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Female labor supply and rural pension eligibility in Brazil ☆

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ABSTRACT

In 1991, Brazil expanded its rural retirement pension to cover millions of previously uncovered women, conditional on work requirements. We use a difference-in-differences approach to show that this expansion drastically increased married women's employment by nine percentage points, or 26 percent. This increase in labor force participation occurred among women who were immediately age-eligible, and among younger cohorts that would be eligible in the future. These results illuminate the capacity of workers to respond to financial incentives for labor participation, and the extent to which younger workers might be forward-looking as they respond to retirement incentives.

1. Introduction

Labor force participation among women in rural Brazil increased by a surprising 26 percent between 1990 and 1992. This dramatic growth in female labor supply, one of the world's largest seen in a span of a few years, occurred on the heels of a generous expansion of the rural pension regime. Pension expansions are usually found to depress labor supply through a negative wealth effect (Huang and Zhang, 2021; Bando et al., 2016, 2020, 2022; Kaushal, 2014; de Carvalho Filho, 2008). This expansion, however, created a competing eligibility incentive that, we show, was particularly effective in increasing labor-force participation for women likely because they were initially less attached to the labor force. In this paper, we model the various labor-supply incentives created by this 1991 rural pension expansion, and use annual large-scale household data and a difference-in-differences specification to show that the pension led to a dramatic increase in women's labor supply on the extensive margin. The design of transfer systems can influence women's labor-force participation more broadly (Kleven, 2019; Bastian, 2020). Understanding how transfer design facilitates female labor supply has particular implications for economic development, as increases in female labor-force participation are associated with prosperity and broader improvements in gender relations (Goldin, 1995; Dinkelman and Ngai, 2021; Blau and Kahn, 2013; Anderson and Eswaran, 2008).

The rural pension expansion, passed and implemented in 1991, newly provided a non-contributory pension to women who were not household heads, provided that they could produce evidence of a certain number of years of rural work. Our extended difference-in-differences specification compares the pension receipt and labor supply of married rural women to that of married urban women (first difference), before and after the reform (second difference), to find a sustained increase in labor supply among married rural women of nine percentage points, or approximately 26 percent. This increase was immediate among all cohorts, but larger and short-lived among women who were near retirement age when the expansion took effect, and smaller but sustained among women in younger cohorts. Our 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 will increase their labor supply in anticipation.

Our finding that an increase in pension generosity is associated with an increase in labor supply is uncommon among the literature exploring retirement pensions and labor supply. Much of the existing literature documents responses consistent with a wealth effect: more pension generosity is associated with declines in labor supply (Huang and Zhang, 2021; Bando et al., 2016, 2020, 2022; Kaushal, 2014; de Carvalho Filho, 2008), while less pension generosity is associated with increases in labor supply (Staubli and Zweimüller, 2013; Neumark and

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Song, 2013; Brown, 2013; Mastrobuoni, 2009; De Vos et al., 2018; Duque, 2021). Some papers identify the difference in labor supply between age-eligible individuals and non-age-eligible individuals as a wealth effect (Bando et al., 2016; Duque, 2021; Shu, 2018; de Carvalho Filho, 2008). Other papers consider that difference to be the effect of current eligibility, which is suggestive of liquidity constraints or reference-dependent behavior driving retirement decisions (Staubli and Zweimüller, 2013; Neumark and Song, 2013; Cribb et al., 2016; Manoli and Weber, 2016; Geyer and Welteke, 2021; Rabaté et al., 2024). Regardless, the difference in labor supply between age- and non age-eligible individuals is confounded by labor supply responses among the non-age eligible as the non-age eligible may also change their lifetime labor supply (Jacobs, 2010). While most related literature finds little evidence for such upstream effects of pension reforms, some notable exceptions provide evidence of forward-looking adjustments in labor supply facing changes in retirement incentives (Rabaté et al., 2024; Hairault et al., 2010; Carta and De Philippis, 2021; Becerra, 2023).

Our empirical specifications 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. Further, and perhaps more importantly for explaining why our results suggest an opposite sign from previous literature, the reform studied here creates an incentive to increase labor supply to achieve pension eligibility, in addition to the traditional wealth effect that discourages labor supply. Our results suggest that this forward-looking eligibility effect is particularly powerful in bringing married women into the workforce.

A second robust finding in the literature is that people tend to retire at discontinuously higher rates when they reach the age of pension eligibility (Neumark and Song, 2013; Behaghel and Blau, 2012; Shu, 2018; Deshpande et al., 2024). Previous work has emphasized credit constraints, discontinuous marginal labor supply incentives, and reference-dependent preferences at pension eligibility ages to explain this behavior (Staubli and Zweimüller, 2013; Neumark and Song, 2013; Seibold, 2021; Lalive et al., 2023; Gruber et al., 2022). We next use a year-by-year regression discontinuity 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 any age prior to or immediately after the reform. However, a discontinuity at age 55, the age at which women who work in agriculture become eligible for the rural old-age pension following the reform, 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.

The implications of our results are nuanced in a context like Brazil, where rural work is primarily informal and only ten percent of rural households had a woman as their household head prior to the reform. The Brazilian pension system for the elderly is unique in that it has covered rural workers in informal employment since 1971, but that coverage was limited to one person per household and targeted at household heads. As a result, mostly rural men had access to public pensions, and women's total compensation for the same workload was lower than men's, thus discouraging female labor force participation. If, additionally, the prevailing market wage adjusted downward to account for this publicly provided compensation to (mostly male) workers, highly productive women may have stayed out of the market, even as they would have participated in the absence of these cultural and economic frictions. The de-facto targeting of the 1991 pension expansion to women may have helped alleviate such frictions and driven our documented increase in female labor force participation.

We explore these various competing effects of the reform on female labor supply by building a model of labor supply decisions over the life cycle, for people with heterogeneous utility of home- relative to market-produced goods. This model suggests that there are four groups of people driven by countervailing effects – a characterization of labor supply behavior that echos the bunching behavior documented in other contexts (Brown, 2013; Manoli and Weber, 2016; Seibold, 2021). First, those who receive high utility from home, relative to market, production are unlikely to increase labor-force participation and, instead, forgo accessing the pension. Second, a group of marginal workers will now 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 without the expansion, reduce their labor supply to the required amount. Finally, a group of workers that would have worked many more years than required by the expansion instead reduce their labor supply somewhat (and still work more than required) given their extra expected pension wealth. 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 cohort-level smoothing assumption.

The model allows us to document competing effects in labor supply decisions, and quantify the aggregate economy-wide changes to cohort-specific work participation. Together with our empirical patterns, the model sheds light on aggregate lifetime labor supply, differential responses to the pension expansion by cohort, and adjustments in part-time work. The model guides us in understanding how wealth, eligibility, and retirement-timing effects of the expansion influence labor supply over the lifetime, given the treatment effects we estimate. The standard wealth effect of expanded pension benefits encourages people to work less over their lifetimes, while the work requirement creates a separate eligibility effect encouraging some to work more over their lifetime. The retirement-timing effect may be positive or negative in any given year, but sums to zero over the lifetime of a cohort, as the cohort's target retirement age adjusts to new pension incentives.

We find that, as a result of the pension, lifetime labor supply increased by between 4.3 percent (for younger women) and 6.8 percent (for older women), indicating that the eligibility effect was particularly strong for older women. Part-time work among rural women increased by 6 to 10 percentage points, with much of that increase due to new labor market entrants. The female labor-force participation rate increased from 37 percent of the male labor-force participation rate to 57 percent of the male labor-force participation rate, closing the gap by 32 percent.

Our theoretical approach to interpreting labor supply responses to pension incentives differs from the option-value models standard in the retirement literature (Stock and Wise, 1990; Samwick, 1998; Coile and Gruber, 2007). Those models focus on discontinuous returns to working an additional year when an individual is near a retirement eligibility cutoff, and are critical in understanding marginal labor supply decisions near retirement age of groups that are strongly attached to the labor force. Our approach allows us to focus on the impact of the pension expansion, throughout the working life, on groups that are unlikely to work without the expansion. In this way, it is reminiscent of the literature debating the impact of the US's Earned Income Tax Credit and other conditional transfer programs on women's extensive- and intensive-margin labor supply decisions (Kleven, 2019; Whitmore Schanzenbach and Strain, 2021; Verho et al., 2022). This theoretical focus motivates an empirical approach that differs from those often used to explore the labor supply impact of retirement pension programs in developing countries (Bando et al., 2016, 2020, 2022; Kaushal, 2014). Rather than comparing the age-eligible to non-age-eligible – a comparison that necessarily highlights negative wealth effects or reference-dependent retirements – our focus on lifetime labor supply reveals nuanced behavioral responses in which expansions in generosity may increase labor market participation.

2. Institutional background

The Brazilian Constitution of 1988 initiated a dramatic expansion of retirement pensions in rural areas that had a particularly large impact on women. The rural pension system in place prior to this reform, established in 1971 and referred to as PRORURAL, granted a retirement 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 married women were not eligible. Receipt of the rural pension was not means- or retirement-tested; rural work, which included informal work, was verified by local ARENA party officials.[1] Rural participants did not make earnings-based contributions to the pension system during their working life; rather, the rural pension system was funded with a 2.1 percent tax on final agricultural goods and a three percentage point tax on the payroll of urban employers (Schwarzer and Querino, 2002).[2] 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 an old-age pension at age 65, or a length-of-service pension after 30 years of service. The urban benefit amount depended on a recipient's years of service and recent labor earnings, but was bounded below by 90% of the minimum wage. In addition to worker contributions, the urban system was funded by a payroll tax on employers and Treasury supplements when necessary. Receipt of the urban pension required recipients to quit their current job, though they could continue working elsewhere.

The 1988 Brazilian Constitution committed to consolidating and equalizing these two retirement pension schemes, extending a length-of-service pension, in addition to the old-age pension, to informal rural workers, and aligning informal rural workers' service requirements and benefits with those of formal urban workers.[3] In addition, the 1988 constitution increased the minimum benefit for all workers to 100 percent of the minimum wage, decreased age and service requirements by five years for women, and removed the requirement that recipients quit their current job.

While the 1988 Constitution established the basic framework of merging and equalizing the urban and rural scheme, the details of implementation were not released until Law (*Lei*) #8212/8213 was passed in 1991. This law made minor changes to urban pensions and substantial changes to rural pensions (see Table 1). The law adjusted pensions available to formal urban workers by only the constitutional mandates: it increased the minimum benefit amount from 90 to 100 percent of the minimum wage; removed the requirement that recipients quit their current job; and, for women, decreased the eligibility age for the old-age pension from 65 to 60, and the minimum service requirement for the length-of-service pension from 30 to 25 years. Employer and employee contributions remained the same for the formal urban sector, though the extra three percent payroll tax that had previously been explicitly earmarked for rural pensions became part of the employer contribution to the joint pension fund. For rural pensions, *Lei* #8212/8213 removed the restriction allowing only the household head access to rural pensions; reduced the eligibility age for the old-age pension from 65 for all recipients, to 60 for men and 55 for women; introduced a length-of-service pension; and increased the minimum benefit amount from 50 to 100 percent of the minimum wage.[4] Rural contributions changed very little, with the tax on final agricultural goods increasing from 2.1 to 2.2 percent of the final value of agricultural goods.

Following *Lei* #8.212/8.213, the service requirement and benefit structure took on a different form for informal rural work than for formal urban work. Rural workers received a flat benefit equal to the minimum wage, rather than a benefit that increased with prior documented earnings, when they were unable to formally document earnings. Further, they were allowed to document years of rural work, rather than years of contributions like urban workers, to satisfy the service requirements of the old-age pension. This work requirement was phased in gradually: it began at five years for women who had reached age 55 by 1991, and increased in six month increments for subsequent cohorts so that women who reached 55 in 2011 or later were required to have worked for at least 15 years in a rural occupation to receive the old-age pension.[5] Instead of attaining verification from local ARENA party officials, workers verified rural work with the National Social Security Agency (INSS) using documentation of land used in agricultural production, invoices of agricultural sales, or a rural workers' union membership card.[6] There was no minimum hours requirement. In effect, the new retirement pension for informal rural workers was non-contributory, with eligibility relying on age and/or service requirements.

This reform had different impacts on work incentives for rural men and women. Most rural male pension recipients had worked more than the minimum years required prior to the expansion, so the newly expanded work requirement was not binding for men. As a result, the main impact of the pension expansion on rural men was to double the size of the pension received and decrease the eligibility age from 65 to 60. For married women in rural areas, on the other hand, the minimum rural work requirement established with *Lei* #8212/8213 was more likely to be binding. Prior to the reform in 1987, only 37 percent of married rural women aged 25–69 worked, while 93 percent of rural men did so. With the law's passage, millions of married women were newly able to receive a retirement pension, provided that they were 55 or older and could produce evidence of rural work history. A cursory review of employment patterns among rural women, presented with our primary dataset in Section 3, shows that women of all ages increased their labor supply in 1991. 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 to increase

[1] The ARENA party was a group of civilian supporters of the military regime. Schwarzer and Querino (2002) report rural work validations were known to be approved at higher frequency in election years.

[2] There was no requirement for rural workers to contribute based on earnings, as rural income tended to be informal and thus difficult to document. The revenue from the tax on agricultural output was small relative to the urban payroll tax. In this way, the urban scheme cross-subsidized the rural scheme.

[3] The 1988 constitution allows rural workers to reduce their service period by 5 years relative to urban workers, citing the grueling nature of rural work.

[4] The old-age pension and the length-of-service pension are separate pathways to attaining a retirement pension in Brazil. Eligibility for the old-age pension requires that the individual attain a minimum age and work a minimum number of years. Eligibility for the length-of-service pension requires only that an individual work a minimum number of years, though that minimum number of years is substantially higher than required for the old-age pension. The vast majority of rural retirement pensions are attained through the old-age pathway: only .006 percent of all rural retirement pension recipients had earned their pension through the length-of-service pathway in 2020. Both of these pathways are captured by the theoretical model in Section 4 and empirical results in Section 5. We refer to people gaining eligibility for the retirement pension by meeting "age and/or service requirements" to recognize these separate pathways to retirement pensions.

[5] The gradual phase-in of the work requirement for rural workers applied only to those claiming the retirement pension through the old-age pathway, not length-of-service. Each subsequent birth-year cohort was required to produce evidence of an additional six months of rural work to attain pension eligibility: those who reached age 55 in 1992 were required to work for 66 months, those who reached 55 in 1993 were required to work for 72 months, and so on.

[6] See Article 106 of Lei 8.213. The law also created an oversight agency, the *Conselho Nacional de Previdência Social* (CNPS), that monitors and enforces the rural work requirement.

Table 1
Pension Reform of 1991.

Panel A: Rural Workers	Pre-1991 Reform	Post-1991 Reform
Eligibility	• Age 65+, with documentation of work for 1 of past 3 years • Rural household head	• Age 65/60 for men/women with between 5-15 years of work depending on birth year, OR • Full benefits at 35/30 years of work for men/women; reduced benefits at 30/25 years of work • All rural workers
Documentation method	• Local ARENA party officials	• Documentation of land used in agriculture, product receipts, or rural worker trade union id, verified by INSS
Benefit amount	• 50% of min. wage	• 100% of min. wage
Financing	• No employer/employee contributions • Contribution tax of 2.1% of primary value of output • Additional contribution of 3% of urban payroll paid by urban employer	• No employer/employee contribution • Contribution tax of 2.2% of primary value of output • Combined with RGPS

Panel B: Urban Workers	Pre-1991 Reform	Post-1991 Reform
Eligibility	• Age 65/60 for men/women and five years of contributions, OR • Full benefit at 35/30 years of service for men/women • All formal urban workers	• Age 65/60 for men/women and between 5-15 years of contribution, depending on cohort, OR • Full benefit at 35/30 years of service for men/women, reduced benefit at 30/25 years of service • All formal urban workers
Documentation method	• Administrative contribution records, verified by INSS	• Administrative contribution records, verified by INSS
Benefit amount	• Min. benefit: 90% of min. wage • Rises with earnings and years of contribution, capped at ten times the minimum wage	• Min. benefit: 100% of min. wage • Rises with earnings and years of contribution, capped at ten times the minimum wage
Financing	• Employee contributions • Employer payroll tax • Treasury supplements	• Employee contributions • Employer payroll tax • Treasury supplements

Notes. This table describes the major changes to retirement pensions as a result of the reform in 1991, for rural workers (Panel A), and urban workers (Panel B).

labor supply to attain pension eligibility. Section 4 builds a model to explore these incentives in detail, and Section 5 uses an extended difference-in-difference approach and a year-by-year regression discontinuity specification to formally test the model's implications for rural women's labor supply.

3. Data and descriptive statistics

The *Pesquisa Nacional por Amostra de Domicilios*, or PNAD, is an annual, cross-sectional survey of approximately 100,000 households that began in 1967. The survey emphasizes labor-market activity and is representative of the Brazilian population, aged 14 and above. It asks detailed questions about demographic aspects of household members, as well as information on household members' pension receipt and work status. Importantly for this study as the majority of rural work is informal, the PNAD records all employment regardless of its formality. Our analysis focuses on married women between ages 25 and 69, and uses data compiled between 1981–2009. It omits years in which the PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000. Until 2004, the survey included urban areas in all states of Brazil and rural areas in all states except those in the northern region. Rural areas in the northern region were included beginning in 2004. Our main analysis excludes the northern region, but results are robust to including that region.[7]

3.1. Demographics and pension eligibility status

Table 2, Panel A, describes the pension and labor force status of rural and urban residents in the PNAD, aged 25 to 69, between 1981 and 1990 (before the reform) and between 1992 and 2009 (after the reform). Women are substantially less likely than men to identify as the household head in both rural and urban areas. Pension receipt increased among rural residents following the reform: from 21 to 61 percent among women aged 55 and older, and from 29 to 47 percent among men aged 55 and older. After 1991, 11 percent of rural women and 9.4 percent of rural men live in households receiving multiple pensions; a substantial increase from before the reform. Prior to the reform, male employment is higher in rural than urban areas, while female employment is lower in rural than urban areas. Following the reform, however, rural female employment rises to the same levels as urban female employment.[8]

Panel B describes individual and household characteristics. The number of adults living in a household is comparable among rural and urban women, but rural women are more likely to be married and less likely to live in a multi-generational household than their urban counterparts. Consistent with Danzer and Zyska (2022), the number of children living in the household decreases slightly more in rural areas than in urban areas following the reform. Panel C sheds light on the extent to which the changes in non-work eligibility requirements expanded the pool of potential pension recipients. The 5.9 percent of rural women between the ages of 55 and 65, 2.8 percent of urban women between the ages of 60 and 65, and 2.7 percent of rural men between the ages of 60 and 65 in 1992 were newly age-eligible to receive an old-age pension. Fifty percent of rural women who lived with a working spouse, but did not work prior to the reform, could newly

[7] The PNAD began in 1967, but the northern rural areas excluded from the sampling frame, due to their remoteness, until 2004. Appendix B shows robustness to including different regions in the survey.

[8] Beginning in 1992, the PNAD began collecting detailed information on type of work, confirming that the majority of rural work is informal. Permanent employees – a subset of which would be employees at formally registered firms – constituted only about 17 percent of the rural workforce in 1995. The rest of the workforce was comprised of temporary employees (~13%), farmers who are self-employed or employers themselves (~30%), and unpaid workers who produce for their own consumption (~40%).

Table 2
Characteristics of Rural and Urban 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 household head	9.3	13	17	25	86	82	84	76
% of population receiving pension	5.1	14	6.4	8.6	7.3	12	12	13
% of population 55+ receiving pension	21	61	26	35	29	47	50	53
% of population 65+ receiving pension	42	76	39	51	70	84	78	81
% living in household receiving ≥ 1 pension	2.6	11	3.7	5.3	2.0	9.4	3.0	4.9
% worked in reference week	37	53	41	52	93	90	84	81
Average hours worked per week	14	16	16	20	46	41	40	37
B. Individual and Household Characteristics								
Average age	42	43	41	42	42	43	41	42
% married	80	79	68	64	82	77	81	75
Avg. number of children in household	2.5	1.7	1.7	1.2	2.4	1.6	1.7	1.2
Avg. number of adults in household	2.8	2.7	2.9	2.7	2.8	2.7	2.9	2.8
% living in multigenerational household	23	24	28	28	20	21	23	23
C. Change in Non-work Pension Eligibility Status								
% newly age-eligible, 1992		5.9		2.8		0		2.7
% not working with working spouse, 1990 and 1992	50.0	42.5	39.0	37.0	1.7	1.7	4.0	4.4
N Observations	413,212	482,700	1,312,707	2,232,812	389,882	444,375	1,407,995	2,415,637

Notes. Sample contains all PNAD respondents between ages 25 and 69, from the years 1981 through 2009, excluding 1983, 1991, 1994, 1996, and 2000 as the PNAD was not conducted in those years. A respondent is classified as rural if they live in a rural village, and urban otherwise. Columns labeled "Before" include years between 1981 and 1990, unless in Panel C; columns labeled "After" include years between 1992 and 2009, unless in Panel C. The average hours worked per week refers to the average working hours among the joint working and non-working populations. Newly age-eligible in 1992 includes rural women between 55 and 65, urban women between 65 and 60, and rural men between 65 and 60. Individuals are classified as not working with a working spouse if their spouse reports working but they do not.

expect to earn their own retirement pension by entering the workforce for the required number of years. In the empirical analysis that follows, we focus on married rural women as the newly covered group that is affected by both the potential increase in lifetime wealth and the increase in work requirements.

3.2. Trends in women's pension receipt and labor supply

Fig. 1 describes pension receipt and labor supply among married women, ages 25–69, living in rural and urban areas in Brazil from 1981 through 2009. While there was an expansion in pension receipt among both groups of married women throughout this period, the expansion among rural married women was particularly pronounced between 1990 and 1993 (Fig. 1A).[9] Rural married women's labor supply increased dramatically on the extensive margin and in aggregate in two years following the reform, while hours worked among the working experienced a sharp drop. 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. These trends are particularly pronounced in comparison to married women in urban areas, who experienced steady aggregate growth in labor supply, with steady increases along the extensive margin and very little change on the intensive margin. Fig. 2 shows that these patterns were consistent across age groups. Panel A includes married women who were between 25 and 49 in 1991 (pre-retirement age), and Panel B includes women who were between 50 and 69 (retirement age) in 1991. Pension receipt expanded immediately among retirement-age rural women and at a lag, unsurprisingly, among younger married rural women. Both cohorts, however, increased their labor-market participation immediately beginning in 1992. Retirement-age rural married women increased employment by 13 percentage points (43 percent) between 1990 and 1993, while younger rural married women increased employment by 13.5 percentage points (35 percent).

[9] This timing 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.

4. Conceptual framework

This section introduces a conceptual framework in which individuals make lifetime, rather than annual, labor supply decisions to understand why various cohorts may increase their labor supply in response to pension expansion. Individual i from cohort c lives a life of length $\bar{a}_c$ and receives utility from consumption of market-produced goods, C, and of home-produced goods, H, over their lifetime. Their consumption of home goods is inversely proportional to the individual's lifetime supply of market labor, L, with $H = \bar{a}_c - L$. L is the individual's choice variable. Because we are focusing on the labor supply of secondary earners, we assume that the individual holds some household wealth W that does not depend on their labor supply. Without the pension regime, individuals receive a market wage, w, that does not change over their lifetime and is not necessarily equal to the worker's marginal product. The pension regime provides the individual with a pension of present discounted value $\tilde{P}$, if they work at least $\tilde{L}_c$ years over their lifetime.[10] People who work when the expanded pension regime is in place receive a market wage w_P, which may or may not be the market wage that prevails without the pension.

The individual's utility of home-produced relative to market-produced consumption, which can be influenced by societal norms and can also be interpreted as the opportunity cost of market work, is captured by α_i and is heterogeneous across individuals. Individuals maximize their utility subject to a lifetime budget constraint:

$$\max_{L} (1-\alpha_i) log\ C + \alpha_i log\ (\bar{a}_c - L)$$

$$s.t. \quad C \leq \begin{cases} wL + W & \text{without pension} \\ w_p L + W + \left(\tilde{P} \times \mathbb{1}_{L \geq \tilde{L}_c}\right) & \text{with pension} \end{cases}$$

[10] This life-cycle model abstracts from eligibility age. As a result, the pension regime can be defined as a double $\{\tilde{P}, \tilde{L}_C\}$ that captures the two pathways to a retirement pension (old-age, where $\tilde{L}_c$ is between 5 and 15, and length-of-service, where $\tilde{L}_c$ is 25) described in Section 2.

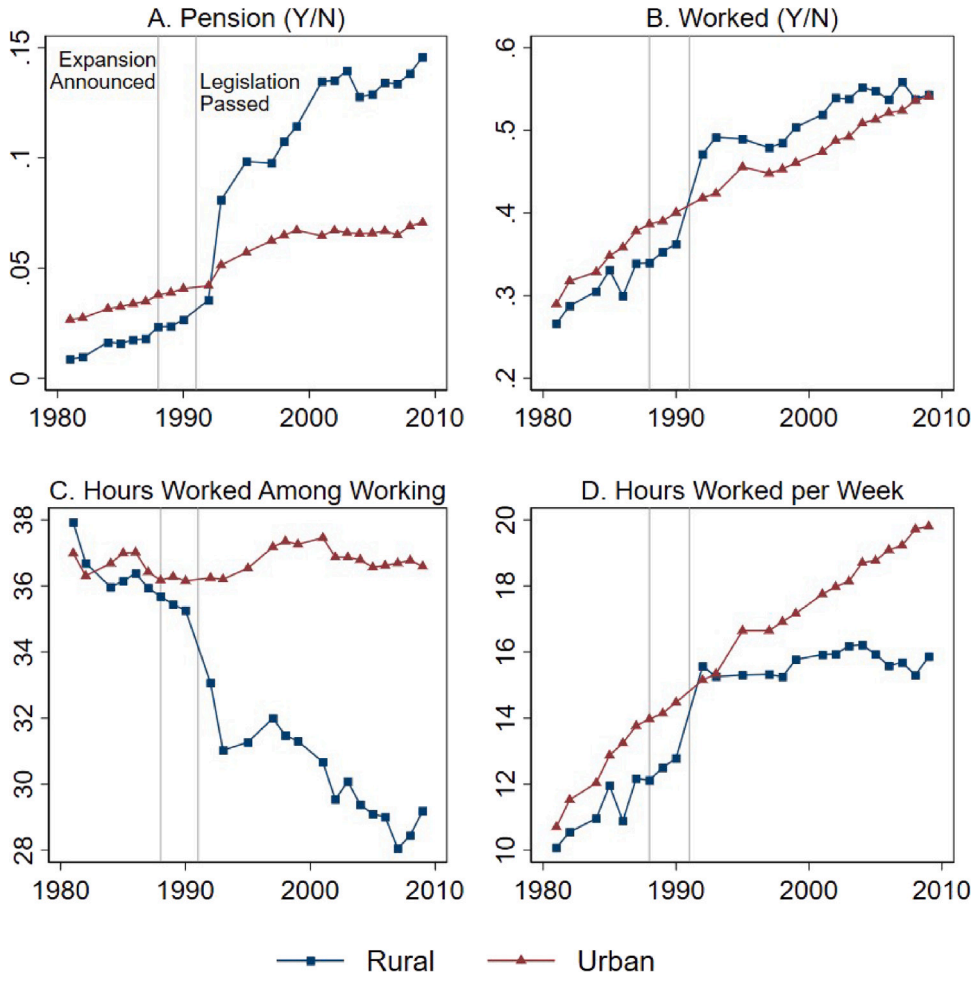

Fig. 1. Married Women's Pension and Work Status in Rural and Urban Areas
Notes. This figure shows pension and labor force status among married women, ages 25–69, in rural areas (navy lines) and urban areas (red lines) from 1981 through 2009. Data source: PNAD 1981 though 2009, excluding years in which PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

4.1. Lifetime labor supply

We find that any pension scheme, $\{\tilde{P}, \tilde{L}_C\}$, affects people's lifetime labor supply differently according to the utility weight they place on home relative to market production, α_i. We illustrate these results with a series of figures that show the number of years an individual chooses to work over their lifetime as a function of the utility they place on home versus market production.

Fig. 3, Panel A, describes the mechanisms driving the lifetime labor supply response to the pension expansion. First, the increase in the size of the pension creates a wealth effect that encourages all workers, regardless of their preferences, to work fewer years. People with a higher utility weight on home production decrease their market labor supply by more than their counterparts with a lower utility weight on home production as a result of this wealth effect. However, people with a higher utility weight on home production are also more likely to be constrained by the work requirement. This second effect, which we refer to as the eligibility effect, counteracts the wealth effect and encourages some people to work more than they would without the work requirement. Some of those responding to this eligibility effect may even work more than they would have without the pension expansion. When enough people in the population experience an eligibility effect that dominates the wealth effect, the pension expansion increases aggregate labor market participation.

These dynamics create four groups of workers, identified in Panel B of Fig. 3, that respond differently to the pension expansion. People with a low value of home production who worked prior to the pension expansion, $\alpha_i \leq \alpha_1 = \frac{w_p(\bar{a}_c+W-\tilde{L}_c)}{w_P(\bar{a}_c+W)+\tilde{P}}$, 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, $\alpha_i \in \left(\alpha_1, \alpha_2 = \frac{\bar{a}_c+W-\tilde{L}_c}{\bar{a}_c+W}\right)$ 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 the 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.[11] 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. This group includes new market entrants who would not have worked without the pension, as well as previous market workers who increase the number of years they work. Finally, individuals with a high value of home production, $\alpha_i > \alpha_3$, who we call "non-responders", do not adjust

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

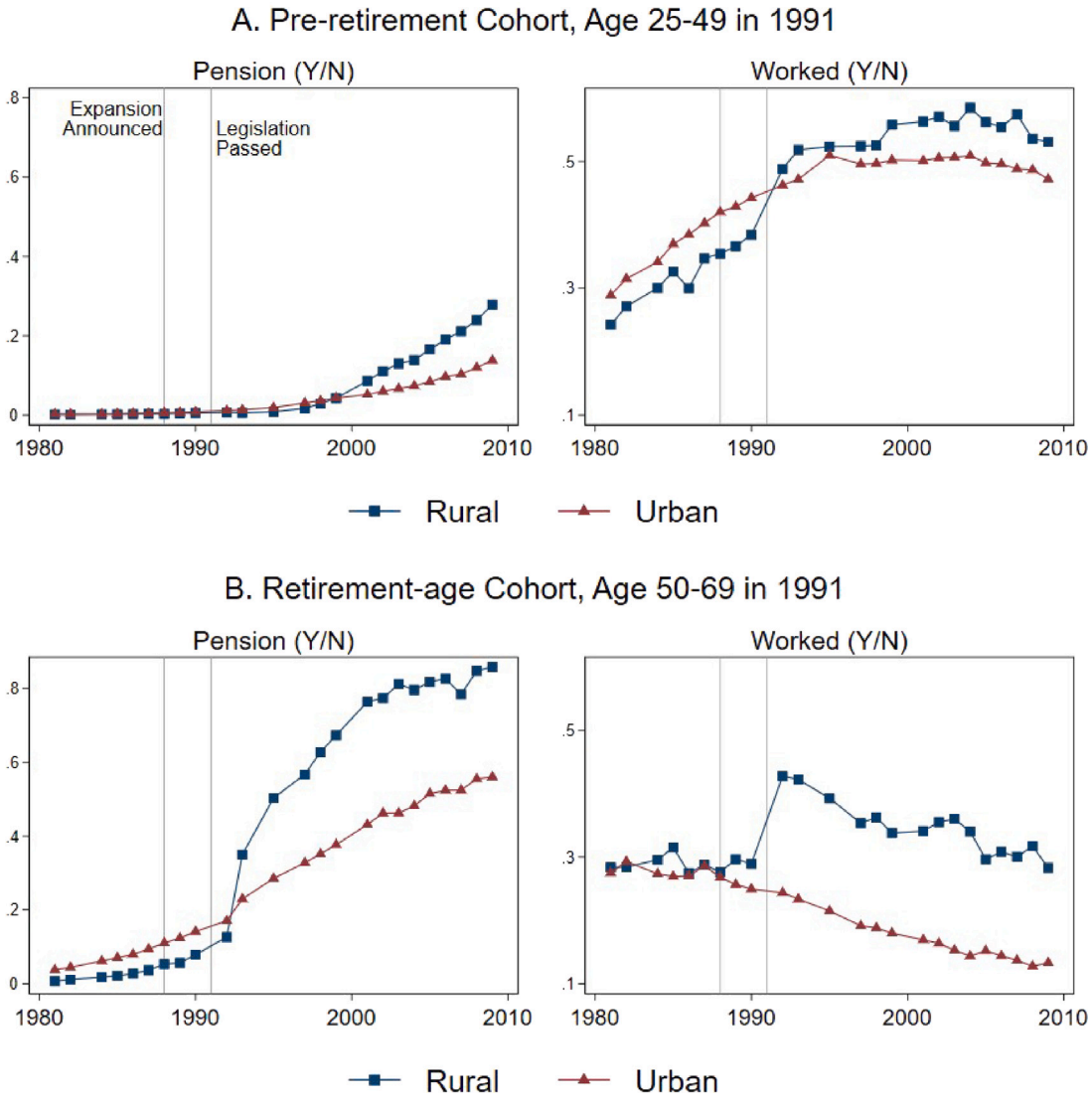

Fig. 2. Married Women's Pension and Work Status in Rural and Urban Areas by Birth Cohort
Notes. Panel A shows pension and labor force status among married women who were between ages 25 and 49 when the law was passed in 1991, in rural areas (navy lines) and urban areas (red lines). Panel B shows pension and labor force status among married women who were between ages 50 and 69 when the law passed in 1991, in rural areas (navy lines) and urban areas (red lines). Data source: PNAD 1981 though 2009, excluding years in which PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

the number of years they plan to work under the pension expansion. Through these mechanisms, this pension expansion encourages people who are more attached to the labor force to decrease their lifetime labor supply, and those who are less attached to the labor force to increase their lifetime labor supply.

4.2. Annual labor supply

Much empirical work on pension expansions, including our own, estimates their impact on annual, rather than lifetime, labor supply. To adjust our model to accommodate annual treatment effects, we add two assumptions. First, we assume each cohort has a target retirement age – i.e., an age at which all members of the cohort plan to and will retire – prior to the pension expansion, $\bar{a}_R$, that could be different from its target retirement age following the expansion, $\tilde{a}_R$.[12] Second, we allow that $\alpha_i \sim G(\alpha)$ within a cohort, and that aggregate lifetime labor supply within the cohort is smoothed across the years before the cohort reaches its target retirement age. As a result, if a pension expansion is introduced in year j when individuals from cohort c are age a_{cj}, the remaining labor supply for that cohort is equally distributed across the next $\tilde{a}_R - a_{cj}$ years.

Decomposing the lifetime labor supply response in this way introduces a third channel, in addition to the wealth and eligibility channels, by which the pension expansion can influence labor supply at an annual level. That channel, which we call the retirement-timing channel, arises when the expansion encourages people to re-allocate their labor supply over their lifetime. The following equation, derived in detail in Appendix A, describes the average annual treatment effect

[12] This assumption of a target retirement age is consistent with literature showing reference-dependent retirement age, our lifetime model, and our regression discontinuity results in Section 5.2. Under the assumption of zero discounting on both home and market consumption, people will concentrate their working years earlier in their career so that they are eligible for the pension as soon as possible.

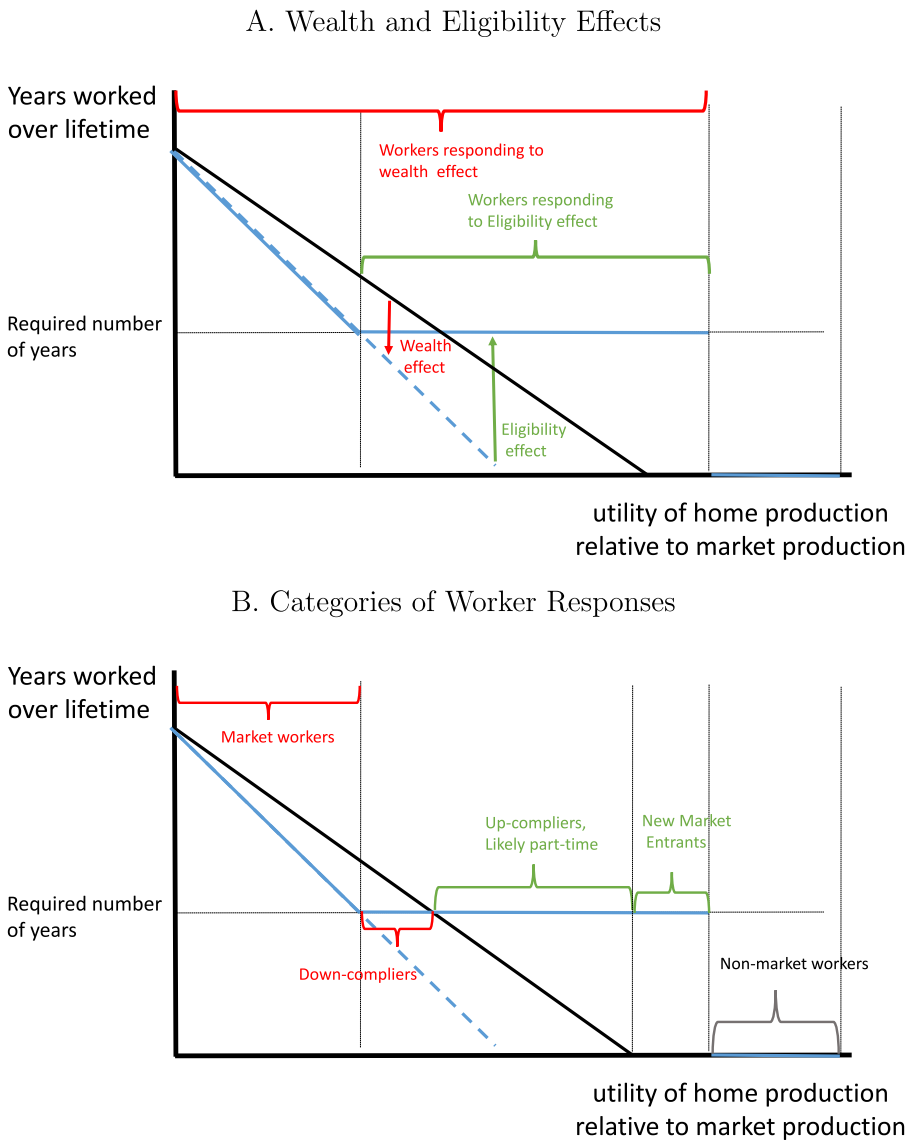

Fig. 3. Heterogeneous Lifetime Labor Supply Responses to Pension Expansion
Notes. This figure shows the optimal number of years an individual works over their lifetime, for heterogeneous utility weight on home production ranging from $\alpha_i \in (0, 1)$. The black solid line describes optimal years worked without a pension expansion. The blue dotted line describes optimal years worked under a pension expansion with no work requirement. The solid blue line describes optimal years worked under a pension expansion with a work requirement. Panel A describes both the traditional wealth effect arising from more generous pension benefits, decreasing lifetime labor supply, and the eligibility effect that increases lifetime labor supply. Panel B identifies four categories of worker responses. Market workers respond only to the wealth effect, and thus decrease their lifetime labor supply following the reform. Down-compliers respond to both the wealth effect and the eligibility effect; the wealth effect dominates and therefore down-compliers decrease their lifetime labor supply. Up-compliers, including new market entrants, similarly respond to both effects, but the eligibility effect dominates, encouraging up-compliers to increase their lifetime labor supply. Non-market workers do not change their labor supply as a result of the pension expansion. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

for cohort c:

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

This expression describes the three mechanisms through which the pension expansion influences average cohort-level annual labor supply: the negative wealth effect, the positive eligibility effect, and the retirement timing effect – which could be positive or negative in any given year but aggregates to zero over the lifetime. The distribution of α_i within a cohort determines which effect dominates in any given year. The lifetime model of labor supply presented in Section 4.1 describes the optimal amount of work someone would choose if they knew, at the beginning of their career, the pension scheme that would prevail when they were ready to retire. The decomposition in Eq. (1) captures the annual adjustments workers make, at various points in their working life, when a new pension regime is unexpectedly introduced in the middle of their potential working lives.

Given the complexity of the different features of the reform, we summarize the possible impacts (through the lens of the model) via the various policy changes, in Table 3. While most aspects of the policy would tend to lower labor supply, the increased work requirement is a strong incentive, increasing labor supply.

Table 3
Summary of Changes in Rural Pension Scheme and Their Expected Effects.

Policy Change	Behavioral Effect	Expected change in Labor Supply
Higher monthly benefit	Wealth Effect	Less Work
Lower eligibility age	Wealth Effect	Less Work
Expansion to non-household heads	Wealth Effect	Less Work
Increase in work requirement	Eligibility Effect	More Work

5. Empirical results

5.1. Difference-in-differences specifications

We estimate the empirical analogue of the annual treatment effect on various cohorts of married women, ΔL_{ct}, using a difference-in-differences specification that compares pension and labor supply outcomes of people living in rural areas to those of people living in urban areas, over time. The following equation describes the extended difference-in-differences specification:

$$y_{irst} = \sum_{\substack{j=1981,\\ \neq 1987}}^{2009} \beta_j \text{Rural}_r + \delta_t + \mu_s + \alpha_{rc} + \Gamma'_{ist} X_{irst} + \varepsilon_{irst} \quad (2)$$

The outcome variable of interest, y_{irst}, is measured for individual i living in geographical area r of state s in year t. This section considers several outcomes: pension receipt, employment, hours worked, and sector of employment. The treatment variable, Rural_r, is equal to one for individuals living in rural areas who are most likely to benefit from the newly expanded retirement rural pension, and zero for individuals living in urban areas. The coefficients δ_t and μ_s represent year and state fixed-effects, while α_{rc} represent cohort-by-rural fixed effects. As a result, the β_j coefficients estimate changes in pension and labor-market outcomes using within state and cohort-by-rural variation. The vector of controls, X_{ist}, is included in robustness checks described in Section 5.1.2. These include controls for state-by-year fixed effects, state-by-rural fixed effects, age, and education. We run this specification on various samples of married women between the ages of 25 and 69, in the PNAD years between 1981 to 2009. The omitted year is the year 1987, immediately before the constitutional reform. Estimates are clustered at the state-by-rural level, resulting in 52 clusters.

5.1.1. Difference-in-differences: Baseline results

The coefficients β_j^{post} for $j > 1991$ that result from estimating Specification (2) with a labor market indicator as outcome variable are the empirical analogue to ΔL_{ct}. Fig. 4 presents these coefficient estimates and 95% confidence intervals, using pension receipt and three measures of labor supply as the outcome variables. Pension receipt among married women in rural areas increased by five percentage points relative to their urban counterparts within two years of the pension expansion, and by 15 percentage points relative to their urban counterparts by 2009. The fraction of married women in rural areas who worked, shown in Fig. 4b, similarly increased relative to its urban counterpart immediately after the reform, by nine percentage points (26 percent) between 1991 and 1993, and remained high through 2009.

The average length of the workweek among working married women in rural areas, however, declined by two hours in 1992, by six hours in 2000, and remained at this low level through 2009 (Panel C). Panel D 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 (12 percent) from 1991 through 1993. This increase in aggregate employment suggests that the short-run labor demand curve is somewhat elastic. However, the treatment effect on overall hours worked fell to zero by 2005.

Fig. 5 explores variation in this annual adjustment by cohort. The sample is women of potential working age when the reform was passed in 1991. Each panel presents the pension receipt and labor market participation estimates from Specification (2), separately for married women who were near the beginning of their working life in 1991, aged 25 to 49, and for those who were near the end of their working life, aged 50 to 69, in 1991. As expected, pension receipt increases quickly among married rural women close to eligibility age when the reform was passed, and more slowly for younger cohorts. 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 50 and 69 were 15 percentage points more likely to work in the year following the enactment of Law #8212/8213. The increase in labor supply for younger cohorts, on the order of five percentage points for those who were between 25 and 44 in 1991, is smaller initially but slightly more persistent than that for older cohorts. Despite the decline in the average hours worked per week conditional on working, overall labor supply increased for older cohorts, aged between 50 and 64 in 1991, throughout the period considered.

Finally, Fig. 6 shows that the primary adjustment in employment occurred in the agricultural sector. This figure presents the estimates resulting from Specification (2) with an outcome variable equal to the indicator of the sector – agriculture, manufacturing, or services – in which the individual is employed. While changes in occupation codes and classifications encourage caution when interpreting these results, there appears to be a large increase in agricultural employment among married rural women relative to their urban counterparts in 1991, that coincides with generally steady employment in services and manufacturing.[13] This suggests that the expansion of rural retirement pensions provided ample incentive for rural women to enter the local labor force. However, the incentive was not strong enough to generate a meaningful shift in employment away from the services and manufacturing sectors, where wages were higher and the pensions were as large and, in many cases, larger, than rural pensions.

5.1.2. 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 have similar trends in the absence of the expansion in the rural pension system. The point estimates of the pre-trend coefficients, $\beta_j \ \forall j \in [1981, 1987]$, are not economically nor statistically different from zero in general, which somewhat alleviates the concern that this assumption is violated. Second, the exogeneity assumption requires that no other changes occurred simultaneously with the pension reform in 1991, besides the policy change of interest, that influence rural and urban labor market choices in different ways. Under these identifying assumptions, the coefficients of interest $\beta_j, \forall j \in [1991, 2009]$, measure the average annual treatment effect of the pension expansion on rural labor supply.

In Appendix Tables B.1 to B.3, we test for robustness to high-dimensional fixed effects and various household demographics. We include fixed effects for educational attainment and a polynomial of the individual's age as a control, to account for non-linear trends in age-specific work decisions. We also include state-by-year and state-by-rural area fixed effects to account for differential trends and policies by state. Our estimates remain robust to the addition of these controls and fixed effects.

[13] Fig. 6 ends in 2001, which was the last year in which a longitudinally consistent occupation classification was used. The occupation classification was revised dramatically in 2002; we do not consider occupational sectors after that year so as to remove variation due to changes in occupation codes.

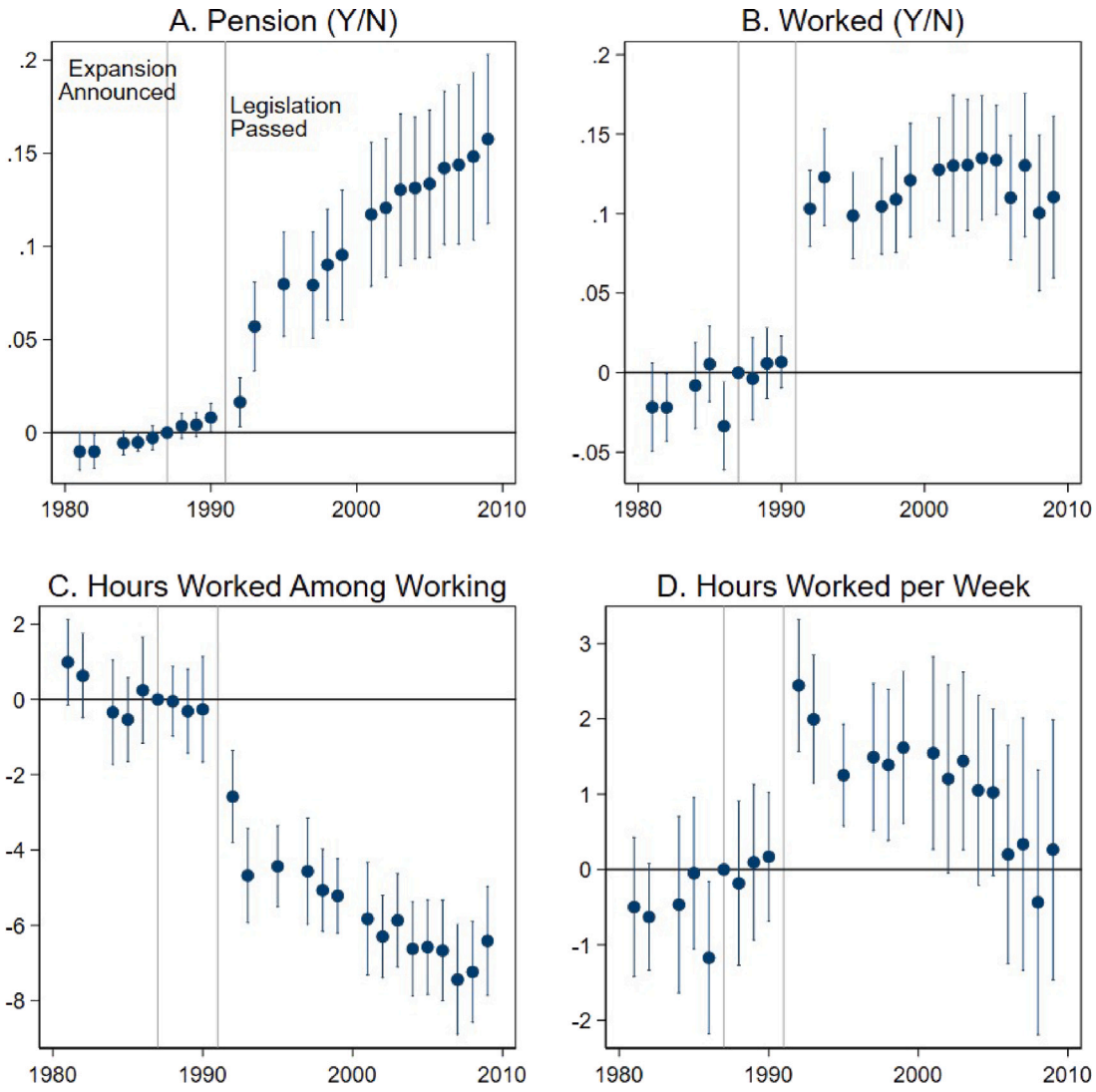

Fig. 4. Pension and Work Status in Rural versus Urban Areas among Married Women Aged 25–69, Difference-in-Difference Estimates
Notes. Each panel shows the β coefficient estimates and 95% confidence intervals on each year from an extended difference-in-difference regression of the form $y_{ist} = \alpha \times \text{Rural}_{ist} + \sum_{j=1981}^{2009} \beta_j \times \text{Rural}_{isj} + \delta_t + \mu_s + \alpha_{rc}$, and standard errors are clustered by rural-by-state. The sample includes all married women aged 25–69 within the year plotted. Coefficients are estimated relative to 1987, the year before the constitutional amendment announcing the expansion of the rural pension scheme; gray vertical lines represent 1987 and 1991, the year in which the implementation of the expansion was announced. Data source: PNAD 1981 though 2009, excluding years in which PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Other pension reforms. One potential remaining issue would be differential changes in the urban and rural systems: coincident changes in the urban retirement pension could affect short-term estimates of the labor supply response, while differential reforms of the rural and urban pension system between 1991 and 2009 could affect long-term estimates of the labor supply response. The 1988 constitutional reform and subsequent 1991 Law #8212/9213 made minor coincident reforms to the urban pension scheme that may have influenced the short-term labor supply of urban workers: a requirement for urban workers to quit their current job in order to claim pensions was removed, the minimum benefit amount was increased, and age and length-of-service requirements for urban women decreased by five years. The first two of these reforms in the urban scheme bias our short-term difference-in-differences estimates toward zero, but the third potentially increases our estimated coefficients. However, were this factor driving our results, we would see a sudden decrease in labor supply in urban areas among married women in 1992 that is not evident in Figs. 1 and 2. Any subsequent reform that differentially affected urban and rural areas over the period considered could affect our long-term estimates. Fortunately, the 1988 constitutional reform and subsequent 1991 law actively combined the rural and urban pension systems; as a result, pension reforms or adjustments made after 1991 affected urban and rural pensioners alike. Significant pension reforms that occurred in our period of analysis include a 1998 reform that cut the size of pension benefits received for all pensioners, and a 2003 reform that decreased the generosity of civil servant pensions.

The descriptive analysis in Fig. 1 alleviates concerns that differential trends between rural and urban workers threaten exogeneity, since it shows quite starkly that 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. Figure B.1 further addresses this concern by comparing the estimates from Specification (2) run on different groups in rural areas – married women, single women, and married men. If married women's labor supply in rural areas is primarily influenced by aggregate labor market shocks that were absent from urban areas, the labor supply of married men and single women in rural areas would mimic the patterns found in Fig. 4. Figure B.1 shows little evidence of similar adjustments in the labor supply of married men immediately after the reform, and some evidence that the decline

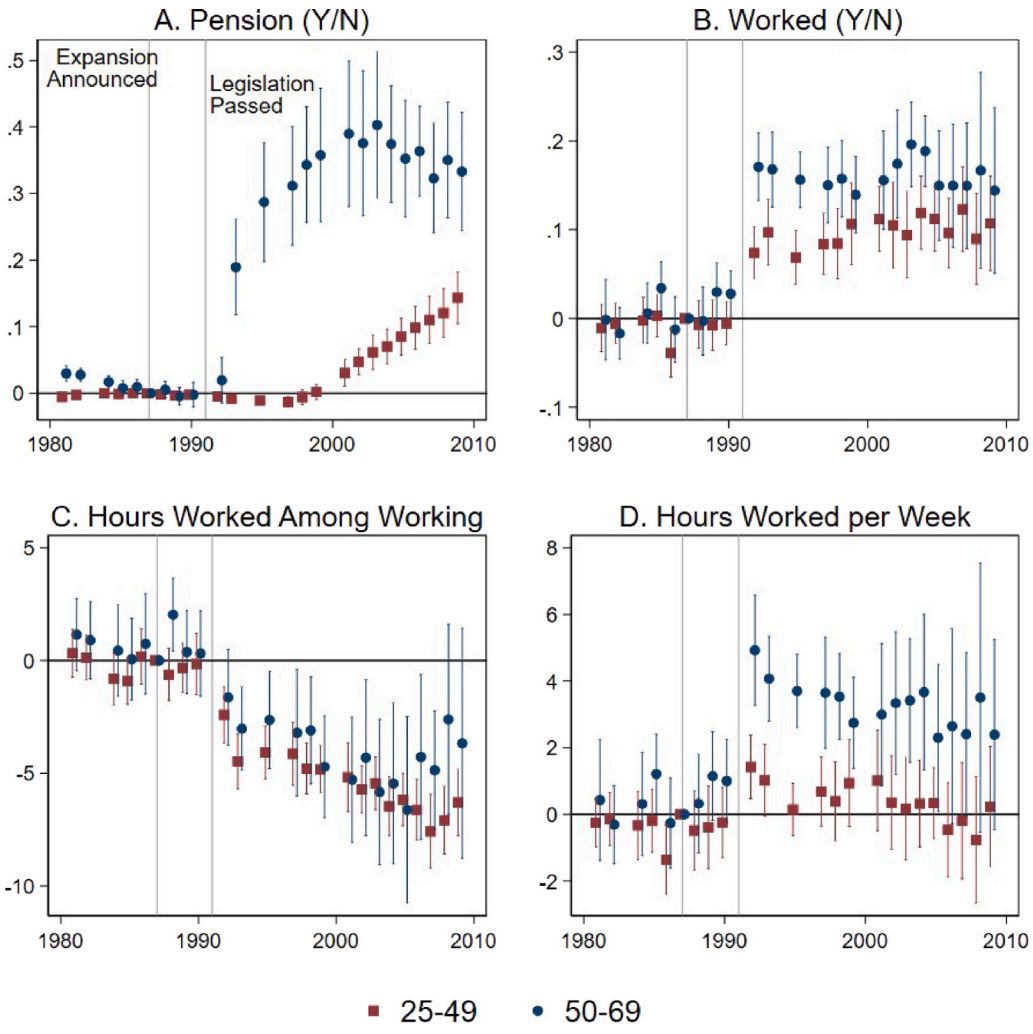

Fig. 5. Pension and Work Status in Rural versus Urban Areas among Married Women, Difference-in-Difference Estimates by Cohorts
Notes. Each panel shows the β coefficient estimates and 95% confidence intervals on each year from an extended difference-in-difference regression of the form $y_{ist} = \alpha \times \text{Rural}_{is} + \sum_{j=1981}^{2009} \beta_j \times \text{Rural}_{isj} + \delta_t + \mu_s + \alpha_{rc}$, and standard errors are clustered by rural-by-state. Navy blue estimates are run on the sample of married rural women who were between 50 and 69 when the law was passed in 1991. Red estimates are run on the sample of married rural women who were between 25 and 49 when the law was passed in 1991. Both sets of estimates are limited to women aged 25–69 within the year plotted and estimated relative to 1987, the year before the constitutional amendment announcing the expansion of the rural pension scheme. The gray lines represent 1987 and 1991, the year in which the implementation of the expansion was announced. Data source: PNAD 1981 though 2009, excluding years in which PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

in rural labor supply in the later years of our sample was a broader rural phenomenon.

Other nationwide policies and shocks. One may be concerned that other policies may simultaneously affect labor supply or shift the labor demand curve. We examine a few in detail, and are unable to find meaningful policy changes that particularly target rural married women at that precise point in time. Two additional policies implemented in Brazil during the period of interest that may differentially affect urban and rural areas include Bolsa Familia (BF) and the Benefício de Prestação Continuada (BPC). BF, a large conditional cash transfer to urban mothers who send their children to school, was introduced in 2002 and may have influenced urban mothers' ability or desire to work outside the home.[14] It is not clear in which direction this would affect our estimates: mothers without children to help around the home may have more housework to do, but mothers without children to take care of around the home may have less housework to do. Regardless, the first BF payments were made in 2005 (14 years after the pension reform), and this would only affect the last few years of estimates. Further, the payments primarily affect women with young children who would be in their 20 s or 30 s – this age group is younger than our cohorts of interest, who were between 25 and 69 in 1991.

The BPC, the second policy of consideration, guaranteed a pension equal to the minimum wage to low-income elderly and disabled individuals. This program, introduced in 1993 and available to rural and urban residents, distributed its first payments in 1996. Low-income individuals were eligible for old-age assistance at age 67 (lowered to 65 in 2003) provided that their family income was no greater than 25 percent of the minimum wage and that they did not receive income from other social security programs or retirement pensions. This implementation of the BPC could affect estimates of the labor-supply response to the 1991 pension expansion if it differentially influenced the labor supply of married rural women. However, Kassouf and de Oliveira (2012) find minimal labor-supply response to the BPC: eligible individuals, age 65 and above, show a small decline in labor supply upon receipt, and do not appear to make anticipatory adjustments in labor supply, while co-residing younger household members do not adjust labor supply when an elderly household member begins to receive the BPC. Our own findings alleviate concerns about endogeneity introduced by

[14] For a detailed overview of Bolsa Familia, see Soares (2011)

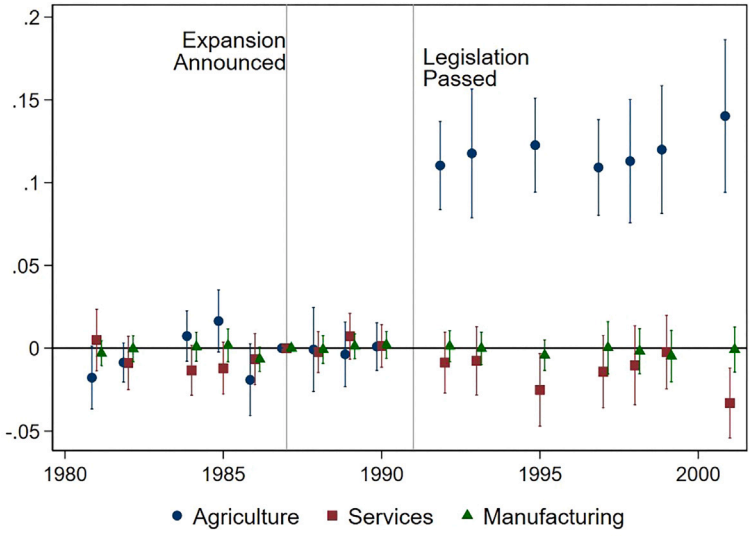

Fig. 6. Employment in Agriculture, Services, and Manufacturing
Notes. Figure shows β coefficient estimates and 95% confidence intervals on each year from the extended difference-in-difference regression: $y_{ist} = \sum_{j=1981}^{2009} \beta_j \times \text{Rural}_{isj} + \delta_t + \mu_s + \alpha_{rc}$, and standard errors are clustered by rural-by-state. The sample includes married women aged 25–69 within the year plotted. Coefficients are estimated relative to 1987, the year before the constitutional amendment announcing the expansion of the rural pension scheme; gray vertical lines represent 1987 and 1991, the year in which the implementation of the expansion was announced. The three outcome variables used to generate the results are indicators of whether an individual worked in agriculture, services, or manufacturing in the given year. Data source: PNAD 1981 though 2009, excluding years in which PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

the BPC: we find that the largest increases in pension payments and labor supply adjustments were between 1991 and 1993, three years before the first BPC payments were made. Further, the difference-in-discontinuity specification in Section 5.2, shows a distinct adjustment in labor supply behavior of married women facing the updated pension eligibility age of 55, but *not* not the BPC age-eligibility thresholds of 67 (from 1991 through 2003) or 65 (after 2003).

Finally, the Brazilian hyperinflation of the 1990s could affect estimates if it differentially affected rural and urban areas throughout this period: inflation peaked twice in the 1990s around 6000 percent, once in January of 1990 and a second time in January of 1994.[15] These inflationary periods, which ended in 1994, do not align perfectly with our policy of interest. Yet, they may affect estimates until 1994 if they had different impacts on rural and urban areas. However, according to Baumann (2002), there was relatively little variation in inequality between urban and rural areas between 1990 and 1997, which includes the inflationary periods, thus alleviating the potential concern. Furthermore, the increase in labor supply persisted far past 1994, even after the hyperinflation ended.

5.2. Regression discontinuities

We next examine whether introducing eligibility for the old-age pension at age 55 influenced the age at which women within a cohort retire. To do so, we use a year-by-year regression discontinuity specification, and estimate the discontinuity in various outcomes at age 55, over time. Fig. 7 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, followed by a panel showing the probability that women worked.

Prior to the reform in 1991, there was a negligible difference in the probability that a married rural woman was working at age 55 versus age 54. However, by 1995, married rural women were four percentage points less likely to work at age 55 than 54, and that difference increased marginally as the years progressed. 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 – for men as well as women, and find no evidence of a discontinuous decrease in labor supply at those ages in any year between 1981 and 2006. These findings suggest that many individuals who had less than the required years of work experience when the expansion was implemented tried to attain the required years by the age of 55. We capture this empirical reality in our theoretical model by assuming that people within a cohort plan to retire at a certain age, which we call the target retirement age. We then allow the target retirement age to change in response to the pension expansion.

6. Changes in labor market participation by cohort

The large increases in married women's overall labor supply at the annual frequency, shown in Fig. 4, were driven by large, steady increases in labor market participation among the cohorts aged 25 to 69 when the pension expansion was implemented in 1991. We explore these increases further in Table 4, by grouping observations into multiple-year bins to estimate the extensive-margin empirical treatment effect for five different cohorts, defined by their age upon the implementation of the pension expansion in 1991. We run an adapted version of Specification (2), setting the years between 1987 and 1990 as the reference period. In this table, extensive-margin estimates of ΔL_{ct} range between seven and nine percentage points for younger cohorts, and rise to 12 to 18 percentage points for older cohorts. While these observed annual increases in labor market participation are largest among the cohort closest to retirement age, we cannot immediately conclude that older married women increased their lifetime labor supply participation by more than their younger counterparts. Younger cohorts knew the parameters of the pension regime that would prevail upon their retirement at the beginning of their careers, but older cohorts had to adjust to a new pension regime in the middle of their careers. As a result, older cohorts had fewer years to accumulate additional years of work before their target retirement age, contributing to annual labor supply

[15] https://www.rateinflation.com/inflation-rate/brazil-historical-inflation-rate/

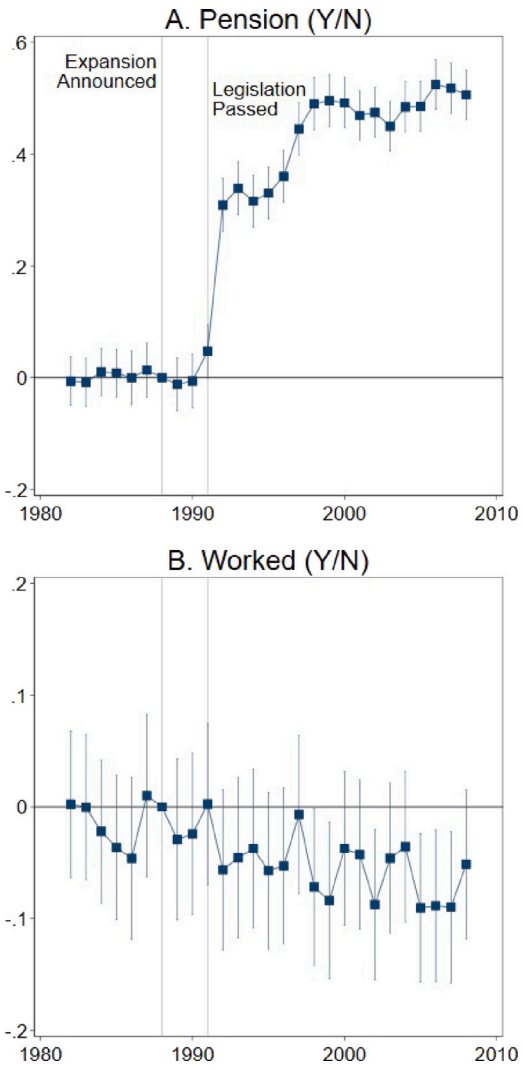

Fig. 7. Year-by-Year Regression Discontinuity at Age 55 among Rural Married Women. *Notes.* These graphs show the point estimates and 95% confidence intervals of the difference in discontinuity at age 55, using a bandwidth of 4 years, between 1981 and 2009. The sample is restricted to married women living in rural areas, and the graph shows a discontinuous decrease in employment that develops at age 55 a few years after the reform and standard errors are clustered by rural-by-state. Data source: PNAD 1981 though 2009, excluding years in which PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000.

adjustments that are larger in magnitude for those closer to retirement eligibility age than those of younger cohorts.[16]

6.1. Bounding lifetime cohort-specific labor supply changes

Fully understanding the impact of the pension on married women's labor market participation requires aggregating cohorts' annual responses into lifetime measures. The final rows of Table 4 present realized adjustments in lifetime labor supply – the average increase in years worked over the lifetime among workers in each cohort.[17]

Table 4
Treatment effect on extensive margin among married women by cohort.

	(1) 25–34 in 1991	(2) 35–44 in 1991	(3) 45–55 in 1991	(4) 55–59 in 1991	(5) 60–69 in 1991
Rural X 1981–1982	−0.01	−0.01	−0.02	−0.02	−0.02
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Rural X 1984–1986	−0.02	−0.02	−0.01	−0.01	0.02**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
Rural X 1992–1995	0.07**	0.08**	0.14**	0.15**	0.16**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Rural X 1997–1999	0.07**	0.10**	0.17**	0.13**	0.12**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Rural X 2001–2003	0.08**	0.13**	0.18**	0.14**	
	(0.02)	(0.02)	(0.02)	(0.02)	
Rural X 2004–2006	0.09**	0.15**	0.17**	0.09**	
	(0.02)	(0.02)	(0.02)	(0.03)	
Rural X 2007–2009	0.09**	0.14**	0.16**		
	(0.02)	(0.03)	(0.03)		
Rural X 2011–2013	0.03*	0.07**	0.09**		
	(0.02)	(0.02)	(0.03)		
Observations	409,976	408,616	236,043	67,923	67,615
R^2	0.030	0.030	0.050	0.041	0.039
Years of Work Required	15	10–15	5–10	5	5
Age in 2013	47–56	57–66	67–76	77–81	82-91
Realized Lifetime adjustments					
Realized years per worker	2.55	2.38	3.39	2.61	2.17
Pct Increase in worker-years	4.34	4.91	6.67	4.91	3.43
Years per person	0.95	1.02	1.32	0.86	0.48
Potential Lifetime adjustments (years per person)					
Upper bound, $\tilde{a}_R = 70$	3.33	4.38	3.60	1.86	0.86
When $\tilde{a}_R$ = discontinuity	2.13	2.31	1.43	0.76	0.80

Notes. Standard errors, clustered by rural-by-state, in parentheses. Table shows β_j coefficients from the regression: $y_{it} = \alpha \text{Rural}_r + \sum_{j=1}^{5} \beta_j \text{YearCat}_j \times \text{Rural}_r + \delta_t + \mu_s + \alpha_{rc}$, where YearCat_j groups observations into five-year bins, with the years 1987–1990 serving as the reference period. Regression is run for five different cohorts, defined by their age upon implementation of the pension expansion in 1991. The realized change in lifetime work is calculated by aggregating treatment effects across the population from 1992 through 2013. Per worker and per person estimates are calculated by dividing aggregate estimates by the number of workers or size of population within cohort in 1991. Potential lifetime adjustments are calculated as described in Section 6.1. Data source: PNAD 1981 though 2009, excluding years in which PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000.

* $p < .10$.

** $p < .05$.

Women who were between the ages of 25 and 34 in 1991, for example, increased their lifetime labor supply by an average of 0.95 years per person by 2013, while women who were between the ages of 45 and 55 increased their lifetime labor supply by an average of 1.32 years per person by 2013. Realized lifetime increases are then noticeably smaller for cohorts who were older than eligibility age upon implementation, falling to an average of 0.86 years per person for those between 55 and 59 in 1991, and of 0.48 years per person for those between 60 and 69 in 1991.

These realized lifetime increases are complete for older cohorts that have fully retired, but younger cohorts may not have completed their working lives by 2013. We next conduct a bounding exercise, motivated by two implications of Eq. (1), to provide a range for the lifetime adjustments in labor supply for each cohort. First, all annual adjustments for which the individual is older than the target retirement age, $a_{cj} > \tilde{a}_R$, are weakly negative among cohorts with a dominant eligibility effect. Second, annual labor supply adjustments are similar

[16] See Eq. (1) for theoretical prediction: annual labor supply response is scaled by $\frac{1}{\tilde{a}_R - a_{cj}}$, where a_{cj} is the age of cohort c upon pension expansion and $\tilde{a}_R$ is the cohort's retirement age.

[17] We calculate the realized changes in lifetime work (Table 4). First, we use the cohort-specific coefficient estimates to calculate the additional years worked by all married women in the given age, between 1991 and 2012. "Realized years per worker" is calculated by dividing this by the number of workers in that cohort in 1991, while "Years per person" is calculated by dividing the aggregate number of additional years worked by the cohort size in 1991.

in magnitude prior to the adjusted target retirement age.[18] An upper bound on lifetime labor supply is then the sum of all annual increases in labor supply, realized or projected at a steady magnitude, prior to the cohort's adjusted target retirement age. Suppose, for example, that all cohorts adjust their target retirement age to 70, which is the required retirement age for urban workers, following the expansion. The penultimate row of Table 4 presents the implied upper bounds on lifetime adjustments for each cohort by aggregating the annual estimates of labor market participation adjustments from their age at implementation to age 70.

Alternatively, the difference-in-discontinuities exercise in Section 5.2 can inform assumptions on cohorts' adjusted retirement age. Echoing the discontinuity in labor force participation that developed among cohorts turning 55 in 1998 and later, we assume that the target retirement age ($\tilde{a}_R$ in our model) fell to 55 for cohorts that were 48 and younger in 1991. The target retirement age of older cohorts, however, was potentially limited by the design of the work requirement: women who were 55 in 1991, for example, were required to work for at least 5 years to achieve pension eligibility. Any 'new market entrant,' as Fig. 3 defines, in that cohort would not be able to retire with pension access until age 60. For these older cohorts, we assume a target retirement age equal to the youngest possible age at which an individual in the cohort could retire and receive the lifetime pension, had they not worked at all prior to the pension expansion.[19] Finally, we assume steady annual increases among each cohort between pension implementation and target retirement age, equal to the highest cohort-level annual increase in Table 4. The final rows of that table present the estimates of potential lifetime adjustments calculated under these assumptions for five cohorts of interest.

The increase in labor market participation for cohorts aged 25–34 and 35–44 in 1991, for example, is bounded above by 3.33 and 4.38 years per person, respectively, if all workers within the cohort work until age 70. However, if workers in those cohorts retire as soon as they are age-eligible, the lifetime increase in labor market participation is projected to be 2.13 and 2.31 years per person. The increase in labor market participation for the cohort just below eligibility age upon pension implementation, age 45–55 in 1991, is bounded above by 3.60 years per person but estimated at 1.43 years per person when each member of the cohort retires as soon as a new market entrant would become age-eligible. We also calculate the upper bounds on the lifetime increase in labor market participation for cohorts who were older than the eligibility age in 1991. The upper bounds for married women in these cohorts are 1.86 years per worker for women who were 55–59 in 1991, and 0.86 years per person for women who were 60–69 in 1991.

6.2. What theoretical mechanisms could be driving these differences in response across cohorts?

The observed pattern of lifetime increases in labor force participation across the three youngest cohorts suggests that young women of working age upon implementation of the expansion increased their lifetime labor supply participation by less than their older counterparts, who were also of working age upon implementation, but nearer to the new pension eligibility age. The conceptual framework presented in Section 4.1 suggests two potential mechanisms underlying this empirical pattern. First, the distribution of α among younger cohorts may have been skewed further to the left than that of older cohorts. This would be consistent with changing societal norms or preferences by which younger women place less value in home-produced relative to market-produced goods. In this case, there would be fewer new market entrants and up-compliers (people with a dominant eligibility effect), and more down-compliers and market workers (people with a dominant wealth effect), among younger cohorts than among their older counterparts.

Alternatively, the graduated work requirement – a key aspect of the policy design – could be driving these differences in lifetime labor market participation responses across cohorts of working age upon pension implementation, even when the distribution of α is constant across cohorts. The 15-year work requirement, referred to as $\tilde{L}_c$ in Section 4, was phased in gradually across cohorts; women who were age-eligible in 1991 were required to produce evidence of only five years of rural work, while those who became age-eligible in 2011 and later were required to produce evidence of 15 years of work to access the pension. Our model predicts that a shorter work requirement creates more lifetime years of work among populations with high home productivity, because it brings more people into the labor force – even if some in the labor force work for fewer years than they would have under a longer work requirement.

Fig. 8 illustrates this theoretical result by comparing the impact on the lifetime labor supply of the pension expansion with a 15-year work requirement (Panel A) to that of a pension expansion with a five-year work requirement (Panel B), analogous to comparing the impact of the policy parameters facing the younger cohorts versus those facing the older cohorts. The five-year work requirement has a dominant negative wealth effect for a broader range of home productivity than the 15-year work requirement ($\alpha_2' > \alpha_2$). However, the five-year work requirement also brings more people with higher levels of home productivity into the labor force than does the 15-year requirement ($\alpha_3' > \alpha_3$). If cultural or norm-based preferences meant that the distribution of home productivity among married women in rural Brazil was skewed right, with high density between α_3 and α_3' in Fig. 8, the design of the 1991 phase-in could have led to larger increases in lifetime labor supply among older cohorts with lower work requirements than their younger counterparts with higher work requirements.

Though the lack of reliable data that tracks individuals' informal work history in rural Brazil prevents us from precisely estimating the distribution of α among rural women, the available data indicate a distribution that is skewed right. We find little evidence of a shift in preference distribution when we calculate changes in lifetime labor market participation among younger cohorts with the same work requirement.[20] Large increases in extensive-margin lifetime labor supply among all cohorts imply that the increase in labor supply among up-compliers is larger than the decrease in labor supply among down compliers and market workers. Many married women are at the cusp of labor market participation prior to pension expansion, and are willing to spend a small number of years in the labor force in exchange for a lifetime pension.

7. Part-time work and gender differences in labor supply adjustments

The observed increase in labor market participation was accompanied by a dramatic decline in the length of rural women's working week. Figs. 9 and 10, which further explore intensive-margin adjustments, suggest that this decline is driven by new market entrants working part-time, rather than existing market workers decreasing their working hours. Fig. 9 presents the coefficients that result from running

[18] People re-allocate their labor from later in life to before their new target retirement age. Alternate bounding exercises based on different assumptions of target retirement age are provided in Appendix C.

[19] See Appendix C for details on the graduated work requirement, assumed target retirement ages by cohort, and a detailed description of the bounding exercise.

[20] Appendix C calculates lifetime labor supply in smaller increments among cohorts with the same work requirement, and finds similar adjustments across these cohorts. Since adjustments are similar across cohorts with the same work requirement, who may have different preferences, it is likely the difference in work requirement across other groups of cohorts that drives cohort-level participation patterns.

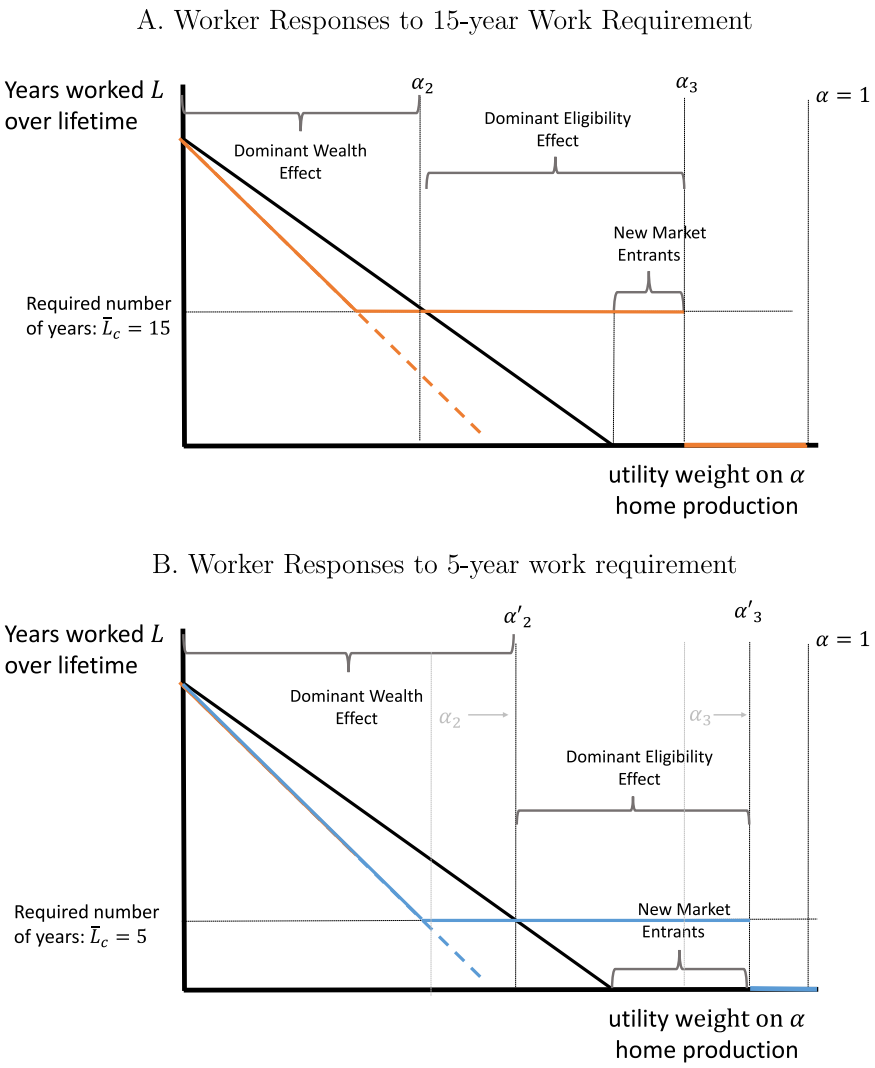

Fig. 8. Heterogeneous Lifetime Labor Supply Responses to Pension Expansion with Different Work Requirements

Notes. This figure shows the optimal number of years worked over an individual's lifetime, for heterogeneous home productivity ranging from $\alpha_i \in (0, 1)$. The black line shows optimal years worked without a pension expansion. The dotted lines show optimal years worked under an expansion with no work requirement. The solid orange and blue lines describe optimal years worked under expansions with various work requirements. Figure A describes the labor supply response to a pension expansion with a 15-year work requirement. People with $\alpha_i < \alpha_2$ experience a dominant wealth effect and decrease their lifetime labor supply as a result of the expansion. People with $\alpha_i \in (\alpha_2, \alpha_3)$ experience a dominant eligibility effect and increase their lifetime labor supply as a result of the expansion. Figure B describes the labor supply response to a pension with a five-year work requirement. Under a five-year work requirement, the wealth effect dominates for a wider range of α, with $\alpha'_2 > \alpha_2$, than under a 15-year work requirement. However, the eligibility effect induced by a 5-year work requirement also brings more people into the labor force than does the 15-year work requirement, with $\alpha'_3 > \alpha_3$. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Specification (2) on three indicators of intensive-margin labor supply: an indicator of part-time work (1–29 weekly hours), full-time work (30–44 weekly hours), and overtime work (45+ weekly hours). The increase in part-time work closely mirrors the increase in labor market participation throughout the early 2000s, while full and over-time work remain largely unchanged. Fig. 10, using descriptive evidence, sheds further light on these findings by decomposing the group of part-time workers into those who work between one and 19 h and those who work between 20 and 29 h. It then compares the fraction of rural workers in each group before and after the reform. The increase in rural part-time work in Fig. 10A is concentrated among married women working less than 20 h per week.

When viewed through the lens of the conceptual framework in Section 4, these intensive-margin adjustments in labor supply can shed light on the dominant "types" of worker responses to the pension expansion, and the distribution of utility weight people place on home relative to market production. A model extension that allows workers to choose between four work-week lengths – low-hour part-time, high-hour part-time, full-time, and overtime – shows that marginal workers who are driven to enter the labor force in response to a dominant eligibility effect ("new entrants") will work the minimum number of hours necessary to document rural work. Market workers and down-compliers who decrease their labor supply in response to a dominant wealth effect will transition from overtime to full-time work, or from full to high-hour part-time jobs.[21] In Fig. 10A, over half of the increase in rural women's part-time work is due to an increase in low-hour part-time jobs. This, in combination with minimal adjustments in full and over-time employment, is evidence of a strong eligibility effect influencing rural married women, and a right-skewed distribution of utility of home relative to market production.

[21] Appendix A.3 adapts the model from Section 4 to include a discrete choice of working time and shows that compliers are more likely to choose to work part-time. An alternative way to understand intensive-margin adjustments in the theoretical framework is to interpret L as number of hours worked per year; this indicates that down-compliers will work longer (potentially part-time) days than up-compliers.

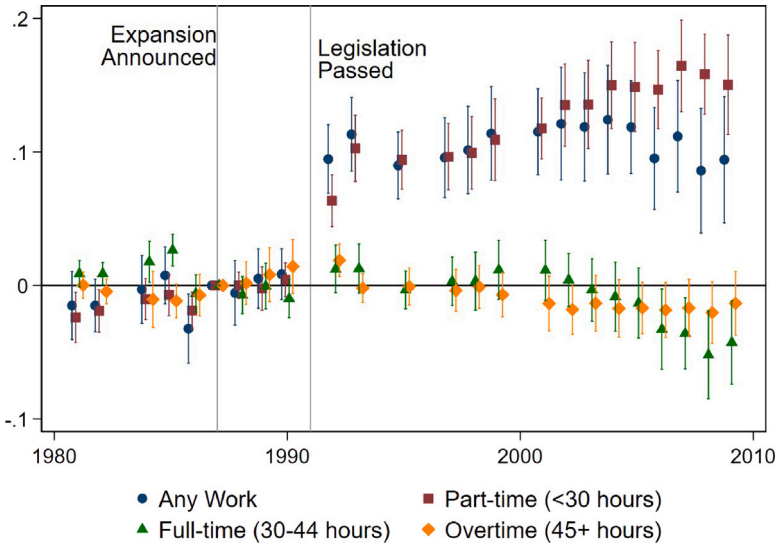

Fig. 9. Adjustments in Working Hours Among Women, 25–69
Notes. Each panel shows the β coefficient estimates and 95% confidence intervals on each year from an extended difference-in-difference regression of the form $y_{ist} = \sum_{j=1981}^{2009} \beta_j \times \text{Rural}_{is} + \delta_t + \mu_s + \alpha_{rc}$, and standard errors are clustered by rural-by-state. The sample includes married women aged 25–69 within the year plotted. Coefficients are estimated relative to 1987, the year before the constitutional amendment announcing the expansion of the rural pension scheme; gray lines represent 1987 and 1991, the year in which the details of the expansion were announced and implemented. The four outcome variables used to generate the results are indicators of whether an individual worked at all within the reference week, between 1 and 29 weekly hours, between 30 and 44 weekly hours, and 45 or more weekly hours. Data source: PNAD 1981 though 2009, excluding years in which PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

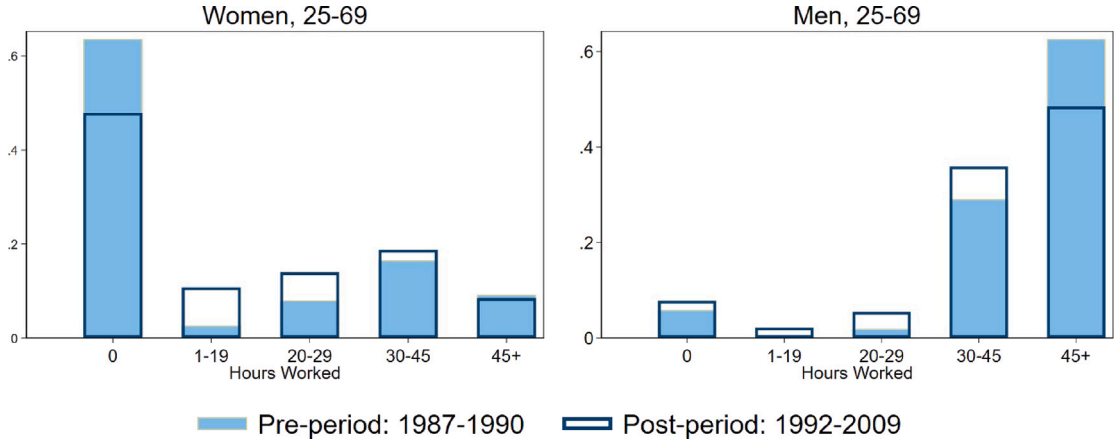

Fig. 10. Adjustments in the Workweek Among Rural Women and Men.
Notes. Figure shows the distribution of full- and part-time work among rural women and men of working age before and after implementation of the expansion. The population age 25–69 is separated into one of four categories based on hours worked per week: no work (0 h), low-hour part time work (1–19 h), high-hour part-time work (20–29 h), full-time work (40–44 h), and over-time work (45+). Data source: PNAD 1981 though 2009, excluding years in which PNAD was not conducted: 1983, 1991, 1994, 1996, and 2000.

These patterns are particularly pronounced when compared to the hourly labor market adjustments of rural men following the reform. While our focus has been on married women, one might also expect such a large expansion in pension benefits to influence the labor market behavior of married men. The expansion was not explicitly limited by gender, yet the economic and cultural context in which the reform was implemented implied that it had substantially different impacts on the labor supply of men and women. Men, who tended to be household heads expecting to receive the rural retirement pension prior to the reform, experienced an increase in pension wealth as a result of the reform due to the lower eligibility age and increased magnitude of pension benefits. However, they also tended to work more, prior to the reform, than the minimum number of years required to earn rural retirement benefits under the new regime. As a result, their wealth effect from the reform was smaller, and eligibility effect less likely to be binding. The labor-supply adjustment among men, shown in Fig. 10B, shows strong evidence of left-skewed distribution and a negative wealth effect: substantially fewer men work more than 45 h a week following the reform, with that decline corresponding to increases throughout the lower end of the hours distribution.[22]

[22] These findings are consistent with de Carvalho Filho (2008), who studies the impact of this pension expansion on the labor supply behavior of newly age-eligible rural men. That paper shows that newly age-eligible rural men, 60–64 in 1991, decreased their labor market participation by 11 p.p., and reduced total hours worked by 6.5, between 1990 and 1992. Its focus on the short-term response of newly age-eligible men abstracts from the broader lifetime adjustments in labor supply treated within this paper. We discuss differences in methods and results across the two papers in detail in Appendix D.2.

8. Conclusion

Middle-income countries, like Brazil, often have low female labor force participation. Cultural, norm-based, and market-based frictions that restrict access to the economy for half the population hinder unleashing its potential for growth and future development. Policies that, with or without intent, expand female labor force participation at such an enormous rate are rare. We document a substantial increase in rural women's labor-market participation in response to their inclusion in the retirement regime. Our results suggest that the retirement reform played an important role in equalizing market forces for women and men.

This paper sheds light on the willingness and ability of workers to react to retirement incentives in a forward-looking manner. The results regarding the immediately age-eligible cohort indicate that elderly workers have the ability to increase their labor supply 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. Consistent with Becerra (2023), who shows that expansions in the generosity of formal pensions in Chile brought workers as young as 30 into the formal labor market, this paper shows that women of all ages who had previously chosen to stay out of the Brazilian rural labor market are willing to enter when the associated pension benefit is large enough.

The magnitude of the labor-supply response we document is large, but so too is the incentive. With 80 percent of rural workers earning less than half of the minimum wage and elderly pensions equal to the minimum wage, annual income may more than double when a rural worker begins to claim an elderly pension (Beltrão et al., 2004). Some simple assumptions allow us to estimate a labor supply elasticity with respect to lifetime wealth: suppose a person works in the rural sector at the minimum wage for forty years and collects an old-age pension throughout fifteen years of retirement. This pension benefit would increase lifetime wealth by around 37 percent. A ten p.p. increase in labor supply implies an elasticity of 0.26 with respect to lifetime wealth. This implied elasticity is comparable to that found among urban Brazilian mothers receiving a child-care benefit, studied in Attanasio et al. (2022), or among European workers adjusting to statutory increases in the early or normal retirement age (Staubli and Zweimüller, 2013; Rabaté and Rochut, 2020; Rabaté et al., 2024; De Vos et al., 2018).

The entrance of such a large number of women into the rural labor market would have had transformative effects, including better outcomes for women and the aggregate economy (Goldin, 1995; Dinkelman and Ngai, 2021; Blau and Kahn, 2013; Anderson and Eswaran, 2008). While the rural workforce remained largely informal, its composition changed dramatically. Many newly age-eligible men left the labor force, while married women of all ages entered to take their place. This lead to an initial surge in total hours worked by married women. In the long-run, however, there was little change in overall labor hours supplied by married women, but that labor was spread among more women working shorter days. The fiscal implications of these adjustments are long-lasting: the increase in benefit amount and coverage would have generated an immediate increase in social security expenditure, and the responsiveness of married women in entering the rural labor market would have increased it yet further. Social Security revenue, however, would have been minimally affected; as these rural workers were not required to contribute to social security, any increase in revenue would have come from the point-of-sale tax imposed on agricultural producers. Indeed, budgetary implications of the 1988 reform have been widely explored, including in de Oliveira and Beltrão (2000).

Our study looks at the impact of this reform on work by married women living in rural areas. It would be interesting to further explore the interplay between working outside the household, marriage decisions, and time spent with children. For instance, households may have been more likely to hire domestic workers as women substituted paid work for domestic work. Expansions of rural pensions in other countries have influenced, 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 labor supply responses to retirement policies. Reforms to retirement pensions often inspire analysis of associated labor supply declines among eligible cohorts. However, this paper shows that an expansion of benefits can, under some circumstances, *increase* labor supply if qualifications are properly managed.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jpubeco.2025.105352.

Data availability

Data will be made available on request.

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