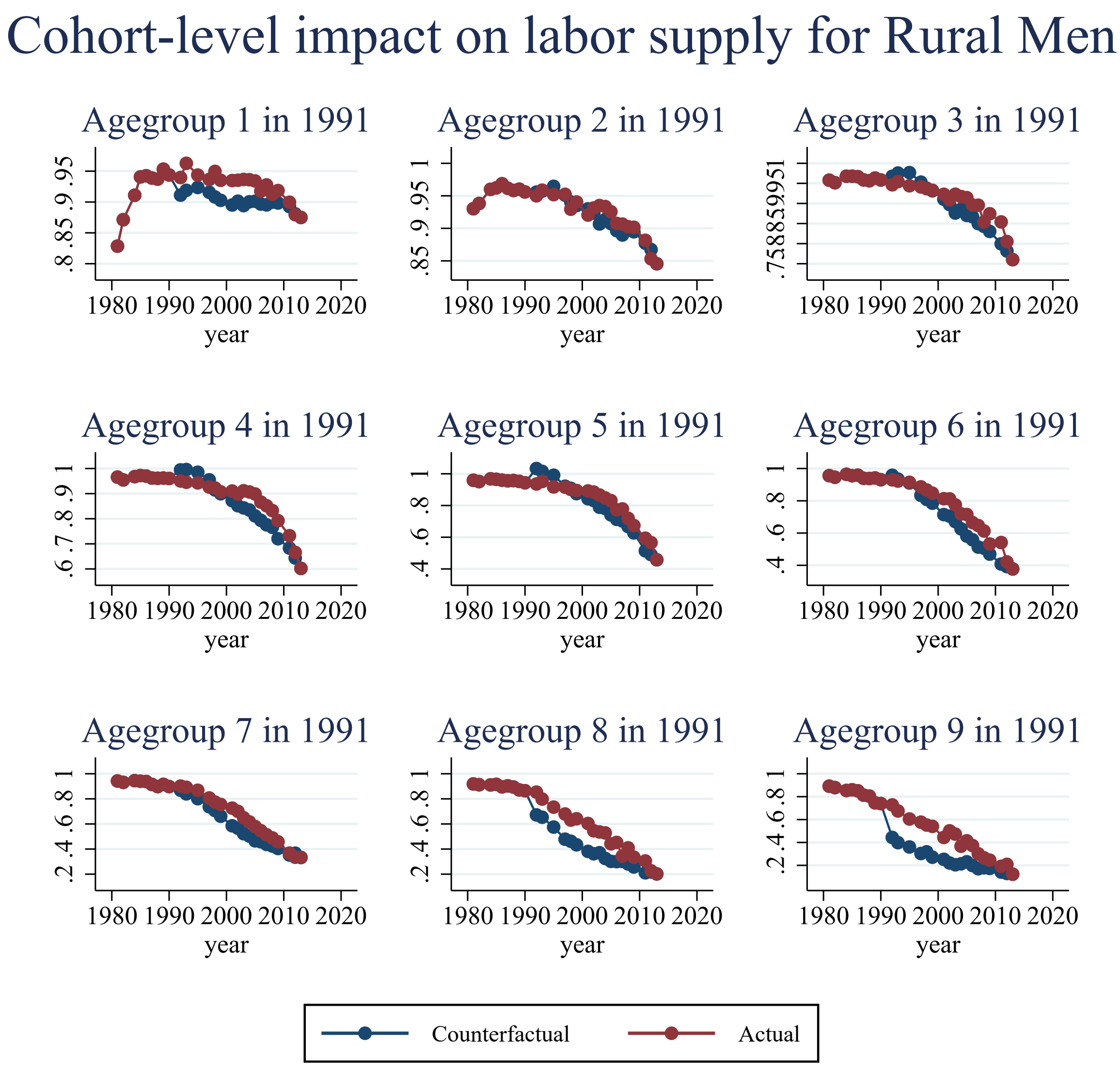


Figure 19: Impact on Lifetime Labor Supply For Rural Men

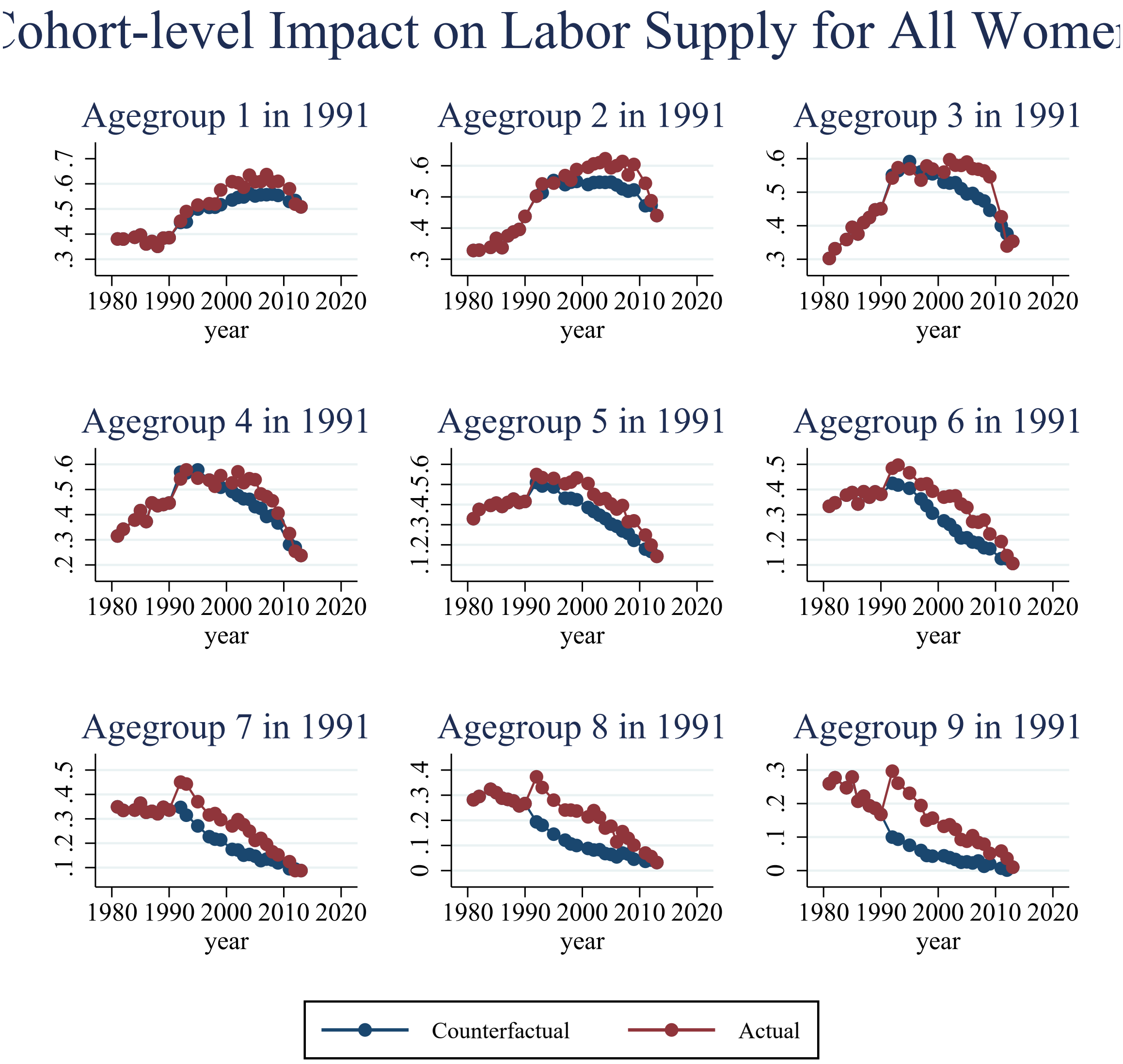


Figure 20: Impact on Lifetime Labor Supply For Rural Women