

Pensions and Fertility: Micro-Economic Evidence

By ALEXANDER M. DANZER AND LENNARD ZYSKA*

This study identifies the causal effect of pension generosity on women's fertility behavior. It capitalizes on Brazil's expansion of the pension system to rural workers, whose pension wealth subsequently more than tripled. Difference-in-differences, instrumental variable and event study methods show that the pension reform reduces the propensity of childbearing of women in fertile age by 8% in the short-run. Completed fertility declines by 1.3 children within 20 years after the reform, reducing the contribution base of the Pay-As-You-Go pension system in the long-run. The fertility response is strongest at higher birth parities, among older women and among mothers with sons.

JEL: J13, I38, H55, D15

Keywords: Pension wealth, Fertility, Old-age security hypothesis, Quasi-experiment, PAYG, Brazil

During the history of mankind, children have been natural candidates to provide old-age support for their parents. While such informal intra-family transfers have been replaced by formal pension schemes in industrialized economies, many developing and emerging economies still face the challenge of expanding coverage and generosity. Yet, how does the introduction and enhancement of public pension systems affect demography? In theoretical work, the introduction of formal old-age pensions has been associated with declining fertility rates—a link that can be rationalized by the old-age security hypothesis of fertility. Macro data seem to support the postulated trade-off between old-age pensions and the number of children per woman. Yet, there is almost no micro-economic evidence on the causal behavioral fertility responses to the introduction or expansion of pension systems.

This paper provides comprehensive and rigorous evidence on the effect of introducing old-age pensions on the fertility behavior of women. We test whether

* Danzer: Catholic University of Eichstätt-Ingolstadt, Auf der Schanz 49, 85049 Ingolstadt, Germany, CESifo and IZA (e-mail: alexander.danzer@ku.de). Zyska: Catholic University of Eichstätt-Ingolstadt, Auf der Schanz 49, 85049 Ingolstadt, Germany (e-mail: lennard.zyska@ku.de). The authors are grateful for valuable comments and suggestions by the editor Dan Silverman, three anonymous referees, Otávio Bartalotti, Vojtěch Bartoš, Michele Battisti, Stefan Bauernschuster, Natalia Danzer, Cormac O'Dea, Philipp Dörrenberg, Vincenzo Galasso, Aixa García-Ramos, Ulrich Glogowsky, Arnt O. Hopland, Steffen Juranek, Wojciech Kopczuk, Dominika Langenmayr, Jann Lay, Hani Mansour, Luca D. Oromolla, Helmut Rainer, Dominik Sachs, Dirk Schindler, Guido Schwerdt, Joachim Winter, Edward N. Wolff, and Floris Zoutman as well as seminar and conference participants in Bath, Kochel am See, Freiburg, Cologne, Tampere, Bergen, Bamberg and Ingolstadt. We are also thankful to Data Zoom, developed by the Department of Economics at PUC-Rio, for providing the codes for accessing IBGE PNAD-data. Zyska worked on this project while visiting NHH Bergen and NYU; he gratefully acknowledges their hospitality as well as funding through the Bavarian Graduate Program in Economics.

women in fertile age—who face an unanticipated, exogenous and substantial increase in public pension wealth—reduce their number of offsprings that might have otherwise served as informal old-age providers within the family. Our study is based on a quasi-experiment in Brazil, where pension eligibility rules, coverage and benefit levels were completely equalized between urban and rural occupation workers in 1991. Rural sector workers became suddenly eligible for generous and de-facto noncontributory publicly provided old-age pensions—especially rural women, who had effectively been barred from the pension system.

Our first contribution is the careful identification of the causal effect of expanding old-age pensions on the fertility of women aged 15-44 using a large nationally representative data set spanning the period 1981 to 2014.¹ Our analysis is based on a difference-in-differences (DID) framework for the short-run assessment. Therefore, we exploit variation over time (pre vs. post reform) as well as variation across groups: female rural workers were strongly affected by the pension reform (treatment group), while their urban counterparts experienced almost no increase in pension wealth (control group). We complement this analysis with an instrumental variable (IV) approach to estimate the semi-elasticity of fertility with respect to pension wealth and an event study (ES) approach for the long-run. A comprehensive assessment of alternative explanations and potential confounders, such as macroeconomic stabilizations or changes in education, child mortality, culture, etc., bolsters our identifying assumptions.

As a second contribution, we study the heterogeneity of fertility responses with respect to women's age as well as the number and gender of previously born children. We expect older women, i.e., those towards the end of their fertility cycle, to respond stronger to the pension reform for five theoretical reasons: (1) they have on average older children, whose survival and, hence, ability to provide old-age support are more likely; (2) they therefore also tend to have better information about the ability of their children as future care-takers; (3) they are closer to the saturation level of fertility, prompting a more immediate fertility response; (4) they gain more in terms of pension wealth given the shorter discounting period; and (5) they are more aware and care more about reforms that will become relevant in the relatively near future. Consequently, fertility effects should be most strongly felt at higher birth parities. Regarding the sex of previously born children, we expect that women who already have a son in the family respond differently from women who have only daughters because of Brazil's inheritance tradition favoring sons.

We find that the rise in pension wealth has a disincentive effect on women's childbearing probability in the short-run, subsequently reducing the total number of births in the long-run. Our estimates show, first, that the annualized probability of childbirth falls by about 0.9 percentage points briefly after the reform,

¹Empirical studies have analyzed the effect of similar pension policies in Brazil, South Africa and Ukraine on labor supply decisions or the nutritional status of children (Duflo, 2003; De Carvalho Filho, 2008; Danzer, 2013).

corresponding to a 8% decrease. The entire effect of the pension reform is concentrated among women in the middle and late phases of their fertility cycle (aged 30-44) whose childbearing probability declines by about 2.4 percentage points (a 24% decrease); the results for women aged 15-29 are insignificant. The fertility response is strongest at higher birth parities and among mothers with sons. Second, the pension reform reduced completed fertility at age 45 by on average 1.3 children within the first 20 years after its implementation. A simple back-of-the-envelope calculation illustrates how these fertility responses can erode the contribution base of a PAYG system and, hence, introduce a structural deficit.

Historically, fertility declined at about the time when many high- and middle-income countries introduced or expanded their social security systems (Ehrlich and Kim, 2007; Schwarz, 2014; Galasso and Profeta, 2018). Although economic theory suggests that public old-age pensions affect individual's reproductive behavior and are a contributing cause to the fertility decline observed in modern economies, testing this link and estimating its size and significance has proven difficult, particularly at the micro-level. Most existing studies provide evidence based on theoretical OLG models; these studies use cross-country variation in aggregated time-series data to estimate the correlation between governmental public pension spending (or coverage rates) and various fertility measures (Hohm, 1975; Ehrlich and Zhong, 1998; Ehrlich and Kim, 2007; Boldrin, De Nardi and Jones, 2015). Other studies estimate the correlation between the generosity of public pension spending and fertility rates for single countries (e.g. Swidler (1983) for the US; Cigno and Rosati (1996) for Germany, Italy, the UK, and the US; Fenge and Scheubel (2017) for Germany). These papers suggest that the generosity of public old-age pensions and fertility (or population growth) are negatively correlated. Quasi-experiments are rare: Biliary and Galasso (2009) use survey data on two quasi-experimental policy changes in Italy in 1992 and 1995 and compare households with worsening pension outlook and those unaffected by the reform. Their results suggest that less generous pensions increase fertility, even in industrialized economies. Surprisingly, there is little evidence on the link between old-age pensions on fertility in low- and middle-income countries where the trade-off should be especially pronounced given the reliance on informal intra-family arrangements for old-age provision. An exception is Nugent and Gillaspay (1983) who use Mexican census data and estimate a negative correlation between changes in the child-to-women ratio and the population share covered by social security at the *municipio* (county) level between 1960 and 1970.

The remainder of this paper is as follows. Section 2 discusses the theoretical background. Section 3 provides details on the Brazilian pension system and the reform of 1991 which we exploit as quasi-experiment. Section 4 describes the data of our empirical analysis, Section 5 the identification strategy. Section 6 presents the results. Section 7 discusses several robustness exercises. Section 8 concludes.

I. Theoretical Background

In caring about their economic well-being at old-age, individuals can secure sufficient and reliable provision through savings, a functioning pension system or transfers from children (Galasso, Gatti and Profeta, 2009). The so-called old-age security hypothesis of fertility (Leibenstein, 1957) implicitly posits the trade-off between children and other forms of pension savings: it postulates that parents not only procreate for the joy of parenthood (as proposed by Becker, Murphy and Tamura, 1990)² but also to secure economic support from their offsprings at old-age.³ In developing countries, widespread poverty and a lack of savings instruments imply that parents need to rely on fertility or on the public pension system (Leibenstein, 1957, 1975; Nugent, 1985). Accordingly, missing or incomplete pension institutions are associated with higher fertility rates (Boldrin and Jones, 2002; Galasso, Gatti and Profeta, 2009; Boldrin, De Nardi and Jones, 2015). The introduction of formal pension systems will, all else equal, exogenously increase the expected old-age pension wealth of individuals. This will in turn lower the need to rely on informal intra-family contracts for old-age provision and, hence, reduce fertility in the long-run. Theoretical considerations suggest, however, that the immediacy and magnitude of this fertility response differ along three dimensions: the age of the woman as well as the number and the gender of previously born children.

A. Age of the Woman

One crucial determinant of the response is the age of the woman, reflecting different phases of her fertility cycle.

First, there is a positive relationship between a woman's age and the precision with which she can target her desired fertility level downwards. At the time of the exogenous pension reform older women tend to have on average more and older children than younger women. Since child mortality is most prevalent in the first five years after birth, older women face lower risks to their children's survival (*survival effect*).

Second, older parents tend to have older children and, hence, a richer set of information about their physical, mental and health constitution. They know their children's gender, ability, and attitudes. For these reasons, older women are less likely to hoard children, which lowers overall fertility (*information effect*).

²If children were exclusively born out of 'joy of parenthood', the increase in public pensions would reduce the need to save for consumption in late adulthood. This would allow more consumption dedicated to children and potentially increase fertility. This theoretical possibility, however, does not seem suitable for rural Brazil, where the coverage with savings instruments was disproportionately low and poverty widespread (Kumar, 2005).

³Empirical tests of the old-age security motive can be found in Neher (1971); Hohm (1975); Cain (1981); Jensen (1990); Hoddinott (1992); Cai, Giles and Meng (2006) and Oliveira (2016). Indirect evidence shows that public transfers crowd out private transfers (Jensen, 2004; Amuedo-Dorantes and Juarez, 2015).

Third, an immediate fertility response will be expected among women who have already achieved or are close to achieving their desired lower fertility (given the new pension wealth level), i.e., among those in the middle or late phase of their fertility cycle. Moreover, since conception cannot be perfectly controlled, older women have a shorter remaining at-risk period, which will reduce the expected number of undesired pregnancies and, hence, increase the certainty about the number of children (*saturation effect*).

Fourth, the fertility response depends on the magnitude of the pension wealth effect, i.e., how strongly the present value of future old-age pension benefits changes as a consequence of the reform. A stronger wealth increase is expected to decrease fertility more strongly. Since older women are closer to retirement age, they discount future benefit streams over shorter periods of time, leading to an overall larger pension wealth (*pension wealth effect*).

Fifth, behavioral responses to the pension reform are more likely when its consequences are more salient which can be expected for individuals closer to retirement age (*salience effect*).

Taken together, the survival, information, saturation, pension wealth and salience effects suggest that older women respond stronger to an increase in the generosity of the pension system in the short-run. Lower numbers of children, higher levels of uncertainty and a lower increase in pension wealth suggest that younger women continue having children until they have their (downwardly revised) desired number of children. In essence, a pension reform would reduce the fertility of younger women less than of older women in the short-run. As another theoretical possibility, young women may postpone having more children, reducing fertility in the short-run. In the long-run younger women can respond stronger, as they have more scope for adjusting to their new desired level of fertility.

To test these theoretical predictions empirically, our analysis differentiates between short- and long-run outcomes (annual childbearing probabilities vs. completed fertility at age 45) as well as between younger and older women (aged 15-29 and 30-44).

B. Number of Previously Born Children

A woman's probability of childbearing tends to be negatively correlated with the number of previously born children, i.e., with birth parity. As a direct implication of the age-specific fertility responses, women will reduce higher birth parities if the pension reform affected all women similarly. Introducing a full coverage pension scheme with a *de facto* flat pension for rural workers will cut the overall number of children rural women have. Given that most women in Brazil desire at least two children (according to DHS data), we do not expect negative effects on the first or second child but on higher parities.

C. Gender of Previously Born Children

Women might react differently to the pension reform depending on whether they have already given birth to a son or not. Such gender-sensitive behavior could be explained by cultural norms or inheritance traditions favoring sons. Our ideas are based on the assumption that children of both sexes bring their parents utility and insurance; this is also backed up empirically for Brazil using inter-household transfer data (Saad, 1998). Parents will have children as long as the marginal utility exceeds the marginal cost of an additional child. Nevertheless, based on the tradition that land is almost exclusively inherited to sons in Brazil (Deere and León, 2001), we assume that the first son brings a fixed utility premium to the parents. With declining family sizes, this implicit boy preference becomes more apparent as the chances of remaining without son increase. While there is no indication for gender-related abortions in Brazil (Chiavegatto Filho and Kawachi, 2013), prior evidence suggests that women who have initially given birth to girls are more likely to have additional children in the hope to conceive a boy (Reynolds, 2018); these women are also less likely to use contraception (Arnold, 1992). The presence of a son seems especially important for inheriting land: While inheritance laws are relatively gender-neutral in Brazil, land is nevertheless typically passed to a son.⁴ In consequence, only 11% of land in Brazil is owned by women (Deere and León, 2003). Hence, we expect that women with sons reduce childbearing stronger than women without sons.

II. Fertility and the Policy Reform in Brazil

A. Fertility Trends

Brazil has experienced sharply falling fertility since the middle of the 20th century. The decline started in the 1940s in more affluent urban areas and in the 1970s more broadly. Possible explanations are changes in the demand for fertility (owing to educational reforms or small-family norms evolving from the mass media) and in the supply of family planning services (owing to health care reforms and access to contraception), or changes in nuptial or residential patterns (Martine, 1996; Rios-Neto, Miranda-Ribeiro and Miranda-Ribeiro, 2018). Most of the expansion in urbanization, health care, education, marriage, and telenovelas took place between the 1960s and early 1980s (Martine, 1996; Caetano and Potter, 2004; La Ferrara, Chong and Duryea, 2012). Starting in the 1990s, demographers observe a fertility stopping behavior among older women with sterilization; fertility becomes concentrated among women under 25 years of age with rising rates

⁴While women and men have the same rights to land ownership in principle, the Brazilian agrarian law has not been codified. This gives great weight to cultural norms and traditions (Barsted, 2005). Traditional inheritance practices, lack of documentation or family farming policies impede land ownership for Brazilian women; for simplicity or tradition, land is most often exclusively registered under the name of the family head: regularly the male partner (Onsrud, Paixao and Nichols, 2006).

of teen pregnancies (Rios-Neto, Miranda-Ribeiro and Miranda-Ribeiro, 2018). In this environment of declining fertility, Brazil implemented a comprehensive pension reform.

B. The Pension Reform

Before the 1970s, only formally employed urban workers were entitled to old-age pensions in fragmented occupation specific programs. With the Assistance to the Rural Worker Program (FUNRURAL) in 1971, the first pension scheme for formally employed rural workers was established; however, since 95% of rural workers have no formal job (PNAD data) it left the vast group of informal or self-employed rural workers effectively uncovered.

The first free elections in 1985 marked the end of the military rule in Brazil and paved the way for the Constitution of the Federative Republic of Brazil, approved in October 1988. Unlike in most other countries, the Brazilian public social security system (including pensions) was enshrined in the Constitution, making the pension system hard to modify or even abolish.⁵ Accordingly, no significant reforms were undertaken until the early 2000s (Hunter and Sugiyama, 2009).

The Brazilian pension system enrolls citizens according to the occupations recorded in their official work history (Carteira de Trabalho e Previdência). With the codification into law, the coverage of pensions was universalized such that rural workers got—for the first time in Brazilian history—access to pension benefits (see Figure A1 for pension scheme affiliations after the reform).⁶ As benefits were equalized for eligible individuals, the reform had a particularly strong impact on the rural population, especially women. The implementation of the pension reform started with its lawful approval in July 1991. Potential anticipation effects, e.g., that individuals foresee the reform and adjust their behavior accordingly, are weak owing to considerable information deficits about the specific design of the new pension system before its implementation in 1991. The political struggle between a leftist National Constitutional Assembly and a conservative govern-

⁵The constitutional reform with respect to social protection also affected the rules governing health care and maternity leave. While constitutionally enshrined, actual health reforms (most notably, the Saude da Familia program) were implemented only a decade after the pension reform (Caetano and Potter, 2004; Ministério da Saúde, 2008; Rocha and Soares, 2010). The value of maternity leave benefits is negligible compared to old-age pensions. Moreover, benefits such as paid maternity leave reduce the relative costs of children and would consequently increase fertility.

⁶Rural workers are enrolled in the rural pension scheme. Formally, an extremely soft documentation requirement (confirmation of work) was still in place to confirm any kind of past agricultural activity: Agricultural and fishing associations, unions, government agencies, and even the church were entitled to confirm work in agriculture, under sharecropping/tenancy contracts, as co-owner of land, or as worker in small scale mining. Anecdotal evidence suggests that destitute elderly were granted proof of agricultural work even if they lacked birth certificates or other proof of age. Urban workers who never worked formally throughout their career also became eligible for a social assistance pension (the BPC). Since urban workers have traditionally moved between formal and informal jobs (Bosch, Goni and Maloney, 2007), most urban workers continued to be eligible for the urban pension. The BPC has only 500,000 old-age claimants (Schwarzer and Querino, 2002). Accordingly, we do not find any differential fertility response between urban formal and urban informal workers (Table A1).

ment that tried to block the implementation of the envisaged reforms introduced reform uncertainty. The exact design features remained undefined in the constitution and unspecific until before the political implementation (Barrientos, 2013). According to qualitative evidence, rural workers remained uninformed about the proposed changes (Lui Gallassi, 2012). Most Brazilians learned about the actual implications of the pension reform by observing pension payments for the elderly within their family (Lui Gallassi, 2012). Against this background, young individuals were unable to anticipate the reform.

The benefit rules and provisions of the Brazilian pension scheme before and after the reform and the different pension formulae (old-age, lengths-of-service, disability) after the reform are illustrated in Table 1.

Before the reform, rural workers had to document formal employment to receive a pension; but no more than 2-6% of rural women were legally employed in the 1980s, according to official statistics (PNAD data; Neri (2002)). Even among the formally employed, at most one household member was eligible for old-age pensions, mostly the husband. Informal rural workers were effectively barred from the pension system.

For urban workers, the reform left the eligibility rules (e.g., qualifying age thresholds) and the benefit calculation almost unchanged; only the minimum benefit level increased from 90% to 100% of the minimum wage. Quite differently, the pension reform expanded coverage and pension benefits dramatically for rural workers. Irrespective of being able to prove formal employment or having made any social security contributions, they became eligible for old-age retirement benefits from a qualifying age of 55 (60) years for women (men). Even unpaid workers in subsistence agriculture, past or present, became entitled for the formal rural pension scheme. The pension generosity increased predominantly owing to a reduced retirement age (women minus 10 years, men minus 5 years); an increase in benefits from 50% to 100% of the minimum wage; and, the abolition of the one-beneficiary-per-household restriction. In essence, the pension system in rural areas was transformed from exclusive and meager to full-coverage and generous.

In line with almost unchanged benefit rules, the indexed number of urban pension eligibles and recipients seems hardly affected by the reform in 1991, according to Figure 1. Quite differently, eligibility for rural pensions more than doubled between 1990 and 1992, as did the number of rural pension recipients with a small delay. The enrollment of newly eligible pensioners was not implemented immediately owing to bureaucratic delays (De Carvalho Filho, 2008). However, benefits were automatically adjusted and more than 2 million rural beneficiaries started receiving pensions until 1994, providing a strong signal for the credibility of the reform (Dias and Amaral, 2001). Importantly, the contribution side of the pension scheme was not altered for urban or rural workers (Table A2), thereby not affecting labor supply incentives. For rural workers the Brazilian pension scheme has remained noncontributory (Schwarzer and Querino, 2002).

Figure 2 documents average pension incomes, paid out to rural and urban

TABLE 1—THE BRAZILIAN RETIREMENT PENSION SYSTEM BEFORE AND AFTER THE REFORM IN 1991

Occupation	Pension type		The pension system before the reform	The pension system after the reform
Rural occupation	Old age	Eligibility criteria:	Minimum age of 65 years, documented formal employment for one out of past three years or three years overall. Weak documentation requirements.	Minimum age of 60/55 for males/females.
		Benefit level:	Flat and equal to 50% of the minimum wage.	Same rules as urban workers.
		Restrictions:	Only one person per household is eligible.	No restriction in the number of beneficiaries per household.
	Length of service	Eligibility criteria:	Not eligible.	Same rules as urban workers.
	Disability	Eligibility criteria:	Available at any age.	Available at any age.
		Benefit level: Restrictions:	Flat and equal to 50% of the minimum wage. Needs to stop working.	Same rules as urban workers. Needs to stop working.
Urban occupation	Old age	Eligibility criteria:	Minimum age of 65/60 for males/females.	Same age limits as before.
		Benefit level:	Benefit level is 90% of the minimum wage. Earnings related part determined by length-of-service pension.	Benefit is 70% of earnings-based benefit (average income of last 36 months) at the minimum eligibility age plus 1% for each year of payroll tax contributions, up to 100%. Minimum benefit increased to 100% of the minimum wage.
		Restrictions:	Needs to quit the current job to apply for benefits. No earnings/retirement test after that.	Allowed to stay in the current job.
	Length of service	Eligibility criteria:	Eligibility after 30 years of work. Full benefits after 35 years of work. Fewer years for some types of work. No minimum age requirements.	Eligibility after 30/25 years of work for males/ females. Full benefits after 35/30 years of work for males/females.No minimum age requirements.
		Benefit level:	Benefits determined by years of documented work and recent labor earnings. Minimum benefit is 90% of the minimum wage. Bonus for continued work beyond maximum eligibility period.	Benefit is 70% of earnings-based benefit (average income of last 36 months) at the minimum eligibility age plus 6% for each additional year of service, up to 100%. Minimum benefit increased to 100% of the minimum wage.
		Restrictions:	Needs to quit the current job to apply for benefits. No earnings/retirement test after that.	
	Disability	Eligibility criteria:	Available at any age.	Available at any age.
		Benefit level:	Benefit is 90% of the minimum wage.	Benefit is 80% of earnings-based benefit plus 1 % for each year of payroll tax contributions, up to 100%. Minimum benefit level of 100% of the minimum wage.
		Restrictions:	Needs to stop working.	Needs to stop working.

Benefit Calculation After the Pension Reform:

After the reform, monthly benefit levels for all types of pensions (old-age, length of service and disability) were equalised for all eligible individuals and formally determined as follows: $Old\ Age_i = \max \left\{ (0.7 + 0.01 \times \frac{P_i}{12}) \times B_i; 1 \times \min wage \right\}$, $Length\ of\ Service_i = \max \left\{ (0.7 + 0.06 \times ADS_i) \times B_i; 1 \times \min wage \right\}$, $Disability_i = \max \left\{ (0.8 + 0.01 \times \frac{P_i}{12}) \times B_i; 1 \times \min wage \right\}$, with B_i being the benefit income determined as the average of the final 36 monthly earnings on which individual i has paid social security contributions. P_i indicates the number of months during which individual i paid social security contributions (payments of the payroll tax) in all her working career. ADS_i indicate additional years of service. The minimum benefit level—which is also applicable for all individuals who fail to prove formal earnings and/or social security contributions—equals 100% of the minimum wage for all types of pensions. The pension system makes 13 benefit payments per year, which are uprated along with the national CPI (the minimum pension can be uprated by more than the CPI).

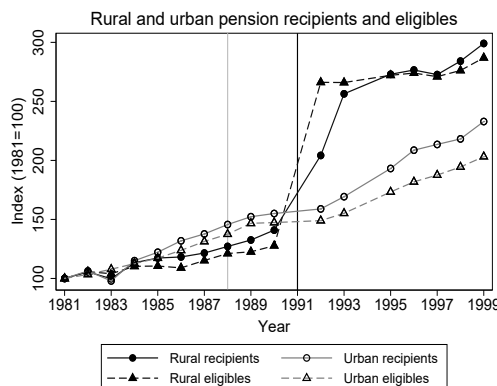


FIGURE 1. DEVELOPMENT OF THE INDEXED NUMBER OF PENSION ELIGIBLES AND RECIPIENTS (1981=100), BRAZIL 1981-99

Note: Graph shows the indexed number of rural and urban old-age pension eligibles and recipients (1981=100). Vertical lines: new Constitution approved in 1988 (light-gray); Pension reform implemented in 1991 (black). Eligibility and receipt defined by age: 65 for rural elderly before the reform, 55/60 for women/men after the reform; 60/65 for urban women/men before and after the reform. Rural and urban groups are defined according to occupation and location (for details see Section III).

Source: PNAD 1981-90, 1992-93, 1995-99.

households in the years before and after the reform. Evidently, the reform in 1991 was comparatively more beneficial for rural pensioners. The mean pension benefits of urban pensioner households increased by 15% (117 BRL) whereas the increase was 134% (311 BRL) for rural pensioner households between 1990 and 1992.

While the figure illustrates the immediate change to the cash flow of pensioners after the reform, the identifying variation relevant to our fertility analysis is the one in pension wealth of not-yet retired workers: Figure 3 shows the increase in accumulated discounted gross pension wealth of rural and urban female workers (top) and rural and urban worker couples (bottom); for further details on the pension wealth computation, see online Appendix Section B. The pension wealth of rural worker couples rose by factor three, illustrating that rural workers—and especially women—benefitted disproportionately from the reform, while urban workers were hardly affected.

The notable increase in pension wealth of rural workers led to substantial declines in poverty among rural households (Schwarzer, 2000; Schwarzer and Querino, 2002), a spike in retirement among the rural elderly (De Carvalho Filho, 2008) and some increase in school enrollment among children co-residing with beneficiaries (De Carvalho Filho, 2012).⁷ The household income boost from the

⁷PNAD data allow a cautious investigation of transfers from non-labor and non-pension sources (including from other family members inside or outside the household). Compared to the pre-reform

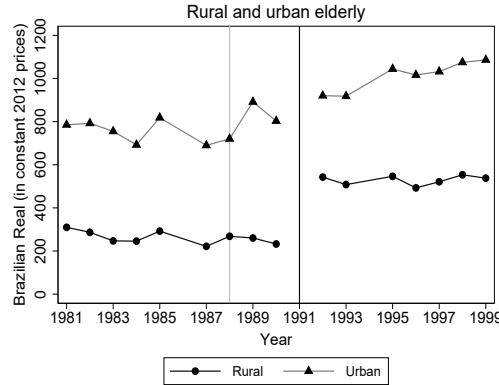


FIGURE 2. AVERAGE MONTHLY PENSION INCOME, BRAZIL 1981-99

Note: Graph shows average household pension income of rural and urban households with at least one old-age pension recipient, based on eligibility by age. Vertical lines: new Constitution approved in 1988 (light-gray); Pension reform implemented in 1991 (black). Rural and urban groups are defined according to household location.

Source: PNAD 1981-90, 1992-93, 1995-99.

pension reform has a direct (and partly mechanic) effect on poverty levels (on a per capita basis). The fertility decline resulting from the pension reform may have a delayed influence on wealth, poverty and education. Schooling of children may be especially affected in the presence of a quality-quantity trade-off (e.g., through reduced child labor or more spending on school books). While we expect such links to be more viable in the long term, later policy reforms may also directly affect these outcomes.

With the pension reform, Brazil embarked on a path from fragmented provision to inclusive universalism that relied on changes in the population's beliefs: The introduction of the new Constitution and the move towards democracy were embedded in new political organizing principles and a new and inclusive political language so that citizens could believe in the announced reforms: The success of Brazil's Constitution is exemplified in the political competition based on universal access to elections,⁸ greater political stability, effective stabilization efforts, and the establishment of a relatively professional bureaucracy (Melo, 2017). Surveys regarding the effectiveness of the pension system in the 1990s reveal that 93% of rural households reported no or very little difficulties in applying for the pension and only very short waiting time periods before approval. Rural recipients

level, transfer receipts declined by 14% for rural pensioners whereas they increased by 21% for urban pensioners. Accordingly, we observe a partial crowding out of private transfers (-141 BRL) through pension receipts (+311 BRL) in rural occupations.

⁸With the introduction of suffrage for illiterates the fraction of the total population voting in presidential elections rose from below 20% in the 1960s to more than 50% in 1989.

reported very high levels of satisfaction with the pension system and payout of benefits (Delgado and Cardoso Jr., 2005).⁹

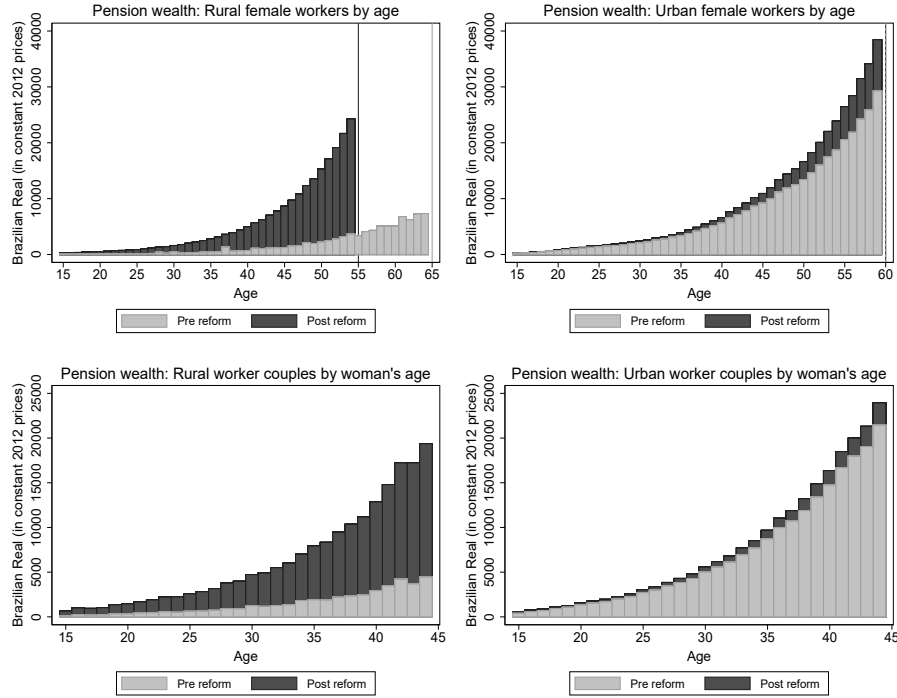


FIGURE 3. GROSS PRESENT PENSION WEALTH OF RURAL AND URBAN FEMALE WORKERS AND OF RURAL AND URBAN WORKER COUPLES WITH A WOMEN AGED 15-44.

Note: Pre- and post-reform pension wealth is computed as the present value of expected old age benefits before/after the reform adjusted for real interest rates and average survival probabilities (computed using IBGE mortality tables; first time available in 1998): $Pension\ Wealth = \sum_{t=0}^{T-a} s_{a,t} \times \frac{1}{(1+i)^t} \times pension_t$, with $s_{a,t}$ denoting the probability of a person of age a in a given year surviving until year t ; $T - a$, indicates the remaining maximum lifespan differentiated by sex and birth cohort; i is a constant discount rate (12% following Azzoni and Isai (1994)); and $pension_t$ denotes the old age pension benefits in t . A non-retired person receives the pension starting in a future period $t > 0$, defined by the person's age and the regular retirement age. Rural and urban groups are defined according to occupation and location (for details see Section III). Figure A2 shows pension wealth of rural and urban male workers. For further details on the pension wealth computation, see online Appendix Section B.

Source: PNAD 1981-90, 1992-93, 1995-99.

⁹While interviews in 2012 reveal a relatively high level of distrust in legal and political institutions in Brazil in general, respondents articulated trust in the persistence of the pension system (Lui Gallassi, 2012).

III. Data

Our empirical analysis exploits several cross-sections (1981-90, 1992-93, 1995-99, 2001-09, 2011-14) of the Brazilian National Sample Household Survey (PNAD), conducted annually by the Brazilian Census Bureau (IBGE) since 1971.¹⁰ The PNAD is a nationally representative high-quality survey that collects a rich set of variables on individuals and their households; its sample size is gradually increasing in line with population growth: from 1981 to 1985 (from 1986), the sample size was about 1/250 (1/500) of the Brazilian population.

Our analysis of fertility responses to the pension reform is based on two outcome variables: First, to assess the short-run effect of the reform on the probability of childbearing, we construct a dummy variable taking on the value of one if a woman has given birth to a child in the past 12 months, zero otherwise (based on the household roster and birth data).¹¹ Our sample includes female respondents in fertile age between 15 and 44 in the years 1981-99.¹² We exclude the 2000s from our analysis owing to later reforms of the pension and health care systems. This leaves us with a working sample of $N = 1,442,376$.

Second, to analyze completed fertility we compute the total number of births of women aged 45: This measure allows a long-run assessment of changes in the number of children, which is important to capture the demographic significance of the reform and to rule out the possibility of timing effects in short-run fertility responses. The information to construct this variable is obtained from the PNAD survey years with a fertility section including information on the total number of births (alive or dead), i.e., the 1984-85, 1992-93, 1995-99, 2001-09 and 2011-14 waves. Our sample includes female respondents of the birth cohorts 1930 to 1969, who are between 45-69 years of age in a given survey year.¹³ We retrospectively assign the reported total number of births of women older than 45 years to the year in which they were 45 years old.¹⁴ The sample size is $N = 746,671$.

Our research strategy exploits the fact that the reform was disproportionately beneficial for rural workers (treatment group) compared to urban workers (control

¹⁰The PNAD was not conducted in the years 1980, 1991, 1994, 2000 and 2010. Since 1981, the entire country is covered in the survey, apart from extremely remote areas of the following States of the Brazilian Federation: Acre, Amapa, Amazonas, Para, Rondonia and Roraima (accounting for about 1.7% of the Brazilian population).

¹¹Multiples or children born in the same year are coded like single births. This coding scheme also implicitly accounts for the fact that multiple births are more common among older mothers.

¹²We keep women who are younger than 15 ($N=283$; 0.02% of the sample) or older than 44 ($N=1,340$; 0.09% of the sample) and who give birth to a child in the sample and recode their ages to 15 or 44, respectively. In a robustness check we re-run our main regressions excluding women outside the 15-44 age range and find very similar results (Table A3).

¹³In 1984, the fertility section is only answered by women up to 54 years old. We exclude women above age 69 to account for the selective mortality of women with respect to their total number of births, see e.g. Barclay and Kolk (2019). Further, we exclude observations if the total number of reported births exceeds 20.

¹⁴As a robustness check we assess completed fertility of women close to the age 45 only. In order to bridge data gaps between surveys with complete fertility questionnaires we resort to ages 45-47 from 1996 to 2014, 45-50 for 1984 and 1985 and 45-52 for 1992, 1993 and 1995. The results are robust to using these substantially smaller samples (Figure A3).

group), in absolute and relative terms. Rural vs. urban pension schemes in Brazil are based on occupation, not residence. Therefore, we categorize rural and urban workers following previous studies (De Carvalho Filho (2008, 2012); see online Appendix Section C for details regarding assignment and imputation of missing values): First, we rely on the classification of the individual's current occupation performed during the reference week (45% of the short-run and 44% of the long-run sample). Second, for individuals not employed during the reference week we use retrospective occupational information available for up to 4 years prior to the reference year (6% and 5% of the samples). Third, for individuals with insufficient personal occupational information we assign the rural status based on the occupation of the family head (42% and 21% of the samples). Finally, for individuals with insufficient personal and household head information we assign the status using information on the household location, i.e., rural or urban residence (7% and 30% of the samples).¹⁵

As we allocate the urban or rural group predominantly based on occupation, selective residential migration is not a threat to our identification strategy. Note, that internal migration in Brazil was low in the relevant time period: Below 8% (5%) of urban (rural) inhabitants had changed their residence across federal states in the past eight years, according to the censuses 1991 and 2000.¹⁶ We do not find any evidence for compositional changes in the sense that female rural residents become relatively more or less likely to work in urban occupations after the reform (Figure A4).

IV. Identification Strategy

The Brazilian social security reform of 1991 provides plausibly exogenous variation for the identification of the effect of the pension reform on reproductive behavior: As rural workers received at most sketchy and meager pensions before the reform, the old-age security motive was probably a key factor in their fertility decisions. Accordingly, the substantial pension reform is expected to induce a disproportionate negative fertility response among rural women.

To capture these effects, we employ three strategies: First, we estimate policy effects by exploiting the difference in annual birth probabilities over time (pre vs.

¹⁵We investigate the robustness of our classification with alternative approaches, i.e., classifying the status only with household location (excluding steps 1-3), only with personal occupation and household location (excluding step 3) or only based on personal and family head occupational information (excluding step 4); alternative approaches provide similar results (Table A4). Further, we exclude female rural workers from mixed occupation households (wife and husband work in different occupational areas, i.e., in a rural and an urban occupation) in our main sample (6.8% of the initial sample). In a robustness check we re-run our main regressions including mixed occupation households and find very similar results (Table A5).

¹⁶We acknowledge that some forward-looking workers may have self-selected into specific occupations based on differences in the pension system. For women in the middle and late phase of their fertility cycle this selection is, however, a predetermined characteristic. Also, residential selection was modest in the observation period. The typical suburbanization of the middle class is not a relevant phenomenon in Brazil (Herzog, 2018). To the contrary, if women with lower fertility aspirations moved into cities, we would underestimate the fertility reduction for women in rural occupations.

TABLE 2—DESCRIPTIVE STATISTICS FOR PRE AND POST REFORM SAMPLES

Sample A: Short-run analysis								
Urban occupation	pre reform (N=666,256)				post reform (N=437,115)			
	mean	sd	min	max	mean	sd	min	max
Newborn child under 1 year old	0.09	0.29	0	2	0.07	0.25	0	2
Age	27.36	8.29	15	44	28.20	8.52	15	44
Age partner	31.92	9.16	15	99	32.41	9.30	16	98
Years of education	6.40	4.07	0	17	7.36	3.98	0	17
Married	0.52	0.50	0	1	0.52	0.50	0	1
Household Income	3,000	4,892	0	820,542	2,509	4,104	0	564,481
Woman's income share	0.15	0.27	0	1	0.20	0.31	0	1
Wealth index	0.17	0.96	-8.69	9.32	0.14	0.91	-8.55	12.13
Not worked reference week	0.53	0.50	0	1	0.49	0.50	0	1
Worked 1-10 hours ref. week	0.01	0.10	0	1	0.02	0.13	0	1
Worked 11-20 hours ref. week	0.05	0.21	0	1	0.06	0.23	0	1
Worked 21-30 hours ref. week	0.07	0.25	0	1	0.07	0.26	0	1
Worked 31-40 hours ref. week	0.13	0.34	0	1	0.15	0.36	0	1
Worked 41-50 hours ref. week	0.15	0.35	0	1	0.15	0.36	0	1
Worked 51-60 hours ref. week	0.04	0.20	0	1	0.04	0.20	0	1
Worked >60 hours ref. week	0.02	0.15	0	1	0.02	0.14	0	1
No. of adults in household	2.99	1.50	0	22	2.82	1.38	0	16
Caretaker in household	0.17	0.37	0	1	0.16	0.37	0	1
Rural occupation	pre reform (N=153,804)				post reform (N=69,644)			
	mean	sd	min	max	mean	sd	min	max
Newborn child under 1 year old	0.14	0.35	0	2	0.11	0.31	0	2
Age	27.08	8.84	15	44	27.53	8.92	15	44
Age partner	32.58	10.35	15	98	32.91	10.49	15	89
Years of education	2.69	2.68	0	17	3.53	2.96	0	17
Married	0.62	0.49	0	1	0.62	0.49	0	1
Household Income	1,236	2,704	0	183,294	893	2,157	0	176,907
Woman's income share	0.05	0.17	0	1	0.06	0.19	0	1
Wealth index	-0.24	0.96	-7.93	8.58	-0.23	1.12	-7.31	9.98
Not worked reference week	0.72	0.45	0	1	0.68	0.47	0	1
Worked 1-10 hours ref. week	0.00	0.02	0	1	0.00	0.05	0	1
Worked 11-20 hours ref. week	0.02	0.15	0	1	0.08	0.27	0	1
Worked 21-30 hours ref. week	0.06	0.25	0	1	0.08	0.27	0	1
Worked 31-40 hours ref. week	0.08	0.28	0	1	0.07	0.26	0	1
Worked 41-50 hours ref. week	0.07	0.25	0	1	0.06	0.23	0	1
Worked 51-60 hours ref. week	0.03	0.17	0	1	0.02	0.15	0	1
Worked >60 hours ref. week	0.01	0.09	0	1	0.01	0.10	0	1
No. of adults in household	2.88	1.37	0	15	2.78	1.31	0	16
Caretaker in household	0.14	0.35	0	1	0.15	0.36	0	1
Sample B: Long-run analysis								
Urban occupation	pre reform (N=199,353)				post reform (N=397,575)			
	mean	sd	min	max	mean	sd	min	max
Total number of births	4.67	3.67	0	20	3.12	2.47	0	20
Childlessness (number of births=0)	0.10	0.31	0	1	0.11	0.31	0	1
Years of education	4.41	4.36	0	17	7.02	4.89	0	17
Married	0.52	0.50	0	1	0.61	0.49	0	1
Lifetime labor supply (years)	13.91	1.24	10	17	16.23	1.50	10	20
Rural occupation	pre reform (N=52,613)				post reform (N=66,674)			
	mean	sd	min	max	mean	sd	min	max
Total number of births	6.80	4.31	0	20	5.21	3.65	0	20
Childlessness (number of births=0)	0.08	0.26	0	1	0.07	0.26	0	1
Years of education	1.72	2.52	0	17	2.70	3.15	0	17
Married	0.72	0.45	0	1	0.80	0.40	0	1
Lifetime labor supply (years)	8.81	2.85	0	16	10.29	3.07	0	18

Note: Sample A consists of Brazilian women aged 15-44. Sample B consists of Brazilian women of the birth cohorts 1930 to 1969, aged 45-69. Rural and urban groups are defined by: (1) occupation during the reference week, (2) occupation up to 4 years prior to the reference year, (3) occupation of the family head, (4) household location. Mixed urban-rural couples excluded. For more information see the variable descriptions in Tables A6-A11.

Source: Sample A: PNAD 1984-85, 1992-93, 1995-99, 2001-09, 2011-14; Sample B: PNAD 1981-90, 1992-93, 1995-99.

post reform) between treatment and control group (rural vs. urban women). This difference-in-differences (DID) estimator captures the deviation of actual rural fertility trends from expected fertility trends that would have been observable without the pension reform. Second, we estimate the semi-elasticity of fertility with respect to pension wealth in an instrumental variable (IV) setup. Here, we regress the incidence of childbearing on the natural log of accumulated gross present pension wealth, which we instrument with the interaction of our treatment group and post-reform indicators. Third, we implement an event study (ES) approach for completed fertility of women aged 45.

A. Difference-in-Differences Estimation

We investigate the short-run effect of the pension reform on the reproductive behavior of women in fertile age using the DID method. The research design is not sensitive to time-invariant differences between rural (treatment) and urban (control) workers, like persistent family roles or tastes for fertility. At the same time, DID accounts for macro trends that affect rural and urban areas similarly. This is relevant as Brazil underwent a period of macroeconomic stabilization in the early 1990s (for more details, see online Appendix Section D). The universal and exogenous change in pension generosity permits the estimation of causal fertility responses by comparing childbearing trends between the treatment and control groups before and after the pension reform (the treatment).

Formally expressed, our short-run (SR) OLS reduced-form model with repeated cross-sections can be written as:

$$(1) \quad y_{igtr}^{SR} = \alpha^{SR} + \beta(RURAL_g^{SR} \times POST_t^{SR}) + \gamma RURAL_g^{SR} + \lambda_t^{SR} + \phi_r^{SR} + \psi' X_{igtr}^{SR} + \epsilon_{igtr}^{SR},$$

with the dependent variable y_{igtr}^{SR} representing a dummy equal to one if woman i of group g in region r in year t has given birth to a child within the last 12 months before the interview, zero otherwise. $RURAL_g^{SR}$ is an indicator variable for rural female workers and $POST_t^{SR}$ a dummy variable that indicates observations in the years after the pension reform in July 1991. The interaction of interest $RURAL_g^{SR} \times POST_t^{SR}$ indicates rural female workers eligible for a future pension after the reform. The coefficient of interest β captures the differential fertility trend between treatment and control groups. If the pension reform led to a decline in fertility, β carries a negative sign.

The model includes a full set of time fixed effects λ_t^{SR} ; hence, our approach relies on the assumption that no shock affects the two groups differently. Further, we add region (Brazilian federal states) fixed effects ϕ_r to capture time-invariant regional specific factors. Finally, our regression set-up incorporates time-varying covariates represented by the vector X_{igtr}^{SR} . The set of controls includes individual characteristics such as years of schooling, a dummy for married (including

informal unions and domestic partnerships), age dummies and dummies for birth parity, i.e., 1 to 5+ previously born children (zero being the omitted category); job related characteristics are dummies for 1-10, 11-20, 21-30, 31-40, 41-50, 51-60 and 60+ hours of professional work in the reference week (zero hours, i.e., not working, being the omitted category) and the share of household income (without pension income) earned by the woman; household characteristics are the natural logarithm of monthly household income (without pension income) and wealth (using the first principal component from a set of 45 indicators for housing characteristics and durables), dummies for the number of adults in the household and a dummy for the presence of a potential caretaker in the household (i.e., a non-working pensioner aged 60 or above) as well as age of the partner dummies. Further we include time-varying control variables measured at the group and regional level: At the regional level we control for the prevalence of TV reception and for regional industry-specific trade shocks, as telenovelas (see La Ferrara, Chong and Duryea, 2012) and trade liberalization (see Braga, 2018) have been identified as influencing factors of fertility in Brazil. At the regional level and differentiated by urban and rural location, we control for the shares of protestants, of individuals of other faiths, or of no religion (catholic being excluded as omitted category) and for shares of individuals of different races, i.e., black, mixed-race and other (white being excluded as omitted category); at a macro-regional level, we also control for child mortality rates (under 60 months of age), based on Demographic and Health Survey (DHS) data.

The idiosyncratic disturbance term is denoted by ϵ_{igr}^{SR} . Standard errors are clustered at the region level (Brazilian federal states: 26 clusters). Since the Brazilian pension reform can be considered unanticipated and exogenous, the inclusion of covariates should not change our estimates of β , while improving precision. To illustrate this, we include covariates in the results tables in a step-wise fashion.

Taking advantage of the large sample size, we perform subgroup analyses to test whether the effect of the pension reform differs across women at different phases of their fertility cycle. First, we split the estimation sample into younger (aged 15-29) and older (aged 30-44) women and estimate model (1) for both subsamples.¹⁷ In the robustness section, we also address even more granular age groups. Second, we investigate the intensive margin of fertility by splitting the sample into groups of women at different birth parities: This analysis sheds light on the reform effect on childbearing for women with zero, one, two, three, four, and at least five previously born children. Finally, we also separate the sample into groups of women who already have at least one son, at least two sons, only daughters and those who have no prior children at all. Comparing these estimates sheds light on the sensitivity of fertility responses to the presence of a boy—and, hence, a potential heir—in the family.

¹⁷The results are very similar when using a triple-differences approach on the pooled sample (results available on request).

The validity of DID rests on the assumption that rural and urban women would not have had any systematic different fertility trends in the absence of the reform. Our identifying assumption is that fertility trends were similar for urban and rural women before the reform, and that any estimated fertility response is attributable to the differential growth of pension wealth across the two groups. We show the plausibility of the common trend assumption using a test method in the spirit of Granger (1969). The test sample contains ten pre-reform (1981-90) and seven post-reform (1992-93, 1995-99) years. The interaction terms, $RURAL_g^{SR} \times YEAR_t^{SR}$, test for differences between treatment and control groups, conditional on a full set of group and time effects and including all covariates.

Each estimate of Table A12 reports the year specific difference between treatment and control for the full sample (col. 1), the sample of younger women (col. 2) and the sample of older women (col. 3). The fertility trends are not significantly different between rural and urban women in the pre-treatment period, as evidenced by the insignificant pre-reform interaction coefficients, almost all of which are very close to zero. Only two estimates out of 27 (7.4%) are statistically significant at the 10% level, which is a fully acceptable incidence rate for Type-I errors. This suggests that rural and urban women were on the same fertility trajectory before the pension reform.

Additionally we test for structural breaks along the entire time-period using placebo reforms. We find no evidence for fertility responses before the actual reform date in 1991 (Table A13).

B. Instrumental Variable Estimation

Beside the policy effect of the pension reform, we aim at estimating the semi-elasticity of fertility with respect to pension wealth. Since pension wealth is potentially endogenous, we exploit the timing of the policy and the differential impact across population groups in Brazil, i.e., the $RURAL_g^{SR} \times POST_t^{SR}$ interaction, as an instrumental variable. Therefore, we apply a 2SLS estimation strategy that allows us to crystallize the exogenous variation in pension wealth.

In the first stage, we regress the age-specific accumulated discounted gross pension wealth ($pensionwealth_{igtr}$) on the instrument as well as the full set of covariates:

$$(2) \quad \ln(pensionwealth)_{igtr} = \sigma^{SR} + \theta(RURAL_g^{SR} \times POST_t^{SR}) + \eta RURAL_g^{SR} + \delta_t^{SR} + \tau_r^{SR} + \kappa' X_{igtr}^{SR} + \mu_{igtr}^{SR}.$$

In the second stage, we regress birth probabilities on the predicted values of

pension wealth:

$$(3) \quad y_{igtr}^{SR} = \alpha^{SR} + \beta \ln(\widehat{pensionwealth})_{igtr} + \gamma RURAL_g^{SR} + \lambda_t^{SR} + \phi_r^{SR} + \psi' X_{igtr}^{SR} + \epsilon_{igtr}^{SR}.$$

This estimation procedure requires a sufficiently strong and exogenous instrument. We assess the strength of the instrument with the F-statistic of the first stage, which exceeds the critical value multiple times across all samples. Also, t-statistics of the excluded instrument in the first stage are close to or over 60, suggesting a very strong instrument. The exogeneity of the instrument is plausible since the universal pension reform was implemented exogenously and without anticipation. Given that the contribution side of the pension schemes did not change for workers (Table A2), the pension reform did not create incentives to work. Essentially, the reform affects fertility levels only through its effect via pension wealth.

C. Event Study Estimation

Fertility adapts gradually and women differ with respect to their remaining adjustment period until completing fertility after the reform. Therefore we explore the dynamic long-run effect of the pension reform in 1991 on the total number of births of women aged 45 using an ES approach with control group. Our sample covers the period 1975–2014. We include interactions of the time dummies and the treatment indicator, $RURAL_g^{LR} \times YEAR_t^{LR}$, for all periods in our model.

In practice we estimate the following equation for long-run (LR) effects:

$$(4) \quad y_{igtr}^{LR} = \alpha^{LR} + \sum_{t=-16}^{23} \beta_t (RURAL_g^{LR} \times YEAR_t^{LR}) + \gamma RURAL_g^{LR} + \lambda_t^{LR} + \phi_r^{LR} + \psi' X_{igtr}^{LR} + \epsilon_{igtr}^{LR},$$

with the dependent variable y_{igtr}^{LR} representing the number of births of woman i at age 45 of group g in region r in year t ; $RURAL_g^{LR}$ is the indicator for the treatment group. $YEAR_t^{LR}$ are indicator variables for years $t \in [-16, 23]$. The specification allows for sixteen ($\beta_{-1}, \beta_{-2}, \dots, \beta_{-16}$) pre-treatment (lead) effects and twenty-three ($\beta_{+1}, \beta_{+2}, \dots, \beta_{+23}$) post-treatment (lag) effects; hence, the β_t coefficients capture the differential fertility trend between treatment and control groups for each year between 1975 and 2014. If the pension reform led to a decline in the total number of births, the post-reform β_t 's carry a negative sign. The model includes birth cohort fixed effects λ_t^{LR} and region (Brazilian federal states) fixed effects ϕ_r^{LR} to capture time-invariant regional specific factors. Finally, our regression incorporates the covariate vector X_{igtr}^{LR} , including years of schooling, a dummy for married (including informal unions and domestic partnerships) and

a proxy for lifetime labor supply (the sum of predicted cubic age-specific work probabilities over the working life separated by Brazilian federal state and urban/rural).¹⁸ The idiosyncratic disturbance term is denoted by ϵ_{igr}^{LR} . Standard errors are clustered at the region level (Brazilian federal states: 26 clusters).

An attractive feature of an event study is that the interactions of post-treatment time dummies with the treatment indicator reflect dynamics of the completed fertility response after the reform. For instance, the lag coefficients indicate whether the treatment effect fades out, stays constant, or increases over time. The effect is expected to increase after the reform since women close to 45, who have revised their fertility target downwards, have only limited capacity to restrict their fertility given their proximity to age 45 and their previously born children; younger women have a longer remaining adaption period. Further, fertility norms adjust slowly. The lead coefficients shed light on the common trend in completed fertility between the rural (treatment) and urban (control) group before the reform; insignificant pre-treatment coefficients are indicative of a common trend before the reform.

D. Addressing Potential Confounders

Our identification strategy rests on the assumption that no other policy changes or alternative determinants of fertility explain the disproportionate decline in rural fertility behavior. In the following, we analyze macroeconomic stabilization efforts and assess trends in marriage rates, education, health care, incomes, wealth and employment between rural and urban women showing that the treatment and control groups were on very similar trajectories regarding these factors over time. We also discuss the role of cultural change in Brazil with respect to religion and telenovelas, the role of trade liberalization and patterns regarding the quantity-quality trade-off between the number of children and the investment made in their quality, i.e., education. In our regression analysis we control for these factors.

Macroeconomic stabilization. Following a period of economic stagnation and high inflation, Brazil underwent significant stabilization efforts during the late 1980s and early 1990s. A series of seven stabilization plans intended to bring down persistently high inflation, stimulate output and liberalize the economy. As discussed in greater detail in online Appendix Section D, these plans did not change the wealth distribution between urban and rural jobs in a way that could explain the observed fertility patterns.

Marriage. Marriage and fertility are positively correlated. But neither the Constitution nor the pension reform contain any changes affecting the incentives to marry, not least since pension eligibility is independent of marital status. In

¹⁸We implicitly assume that women have not changed their marital status and state of residence since fertile age. In fact, migration and divorce rates were low in Brazil in the relevant time period (the crude divorce rate was 1.5/1000 inhabitants, see Covre-Sussai (2016)). In a robustness check we re-run our ES regression excluding marital status and state of residence as control variables and find very similar results (results available on request).

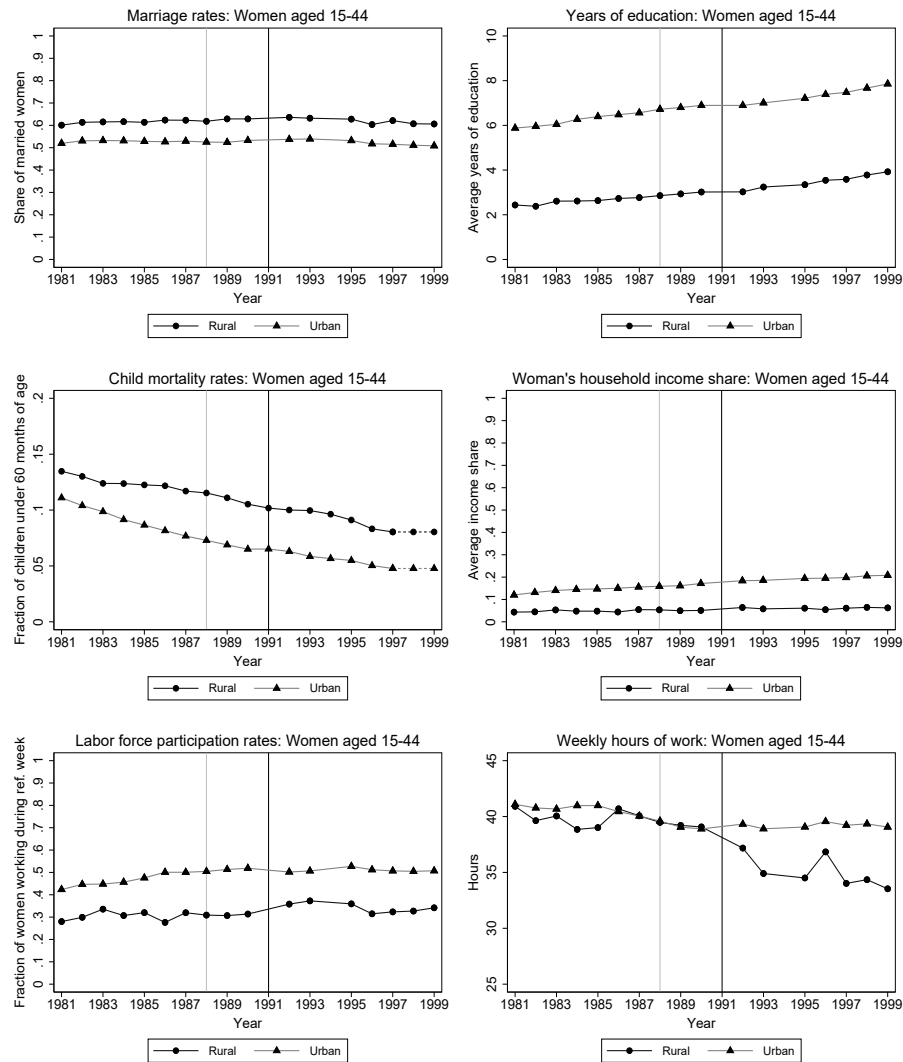


FIGURE 4. CONFOUNDING FACTOR TRENDS: WOMEN AGED 15-44

Note: Graphs show average marriage rates, years of education, child mortality rates, income of women as a share of household income, labor force participation rates, and weekly hours of work for rural and urban female workers. Vertical lines: new Constitution approved in 1988 (light-gray); Pension reform implemented in 1991 (black). Rural and urban groups are defined as in Table 2. Mixed urban-rural couples excluded. Figure A9 shows the trends for women aged 15-29 and Figure A10 for women aged 30-44.

Source: PNAD 1981-90, 1992-93, 1995-99.

Figure 4 (top left) we compare marriage rates of rural and urban female workers. Average marriage rates are higher for rural women but the rates tend to be very stable over the 19 year observation period.

Education. As more educated women face greater opportunity costs of having children, and as education is in general negatively correlated with fertility, an unbalanced educational expansion between rural and urban areas may directly influence the observed fertility rates. The 1988 Constitution mentions education as a basic right. To reduce the illiteracy rate elementary education was made compulsory regardless of age implying compulsory education for adults in so-called popular schools. However, a lack of schools delayed the desired expansion by more than ten years.¹⁹ In Figure 4 (top right) we compare years of schooling of female rural and urban workers. Average years of schooling increase over time; however, rural and urban women are on similar paths. Another threat to identification might stem from the educational expansion for children. Since higher education increases the economic value of a child, parents could afford their targeted level of old-age support with fewer children, as predicted by the quantity-quality trade-off theory. However, since the educational expansion was severely delayed and limited to primary education (which had been free and—in theory—compulsory before) we expect no differential growth in education among children of rural women. When analyzing years of education of children aged 15 or 7-24, we find positive secular trends, but no differences between urban and rural households or between boys and girls (Figure A5).

Health. Changes in health care might explain the fertility decline if improvements in child survival were stronger in rural areas.²⁰ However, the infant and child mortality decline in the critical period between 1986 and 1996 was stronger in urban (38%) than rural (32%) areas, according to data from the DHS (Figure 4, middle left). Consequently, we would underestimate the true fertility decline owing to the pension reform. Another explanation might be a disproportionate expansion in access to health care (e.g., contraception) in rural areas; this might improve rural women's ability to control fertility. However, knowledge of and access to modern contraceptive methods were already widespread during the 1980s in urban and rural areas. Also, the major reform for health and family planning services took place only after the pension reform in 1997 (Caetano and Potter, 2004; Ministério da Saúde, 2008).

Economic empowerment. Fertility may depend on women's relative economic potential and power within the household. Comparing the income of women as a share of household income and, therefore, the relevance of women's paid work for the household, we do not find any disproportionate gain among rural women (Figure 4, middle right).

Labor force participation and employment. Greater female labor force participation implies greater opportunity costs of children and may, hence, lower

¹⁹Only in 1998, Brazil set up the Fund for the Maintenance and Development of Primary Education and Valorisation of Teachers (FUNDEF) to improve enrolment rates, with some effect (De Mello and Hoppe, 2005; Borges, 2008).

²⁰Unfortunately, no data set contains information regarding the health of mothers that would be suitable for our research design. Post-treatment data from the World Values Survey, however, show that the subjective health of mothers in rural areas has converged to the one observed in urban areas.

fertility. Brazil underwent comprehensive unilateral trade liberalization during the late 1980s (for agricultural products and mining) and 1990s (for manufacturing), possibly affecting the labor market. However, since the sectoral distribution of women remained almost constant during the 1990s and 2000s and since female workers were mostly employed in the non-tradable sector (with no discernible spill-over effects), women were at most mildly affected by trade liberalization (Gaddis and Pieters, 2017). Given that urban and rural workers were exposed to similar trade shocks in terms of tariff reductions (Figure A6), trade liberalization should not confound the fertility effect of the pension reform. In the regressions we control for the region-industry specific trade shocks by incorporating annual tariff rates taken from De Paiva Abreu (2004).²¹ The trajectory of labor force participation between rural and urban women is quite comparable, suggesting that the fertility pattern cannot be driven by differential employment growth (Figure 4, bottom left). At the same time, average working hours of women exhibit a declining trend already before the reform. After the reform we observe a disproportionate fall in the working hours of female rural workers (Figure 4, bottom right), which is attributable to the emergence of part-time jobs (11-20 hours) in rural areas (Figure A7); if anything, this pattern works against declining fertility of female rural workers.

Income and wealth. The tightening of minimum wage rules in the Constitution of 1988 might be problematic if the rural population experienced disproportionate income gains. Figure A8 (top left) compares average monthly household incomes (excluding pension income) for households with rural or urban women in childbearing age. Household income fluctuates over time, but there is no differential trend in household income after the Constitution was approved; further, the level difference between rural and urban households is stable for absolute (Figure A8, top left) and relative (Figure 4, middle right) income as well as for wealth (Figure A8, top right).

Religion. Brazil experienced a phase of cultural modernization during the 1980s and 1990s. The influence of the catholic church, with its promotion of traditional family roles and the rejection of modern contraception, diminished slowly. Since the PNAD does not include consistent information on religious affiliations of individuals over time, we use Brazilian Census data from 1980, 1991 and 2000 to generate the regional composition of religious affiliations, for which we control in our regressions. In graphical analysis the most marked observation is a rising share of protestants, of people of other faiths and of people without religion, at the expense of catholicism (Figure A11). This trend is more pronounced in urban than in rural areas and cannot explain the stronger decline of fertility in rural areas. However, membership in the church may be an imprecise determinant of fertility. Based on World Value Survey (WVS) data from 1991 and 1997 we analyze the self-reported importance of religion in an individual's life and confidence in the church (Figure A12). For about 90% of rural and 80% of urban individuals,

²¹Methodologically based on Dix-Carneiro and Kovak (2017). See Table A11 for details.

religion is very or rather important in life. These shares slightly increase from 1991 to 1997 for both groups. With about 80% of rural and about 70% of urban individuals there is also high trust in the churches. There are no disproportionate shifts in these variables between rural and urban individuals that could plausibly explain the stronger decline of fertility in rural areas.

Culture. The general modernization of the Brazilian society is also reflected in the expansion of the coverage of Brazilian territory with Rede Globo television. This led to almost nationwide broadcasting of telenovelas which tend to portray modern, small families. While this expansion mainly took place in the early 1980s, we control for Rede Globo-coverage in our regressions to account for earlier findings that soap operas have contributed to a decline in fertility (La Ferrara, Chong and Duryea, 2012).

V. Fertility Response to the Pension Increase

The plausible behavioral response of women to the pension reform is a reduction in fertility. A comparison of DHS data on the number of desired children indicates that urban women lowered their planned fertility by 0.48 children between 1986 and 1996 while rural women reduced it by 0.55 children (Table A14). The differential is especially large among women aged 30 to 44 who have fewer than the number of children they desire (-0.40 vs. -0.79).²² Yet, how does this change in the desired number of children translate into actual fertility? Older women may immediately stop having children. In essence, we expect a negative short- and long-run response of these women. Younger women may continue having children until they have born their (revised) desired number of children. This implies no short-run, but a negative long-run response. In the following we assess the realized fertility outcomes.

A. Short-Run Effects: DID Estimation

Initially, we assess short-run behavioral responses in childbearing by analyzing the probability that a woman in childbearing age (15-44 years old) delivers a baby in a given year. Across all samples the childbearing probabilities of rural women exceed those of urban women and childbearing rates decline over the entire observation period (Figure 5): The top panel of Figure 5 compares fertility rates for all rural and urban women, with the dashed line representing the urban counterfactual trend fixed at the year 1987. In other words, the dashed line depicts the fertility trend of urban women adjusted to rural women's fertility level as of 1987. Before the reform in 1991 fertility rates between rural and urban women develop similarly. After 1991 and in line with the disproportionate change in pension wealth we observe a relatively stronger (i.e., steeper) decline of

²² Accordingly, we find a stronger increase in contraceptive use among rural compared to urban women from 1986 to 1996 (Table A15). Note, that this is not driven by differences in access to contraception (Caetano and Potter, 2004).

childbearing probabilities of female rural workers in the full sample. There is an immediate drop in the annualized childbearing probability of rural women by 1 percentage point, which increases to 2 percentage points by the end of the 1990s (equivalent to -17%). This decline is not driven by younger women in the 15-29 year age range (bottom left panel), but by women aged 30-44 (bottom right panel). The overall unconditional childbearing decline among older rural women exceeds 30%. These differences by age are consistent with theoretical predictions: Older women are expected to respond more immediately due to survival, information, saturation, pension wealth and salience effects. Younger women seem to continue having babies until they reach their (downwardly revised) desired fertility level. We also explicitly focus on the timing of first birth; however, we find no evidence for postponement behavior when analyzing average ages at first birth over time or along the age distributions (Figure A13).

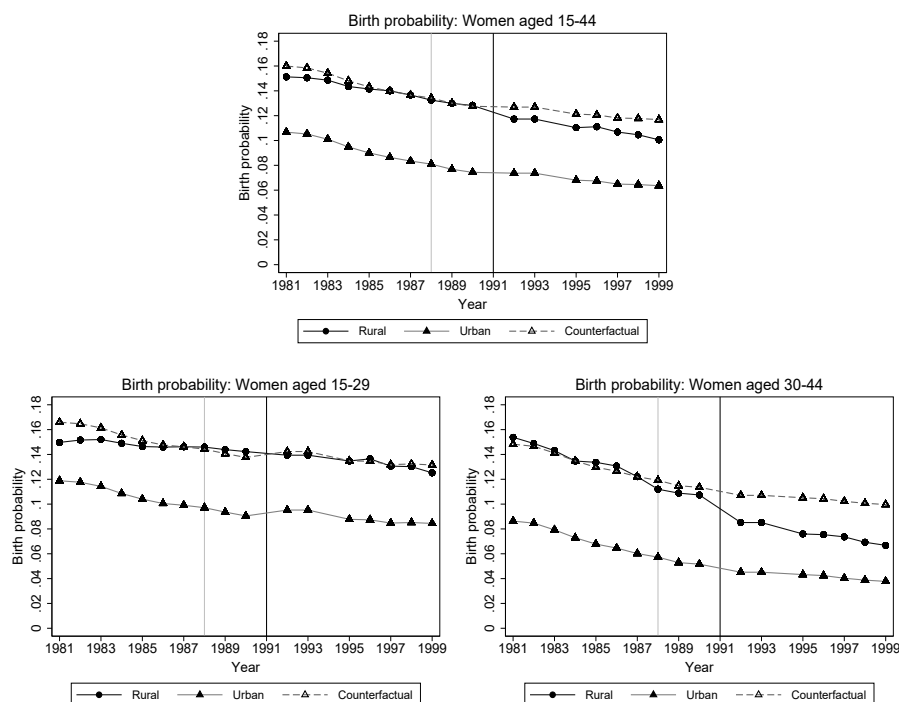


FIGURE 5. BIRTH PROBABILITIES: POOLED (WOMEN AGED 15-44) AND SUBGROUPS (WOMEN AGED 15-29 vs. 30-44), BRAZIL 1981-99

Note: Graphs show 3-year moving averages (2-years at the edges: 1981-82, 1989-90, 1992-93 and 1998-99) of birth probabilities, i.e., average childbearing (0/1) rates within the last 12 months. Counterfactual trend as of 1987: gray dashed line. Vertical lines: new Constitution approved in 1988 (light-gray); Pension reform implemented in 1991 (black). Rural and urban groups are defined as in Table 2. Mixed urban-rural couples excluded.

Source: PNAD 1981-90, 1992-93, 1995-99.

TABLE 3—DID REGRESSION RESULTS: POOLED (WOMEN AGED 15-44) AND SUBGROUPS (WOMEN AGED 15-29 vs. 30-44)

Dependent Variable	Newborn child under 1 year old (0/1)					
	(1)	(2)	(3)	(4)	(5)	(6)
DID women aged	-0.008 (0.003)	-0.008 (0.003)	-0.010 (0.002)	-0.008 (0.002)	-0.007 (0.002)	-0.009 (0.003)
in % to baseline	-6.8	-6.8	-8.3	-6.8	-6.0	-7.6
DID women aged 15-29	0.004 (0.003)	0.005 (0.003)	0.003 (0.002)	0.004 (0.002)	0.005 (0.002)	0.003 (0.003)
in % to baseline	2.9	3.6	2.2	2.9	3.6	2.2
DID women aged 30-44	-0.029 (0.004)	-0.029 (0.004)	-0.028 (0.004)	-0.026 (0.004)	-0.025 (0.004)	-0.024 (0.004)
in % to baseline	-27.7	-27.7	-27.0	-25.5	-24.8	-24.1
Year and region FE	No	Yes	Yes	Yes	Yes	Yes
Covariates (see note):						
Individual	No	No	Yes	Yes	Yes	Yes
Job	No	No	No	Yes	Yes	Yes
Household	No	No	No	No	Yes	Yes
Regional/Group	No	No	No	No	No	Yes
N:	15-44 (1,442,376); 15-29 (854,814); 30-44 (587,562)					
R^2 15-44:	0.006	0.008	0.092	0.098	0.106	0.107
R^2 15-29:	0.003	0.005	0.131	0.136	0.142	0.142
R^2 30-44:	0.011	0.015	0.045	0.048	0.057	0.058

Note: DID estimates of the pension reform. Dependent variable: Dummy, whether a child was born in the last 12 months. Individual covariates: years of schooling, dummy for married, age of the woman, age of the woman squared and dummies for 1 to 5+ prior children (0 omitted). Job related covariates: dummies for 1-10, 11-20, 21-30, 31-40, 41-50, 51-60 and 60+ hours of professional work in reference week (0 hours, i.e., not working omitted) and share of household income (excl. pensions) earned by the woman. Household covariates: log of monthly household income (excl. pensions), household wealth, dummies for the number of adults in the household, dummy for the presence of a potential caretaker in the household, i.e., a non-working pensioner aged 60 or older, dummies for age of the woman and age of the partner. Regional/group covariates: dummy for Rede Globo coverage in the past year (based on La Ferrara, Chong and Duryea (2012) data), regional shares of religious affiliations, i.e., protestant, other faith and no religion (catholic omitted, based on Census data), regional race shares, i.e., Black, Mixed-race and Others including Asian, Indigenous and Other (white omitted, based on Census data), macro-regional child mortality (mortality rates of children under 60 months of age by macro-region, i.e., north-east, mid-west, south, and south-east, based on DHS data) and regional industry-specific trade shocks (based on methodology of Dix-Carneiro and Kovak (2017) and annual tariff rates taken from De Paiva Abreu (2004)). Rural and urban groups are defined as in Table 2. Standard errors clustered at the regional level in parentheses.

Source: PNAD 1981-90, 1992-93, 1995-99.

The expected responses are reflected in DID estimates regarding the probability that a woman has given birth in the past 12 months, for three different samples (Table 3): all women aged 15-44 (top), young women aged 15-29 (middle) and older women aged 30-44 (bottom). The six columns represent different specifications: without controls (col. 1), with year and region fixed effects (col.

2), with individual (col. 3), job related (col. 4), household (col. 5), and with group/region controls (col. 6). The highly significant reform effect in the full sample of women in childbearing age is around one percentage point irrespective of the chosen specification. This is equivalent to a decline in the probability of childbearing by 6-8%. In the young cohort the estimated effects are all very close to zero and largely insignificant. In the older cohort the effects are large: all coefficients are highly significant at around -0.03, equivalent to a decline of 24-28% in the propensity of childbearing in the past year. These estimates are very similar to the aggregate, unconditional drop in birth rates depicted in Figure 5; their stability across specifications suggests that the pension effect is orthogonal to the large number of individual, job related, household, regional and group controls. This supports the identifying assumption of the reform being a valid source of exogenous variation.

A number of covariates are worthy of attention (Table A16): Among the individual level covariates marriage (including informal partnerships) is positively associated with fertility, as expected. Controlling for marriage increases the R-squared substantially. Dummies for the number of previously born children as well as dummies for working hours brackets (if working) are negatively related to fertility. Years of schooling are negatively correlated with fertility in most of our regressions, as are the woman's household income share, household income (excluding old-age pension income of co-residing pensioners) and household wealth. The number of adults in the household and the presence of a potential caretaker are positively associated with fertility. Rede Globo (telenovelas) coverage is negative especially for older women, as found in earlier studies. Child mortality rates are positively related to fertility, as expected.

B. Pension Wealth: IV Estimation

While the effect of the Brazilian pension reform of 1991 on fertility is policy relevant, economists also care about the generally more comparable effect of pension wealth on the childbearing propensity. This effect can be uncovered as the semi-elasticity of pension wealth using a 2SLS IV regression in which the log pension wealth is instrumented with the $RURAL_g^{SR} \times POST_t^{SR}$ interaction in the first stage. The instrument is sufficiently strong across all samples (F-statistic > 3682, T-statistic of the excluded instrument > 60). The estimates confirm the earlier results in a more generalized set-up (Table 4): A 100% increase in pension wealth reduces the probability that a child was born in the past year by 0.5 percentage points. Given that a couple's pension wealth increases by almost 300%, the overall effect is larger than the estimated policy effect in Table 3 ($3 \times -0.005 < -0.009$), although the two estimates do not statistically differ from each other. Below the main results we provide estimates for alternative discount rate specifications. If assuming—in line with the literature—that less wealthy households (Becker and Mulligan, 1997) or rural households (Anderson et al., 2004) have higher discount rates, the estimated semi-elasticities get closer to the policy effect.

The semi-elasticity for the younger and older sub-samples estimates the response for a comparable pension wealth level increase (in %) between younger and older women. This approach deviates from estimating the policy effect for the two age groups in a difference-in-differences set-up by implicitly switching off the pension wealth level differences that emerge from differential discounting periods (from age 15-29 until pension age vs. 30-44 until pension age). The IV estimates eliminate the pension wealth effect described in the theoretical section. The results in Table 4 are qualitatively very similar to the main difference-in-differences results suggesting that differences in pension wealth levels cannot be the main explanation for the differential response between younger and older women.

TABLE 4—IV REGRESSION RESULTS: SEMI-ELASTICITY OF BIRTH PROBABILITIES TO PENSION WEALTH

Dependent Variable	Newborn child under 1 year old (0/1)		
	(1)	(2)	(3)
	Full Sample	Women aged 15-29	Women aged 30-44
Log of pension wealth	-0.005 (0.002)	0.001 (0.002)	-0.012 (0.002)
<i>First-stage statistics:</i>			
Dependent Variable	Pension wealth of woman and her partner		
Instrument	Rural work x After reform interaction		
Coefficient	1.944 (0.030)	1.874 (0.031)	2.080 (0.028)
F-test	4135.45	3682.81	5599.79
T-statistic of excl. instrument	64.31	60.69	74.83
Partial R^2 of excl. instrument	0.084	0.101	0.073
<i>Estimates for alternative discount rates:</i>			
Log of pension wealth	-0.004	0.001	-0.012
30% pre vs. 12% post	(0.001)	(0.001)	(0.002)
Log of pension wealth	-0.003	0.001	-0.008
30% rural vs. 12% urban	(0.001)	(0.001)	(0.001)
Year and region FE	Yes	Yes	Yes
Covariates (see note)	Yes	Yes	Yes
N:	1,442,376	854,814	587,562
R^2 :	0.107	0.142	0.055

Note: IV estimates of the pension reform. ‘First-stage’ regression of log pension wealth on the instrument ($RURAL_g^{SR} \times POST_t^{SR}$) and all other covariates. Power of the first-stage regression reported with F-statistics. Dependent variable in the ‘second-stage’: Dummy, whether a child was born in the last 12 months. Full set of covariates, as in Table 3, column 6. Pension wealth computed as in Figure 3 with a constant discount rate of 12% for the main specification (c.f. Azzoni and Isai (1994)). Rural and urban group definition as in Table 2. Mixed urban-rural couples excluded. Standard errors clustered at the regional level in parentheses.

Source: PNAD 1981-90, 1992-93, 1995-99.

C. Number of Previously Born Children: DID Estimation

If women do not change their fertility behavior as long as their family is small, but stop having children once they reach their downwardly adjusted desired number of children, we observe stronger fertility effects at higher birth parities. This is expected to be more prevalent among women in the middle or late phase of their fertility cycle who have—on average—already born more children than younger women. Indeed, we find that most of the reduction in childbearing appears at higher birth parities (Figure 6 and Table 5).

While the probability of having a first or second child has not significantly declined after the pension reform (top panel of Figure 6 and columns 1 and 2 of Table 5), the fertility effects turns negative at the third child and increasingly so at higher birth parities (middle and bottom panel of Figure 6 and columns 3 to 6 of Table 5). Our estimates (Table 5) show that the childbearing probability declines by 10% (2nd birth parity), 19% (3rd birth parity), 29% (4th parity), and 23% (5th+ parity), respectively. These findings support the stopping hypothesis and can at least partly explain the stronger adjustment effect among older women (who tend to have already more children).

TABLE 5—DiD REGRESSION RESULTS: BY BIRTH PARITY (WOMEN AGED 15-44)

Dependent Variable	Newborn child under 1 year old (0/1)					
	(1) Parity 0	(2) Parity 1	(3) Parity 2	(4) Parity 3	(5) Parity 4	(6) Parity 5+
DID women aged 15-44	0.009 (0.002)	0.005 (0.007)	-0.012 (0.005)	-0.022 (0.006)	-0.042 (0.009)	-0.041 (0.007)
in % to baseline	10.4	2.5	-9.8	-18.5	-28.6	-23.2
Year and region FE	Yes	Yes	Yes	Yes	Yes	Yes
Covariates (see note)	Yes	Yes	Yes	Yes	Yes	Yes
<i>N</i> :	682,684	222,497	232,969	147,617	70,809	85,800
<i>R</i> ² :	0.199	0.078	0.071	0.074	0.078	0.064

Note: DID estimates of the pension reform. Dependent variable: Dummy, whether a child was born in the last 12 months. Full set of covariates, as in Table 3, column 6 (dummies for 0 to 5+ prior children omitted). Rural and urban group definition as in Table 2. Mixed urban-rural couples excluded. Standard errors clustered at the regional level in parentheses.

Source: PNAD 1981-90, 1992-93, 1995-99.

While the results suggest that the pension reform made it more likely for women to have fewer children, does it also make women stop having children altogether? If children were predominantly reared for old-age provision, the need to have any children would be dramatically reduced after the reform. However, we find no evidence for an increase in childlessness after the pension expansion: Figure A14 shows that the fraction of women aged 45 who have never given birth to a child

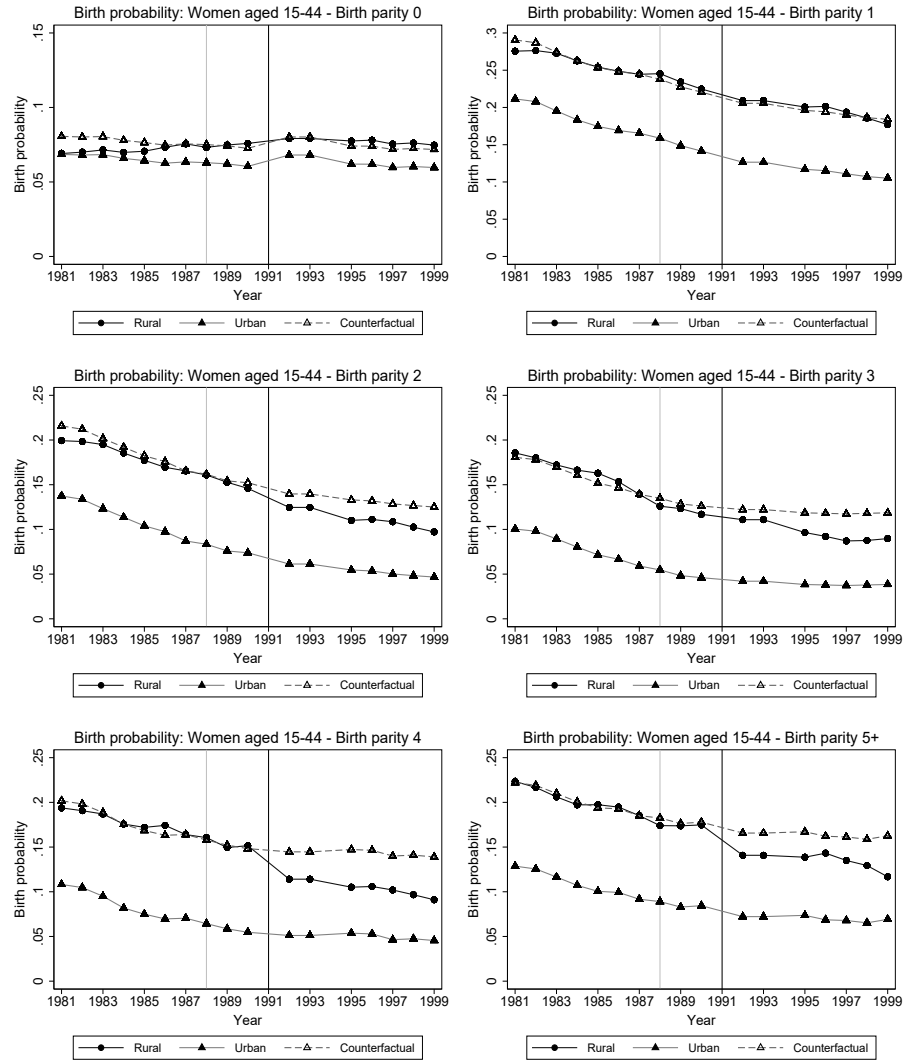


FIGURE 6. BIRTH PROBABILITIES BY BIRTH PARITY

Note: Graphs show 3-year moving averages (2-years at the edges: 1981-82, 1989-90, 1992-93 and 1998-99) of birth probabilities, i.e., average childbearing (0/1) rates within the last 12 months, by birth parity (the number of previous children) up to 5+. Counterfactual trend as of 1987: gray dashed line. Vertical lines: new Constitution approved in 1988 (light-gray); Pension reform implemented in 1991 (black). Rural and urban groups are defined as in Table 2. Mixed urban-rural couples excluded.

Source: PNAD 1981-90, 1992-93, 1995-99.

remained quite stable at 11% for urban women and 8% for rural women, although the modest sample sizes lead to bumpy time series. Nevertheless, there is no clear indication of a higher prevalence of childlessness in the post reform period.

D. Gender of Previously Born Children: DID Estimation

We find significant differences in the probability of childbearing between women who have at least one son, at least two sons, only daughters or no children at all. For these four samples, Figure 7 shows the probabilities of childbearing in the past 12 months (Figure A15 for women aged 15-29 and women aged 30-44 separately). Figure 7 shows consistent declines in childbearing only for women with at least one or two previously born sons. Once we turn to the econometric evaluation in a DID framework (Table 6), we find strong and significant effects only for the overall sample of women with at least one or two boys, a result that is entirely driven by older women aged 30-44. This group reduces the probability of childbearing in the past 12 months by about 30%. Women without children do not reduce fertility in any of the three age samples.

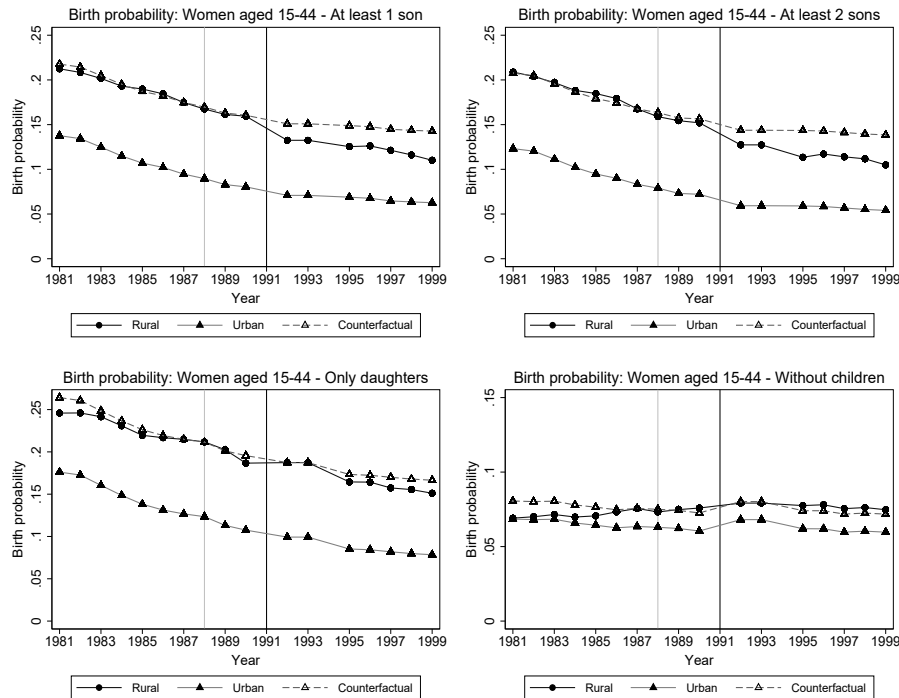


FIGURE 7. BIRTH PROBABILITIES BY OLDER CHILDREN'S GENDER: WOMEN AGED 15-44

Note: Graphs show 3-year moving averages (2-years at the edges: 1981-82, 1989-90, 1992-93 and 1998-99) of birth probabilities, i.e., average childbearing (0/1) rates within the last 12 months, conditional on whether women had already given birth to at least one son, at least two sons, only daughters or no children at all. Counterfactual trend as of 1987: gray dashed line. Vertical lines: new Constitution approved in 1988 (light-gray); Pension reform implemented in 1991 (black). Rural and urban groups are defined as in Table 2. Mixed urban-rural couples excluded.

Source: PNAD 1981-90, 1992-93, 1995-99.

TABLE 6—DiD REGRESSION RESULTS: BY OLDER CHILDREN'S GENDER (WOMEN AGED 15-44)

Dependent Variable	Newborn child under 1 year old (0/1)				
	(1) Full sample	(2) 1+ sons	(3) 2+ sons	(4) Only daughters	(5) No children
DID women aged 15-44	-0.009 (0.003)	-0.024 (0.005)	-0.032 (0.005)	-0.002 (0.006)	0.009 (0.002)
in % to baseline	-7.6	-17.9	-22.5	-1.8	8.9
DID women aged 15-29	0.003 (0.003)	-0.008 (0.007)	-0.012 (0.009)	0.012 (0.011)	0.011 (0.002)
in % to baseline	2.2	-3.8	-5.4	4.9	11.7
DID women aged 30-44	-0.024 (0.004)	-0.030 (0.005)	-0.037 (0.006)	-0.012 (0.006)	0.006 (0.003)
in % to baseline	-24.1	-27.1	-29.5	-12.8	12.2
Year and region FE	Yes	Yes	Yes	Yes	Yes
Covariates (see note)	Yes	Yes	Yes	Yes	Yes
<i>N</i> 15-44:	1,442,376	575,792	264,343	183,900	682,684
<i>N</i> 15-29:	854,814	188,577	59,187	89,762	576,475
<i>N</i> 30-44:	587,562	387,215	205,156	94,138	106,209
R^2 15-44:	0.107	0.079	0.113	0.082	0.199
R^2 15-29:	0.142	0.056	0.136	0.065	0.225
R^2 30-44:	0.058	0.056	0.068	0.057	0.118

Note: DID estimates of the pension reform. Dependent variable: Dummy, whether a child was born in the last 12 months. Full set of covariates, as in Table 3, column 6. Rural and urban group definition as in Table 2. Mixed urban-rural couples excluded. Standard errors clustered at the regional level in parentheses.

Source: PNAD 1981-90, 1992-93, 1995-99.

E. Long-Run Effects: ES Estimation

The introduction of the Brazilian rural old-age pension led to a significant gradual decline in women's completed fertility rate (total number of births at age 45), as depicted in the rural vs. urban time series (Figure 8, left panel): While rural women had on average about 7.1 children in the 1970s and early 1980s, the comparable number was 4.8 children for urban women. This sizeable gap of 2.3 children between both groups remained constant up to the year of the pension reform (1991) albeit fertility levels declined by one child per woman. In 2010, rural (urban) women now have on average about 3.6 (2.3) children, suggesting a strong decline of the urban-rural gap.

The right panel of Figure 8 depicts estimates of our long-run ES approach, i.e., the completed fertility gap between urban and rural women compared to the base year 1987: The estimates fluctuate closely around zero until the year when the rural pension was introduced. After 1991, completed fertility rates declined at much faster pace in rural than in urban areas (with a modest and plausible lag

of one to two years). Until 2010, the rural-urban gap has shrunk by about 1.3 births per women.²³ The first year in which the estimator for completed fertility turns significant is 1994. This implies a quick fertility reduction among 45 year old women after the pension reform: The introduction of rural pensions has an economically significant and lasting effect on fertility in Brazil.

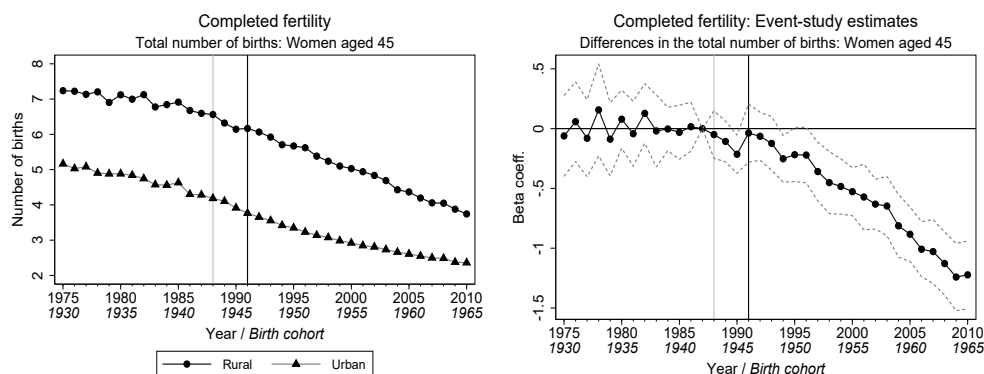


FIGURE 8. COMPLETED FERTILITY: TOTAL BIRTHS AND DIFFERENCES IN TOTAL BIRTHS AT THE AGE OF 45

Note: Left graph shows the average total number of births (alive and dead) of women at age 45. Right graph shows ES estimates of the pension reform for the total number of births (alive and dead) of women at the age of 45 before and after the reform. 90% confidence interval based on standard errors clustered at the regional (federal state) level. Vertical lines: new Constitution approved in 1988 (light-gray); Pension reform implemented in 1991 (black). Rural and urban groups are defined as in Table 2.

Source: PNAD 1984-85, 1992-93, 1995-99, 2001-09, 2011-14.

The causal interpretation of the long-run fertility decline deserves two notes of caution: First, potential confounders are probably more prevalent in the long-run assessment; possible examples are the introduction of Bolsa Familia in 2004 and the financial crisis of the late 2000s. Second, sample sizes become relatively small in the final years of the observation window; we therefore trim the graph in 2010. There is some indication for a flattening out of the fertility decline when we add data points for 2011-2014 (Figure A16).

Long-run declines in fertility can partly and mechanically mediate some of the observed effect of the pension reform on per capita poverty reduction and school enrollment (Schwarzer, 2000; Schwarzer and Querino, 2002; De Carvalho Filho, 2008).

²³Focusing only on women's pension wealth, a 1000 USD increase in pension wealth between a 45 year old women in 1988-90 and a 45 year old women in 2012-14 leads to a reduction of 0.254 children. Accounting for a couple's joint pension wealth, the corresponding effect is 0.12 children.

F. *Methods of Fertility Control*

How was the observed reduction in fertility achieved? In Brazil, the dominant mode of contraception is female sterilization, according to DHS data. Importantly, we observe nationwide and complete knowledge of and access to different methods of contraception already before the pension reform (Table A15, Panel C). Already in the 1980s, female sterilization was the most widely used contraceptive method, especially among older women (28-36%, 1986 DHS data). Nevertheless, while contraceptive use of the pill remained roughly constant in the decade following 1986, female sterilizations soared by 33% in urban and 104% in rural areas. Also, the age of sterilization dropped substantially stronger in rural areas. These results suggest that a reliable and irreversible method of fertility control was chosen to achieve the fertility decline.

G. *Financial Gap in the PAYG Pension System*

Given its favorable demographic composition in the decades prior to 1988, Brazil opted (like most developing countries) for a Pay-As-You-Go (PAYG) pension scheme. In PAYG systems large cohorts of young workers provide for the smaller cohorts of concurrent retirees. The Brazilian pension reform, however, does not only increase the benefit (i.e., expenditure) side of the social security system by expanding generosity; it also reduces the contribution (i.e., income) base by lowering the number of future contributors through today's reduced fertility. To illustrate the total financial gap in the Brazilian PAYG system we conduct a simple static back-of-the-envelope calculation, after fertility levels have adjusted to the new equilibrium. We decompose the total reform effect into a 'generosity effect' and a 'contribution base effect'.

Assuming that the PAYG system is actuarially fair the benefit side with average pension payment B being paid out to N recipients for 13 monthly installments will equal the contribution side with L contributors having paid twelve monthly contributions C . The pension reform makes pensions more generous and, hence, costly. It introduces a rise in the benefit level B and a growth in the number of pension recipients N . At the same time the reform reduces the fiscal base of contributions by reducing the future number of contributors L through the fertility effect (-1.3 children per rural woman) while keeping C constant. Rural workers' contributions are independent of their personal labor income and funded through a merchandise tax for agricultural output, a cross-subsidy from urban social insurance contributions and supplements by the Federal Treasury (Table A2).

The total long-run financial gap resulting from the reform in the Brazilian PAYG system is:

$$(5) \quad -(\Delta B \times 13 \times \Delta N) \times (1 + AC) + (C \times 12) \times \Delta L$$

with the administrative cost AC of the pension system being assumed to equal

either 7% (Mitchell, 1998), 10.75% (Zockun, 1983) or 14.5%.²⁴

We now estimate the relative contributions of the ‘generosity effect’ vs. the ‘contribution base effect’ using PNAD data, based on the assumption that environmental factors such as earnings²⁵ or immigration and policy variables such as tax rates or social security contributions remain constant (Table 7). Expressed as a fraction of GDP, the total funding gap with $AC = 10.75\%$ is around 0.7% in 1995, 0.9% in 2001, 1.1% in 2005 and 1.7% in 2011. These results are consistent with the World Bank (2003), which reports that the Brazilian Pension System for the private sector reached a deficit of 0.9% of GDP in 1999. Importantly, the ‘generosity effect’ accounts for only a modest part of the total financial gap (about 20% in 2011), while the ‘contribution base effect’ of the fertility decline weighs heavily from an actuarial perspective.

TABLE 7—FUNDING GAP OF THE BRAZILIAN PAYG PENSION SYSTEM AS A RESULT OF THE REFORM (IN % OF GDP), FOR DIFFERENT ADMINISTRATIVE COST (AC) ASSUMPTIONS

Generosity effect			Contribution base effect			Total financial gap		
7%	10.75%	14.5%	7%	10.75%	14.5%	7%	10.75%	14.5%
1995			1995			1995		
0.07	0.08	0.08	0.51	0.51	0.51	0.58	0.58	0.59
2001			2001			2001		
0.12	0.12	0.12	0.74	0.75	0.76	0.86	0.87	0.89
2005			2005			2005		
0.18	0.19	0.19	0.86	0.87	0.89	1.03	1.05	1.07
2011			2011			2011		
0.34	0.35	0.37	1.31	1.34	1.37	1.65	1.69	1.74

Note: The table shows calculations of the long term financial gap of the Brazilian PAYG pension system as a result of the reform (in % of GDP as of 2012), decomposed into a ‘generosity effect’ and a ‘contribution base effect’. The long term loss in rural payroll contributors is computed as the difference between the observed number of children and the hypothetical number of children if completed fertility was 1.3 children higher per rural women. Average pension payments and pension recipients are taken from the PNAD. Pension scheme contributions: Monthly average gross income \times 10% (employees average contribution rate) + monthly average gross income \times 28% (employers average contribution rate). Average gross income: Average net income + Average net income \times 18% (the average marginal tax rate).

Source: PNAD 1981-90, 1992-93, 1995-99, 2001-09, 2011-14.

²⁴The World Bank (2005) reports administrative costs of the Brazilian pension system of 10-15%.

²⁵While contributions indeed remained constant, improvements in education (of 3.66 school years between 1990 and 2010) possibly mitigate the funding gap by up to 10-25% 10-20 years after the reform according to our calculations, especially if returns to education are assumed to remain stable at 7% (Brotherhood, Ferreira and Santos, 2019).

This computation illustrates the economic significance of the estimated fertility effect: Fertility consequences of public pension policies are economically costly and can affect the sustainability and political acceptance of a PAYG pension system in the long-run.

VI. Robustness

In this section we discuss the robustness of our results. First, we analyze more granular age groups. Second, we investigate alternative specifications regarding control variables and time trends. Third, we test the sensitivity of our results with respect to regional, occupational and age-specific sample choices. Fourth, we address alternative error correlation structures.

A. Analysis of Granular Age Groups

Our main findings suggest that younger and older women respond differently to the pension reform. To investigate the relationship between age and effect size further we assess DID estimators in six five-year age cohorts (15-19; 20-24; 25-29; 30-34; 35-39; 40-44). Separate regressions suggest (Table A17) no significant negative fertility response among the youngest three groups. The three oldest age groups exhibit highly significant negative fertility responses to the pension reform. The relative reduction in fertility (conditional on the cohort-specific baseline fertility rate) is increasing with age. While women aged 30-34 reduce their probability of childbearing by 21%, the corresponding values are 25% and 33% for women aged 35-39 and 40-44.

In a further refinement we estimate model (1) for fifteen 2-year age cohorts. Again, only women in the middle or late phase of their fertility cycle exhibit a significantly negative fertility response to the pension reform (Figure A17).

B. Alternative Specifications

Alternative model specifications tend to provide very similar results: In Table A18, col. 1 we control for alternative educational variables. While average years of schooling (our control variable in the main analysis) progressed on similar trajectories between urban and rural women, we observe growth in primary school degrees by 15 percentage points in rural and 10 percentage points in urban areas between 1981 and 1991 (Figure A18); the main contributor of this rise stems from the introduction of compulsory education for adults after 1988. This was accompanied by rising shares of secondary and tertiary attainments among urban women. Hence, we amend our previous regression (1) by adding dummy variables for the highest degree obtained (primary, secondary or tertiary) as well as a dummy for literacy. In the following columns we control for the share of retirement income in total household income (col. 2), for family income variables

such as the log of monthly family income without pensions and the share of family income earned by the woman (col. 3), for two dummies indicating whether the woman worked unpaid or in the public sector (col. 4), for additional square terms of years of schooling, log of household income without pensions, share of family income earned by the woman and household wealth (col. 5), for age and age of the woman's partner as linear terms (col. 6), and for age and age of the woman's partner as linear and quadratic terms (col. 7). We also assess the sensitivity of our results by re-estimating model (1) with linear time trends and linear region-specific time trends (Table A19). There might be fertility and labor supply responses due to the income effect emerging from co-residing pensioners. We test the robustness of our results by distinguishing between women co-residing vs. not co-residing with a pensioner (Table A20). None of the alternative specifications alters our main results.²⁶

C. Sample Selection

We conduct a series of robustness checks regarding sample choices: First, we re-run our analysis in all three types of residential areas separately: So-called not self-representative municipalities (Table A21, Panel A), which are included in the PNAD sample only with a probability proportional to the inhabitant population; self-representative areas (Table A21, Panel B), which are completely sampled; and Metropolitan areas (Table A21, Panel C). Despite substantially smaller sample sizes, our results are preserved in all three subgroups: Birth probabilities are negatively affected in the full sample (statistical significance is not always maintained); the effect is not different from zero among younger women and significantly negative among older women.

Second, we re-define treatment vs. control groups: (1) using only household residence, (2) using only personal occupational information and household residence, and (3) using only personal and family head occupational information (Table A4). Our results are robust across different treatment specifications.

Third, we include couples in which wife and husband work in different occupational areas, i.e., in a rural and an urban occupation (Table A5). This increases the sample size by 7.3%, but does not change any of the results no matter whether we control with a dummy indicator for these added women (Panel A) or not (Panel B).

Fourth, we exclude 1623 women (0.1% of the sample) who gave birth at ages younger than 15 years or older than 44 years and who were previously recoded as 15 or 44 years old as is standard in much of the demographic literature (Table A3). Again, the omission of these women has no effect on the results.

Fifth, we can also rule out that women postpone childbearing beyond the cut-off age of 45 years (for instance, if the oldest mothers were 38 years old in 1985

²⁶Our results are also robust to omitting women who receive a pension already at young age (e.g., disability pension), affecting 0.5% of the sample (results are available on request).

but 47 years old in 1995). Figure A19 shows age density-plots for childbearing women in 1985 and 1995. Over time, female rural and urban women tend to give birth earlier as described in the literature (Rios-Neto, Miranda-Ribeiro and Miranda-Ribeiro, 2018).

D. Standard Errors

The error terms in model (1) are likely to be correlated between individuals. To account for this intra-group correlation in our main analysis we cluster standard errors at the regional level (States of the Brazilian Federation). As a robustness check we cluster standard errors at the level of regions and settlement types: Increasing the number of clusters from 26 to 60 does not alter the results (Table A22).

As we exploit data covering a relatively long observation period, fertility rates may suffer from autocorrelation. As illustrated by Bertrand, Duflo and Mullainathan (2003), this can inflate the incidence of Type-I error and lead to significant estimates even in the absence of a true effect. To account for potential autocorrelation in fertility rates we reduce the annual observations of the outcome variable into one pre- and one post-treatment mean observation per group and region. We then repeat our analysis with this ‘collapsed’ outcome variable (only 104 different observations). We still find highly significant negative policy effects for older women and a slightly weaker average effect for all women (Table A23, col. 6). These findings based on only two time periods suggests that autocorrelation is not a major threat to our analysis.

VII. Conclusions

This study estimates the causal effect of expanding public old-age pensions on individual fertility behavior. Exploiting the Brazilian pension reform of 1991 we find that the associated increase in pension wealth has a significant negative effect on fertility: The reform reduced the probability of childbirth by 8% in the short-run and completed fertility by about 1.3 within the first 20 years after the reform. The decrease of the childbearing probability is fully concentrated among women in the middle and late phases of their fertility cycle (aged 30-44), among women with more children and among women who already have a son in the family. A number of robustness checks and falsification exercises support the causal interpretation of the policy effects of the Brazilian pension reform.

Our results lend micro evidence to the long established view that the introduction of pension systems in emerging and developing countries is associated with declining fertility rates at the macro level. The findings bolster the old-age security hypothesis and confirm the credibility of negative correlations found in previous empirical studies using aggregate data. Of course, a note of caution is warranted with respect to the external validity: Our quasi-experiment in Brazil relies on an unusual equalization of pension benefits between urban and rural

areas. Still, many pension schemes in emerging and developing countries disadvantage (or fully exclude) rural populations similar to the system that underwent reform in Brazil in the early 1990s.

Our results are politically relevant in the light of population aging in low- and middle-income countries (LMICs). According to the United Nations (2017), the most rapid demographic aging is projected to take place in LMICs: by 2050, 80% of the world's elderly (age 60+) will be living in those countries. Since most LMICs are insufficiently prepared for the upcoming demographic change, they may experience dramatic economic and social repercussions. While longer lives represent one of the greatest benefits from economic development, governments and societies around the globe have to consider how to provide for the growing number of old citizens. For most countries, public old-age pension systems are a major pillar to grant citizens economic security during retirement (Barr and Diamond, 2009; Holzmann and Hinz, 2009; Willmore, 2007). However, in LMICs these programs are often not generous, exclusive, and complicated with respect to eligibility criteria. In particular, only few of these programs cover the rural population and low-income or informal-sector workers. Improving coverage and benefit levels of pension systems in LMICs is one of the key challenges of the next decades given widespread old-age poverty (World Bank, 2017). From our perspective it is essential that policymakers consider the fertility effects of reforming public pensions, especially when declining fertility can erode the basis of PAYG systems. Avoiding unintended demographic consequences of reforms will make pension systems more sustainable in the long-run.

REFERENCES

- Amuedo-Dorantes, Catalina, and Laura Juarez.** 2015. "Old-Age government transfers and the crowding out of private gifts: the 70 and above program for the rural elderly in Mexico." *Southern Economic Journal*, 81(3): 782–802.
- Anderson, C Leigh, Maya Dietz, Andrew Gordon, and Marieka Klawitter.** 2004. "Discount rates in Vietnam." *Economic Development and Cultural Change*, 52(4): 873–87.
- Arnold, Fred.** 1992. "Sex preference and its demographic and health implications." *International Family Planning Perspectives*, 18(1): 93–101.
- Azzoni, Carlos R., and Joao Y. Isai.** 1994. "Estimating the costs of environmental protection in Brazil." *Ecological Economics*, 11(2): 127–133.
- Barclay, Kieron, and Martin Kolk.** 2019. "Parity and mortality: an examination of different explanatory mechanisms using data on biological and adoptive parents." *European Journal of Population*, 35(1): 63–85.
- Barrientos, Armando.** 2013. "The rise of social assistance in Brazil." *Development and change*, 44(4): 887–910.

- Barr, Nicholas, and Peter Diamond.** 2009. *Reforming pensions. Principles and policy choices.* Oxford and New York: Oxford University Press.
- Barsted, Leila.** 2005. "The legal status of women in the context of agrarian reform." In *FAO: Gender and land compendium of country studies. Food and Agriculture Organization of the United Nations: Rome..* Columbia University Press.
- Becker, Gary S, and Casey B Mulligan.** 1997. "The endogenous determination of time preference." *Quarterly Journal of Economics*, 112(3): 729–758.
- Becker, Gary S, Kevin M Murphy, and Robert Tamura.** 1990. "Human capital, fertility, and economic growth." *Journal of Political Economy*, 98(5): 12–37.
- Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan.** 2003. "How much should we trust differences-in-differences estimates?" *Quarterly Journal of Economics*, 119(1): 249–275.
- Billary, Francesco C., and Vincenzo Galasso.** 2009. "What explains fertility? Evidence from Italian pension reforms." CESifo Working Paper, Munich.
- Boldrin, Michele, and Larry E. Jones.** 2002. "Mortality, fertility, and saving in a Malthusian economy." *Review of Economic Dynamics*, 5(4): 775–814.
- Boldrin, Michele, Mariacristina De Nardi, and Larry E. Jones.** 2015. "Fertility and social security." *Journal of Demographic Economics*, 81(3): 261–299.
- Borges, André.** 2008. "State government, political competition and education reform: comparative lessons from Brazil." *Bulletin of Latin American Research*, 27(2): 235–254.
- Bosch, Mariano, Edwin Goni, and William F Maloney.** 2007. "The determinants of rising informality in Brazil: evidence from gross worker flows." World Bank Policy Research Working Paper 4375, World Bank: Washington, DC.
- Braga, Breno.** 2018. "The effects of trade exposure on marriage and fertility choices: evidence from Brazil." Institute of Labor Economics (IZA), Bonn. IZA Discussion Papers 11875.
- Brotherhood, Luiz Mário, Pedro Cavalcanti Ferreira, and Cezar Santos.** 2019. "Education quality and returns to schooling: evidence from migrants in Brazil." *Economic Development and Cultural Change*, 67(3): 439–459.
- Caetano, André J, and Joseph E Potter.** 2004. "Politics and female sterilization in Northeast Brazil." *Population and Development Review*, 30(1): 79–108.

- Cai, Fang, John Giles, and Xin Meng.** 2006. "How well do children insure parents against low retirement income? An analysis using survey data from urban China." *Journal of Public Economics*, 90(12): 2229–2255.
- Cain, Mead.** 1981. "Risk and insurance: perspectives on fertility and agrarian change in India and Bangladesh." *Population and Development Review*, 7(3): 435–474.
- Chiavegatto Filho, Alexandre Dias Porto, and Ichiro Kawachi.** 2013. "Are sex-selective abortions a characteristic of every poor region? Evidence from Brazil." *International Journal of Public Health*, 58(3): 395–400.
- Cigno, Alessandro, and Furio C Rosati.** 1996. "Jointly determined saving and fertility behaviour: theory, and estimates for Germany, Italy, UK and USA." *European Economic Review*, 40(8): 1561–1589.
- Covre-Sussai, Maira.** 2016. "Socioeconomic and cultural features of consensual unions in Brazil." *Revista Brasileira de Estudos de População*, 33: 53–74.
- Danzer, Alexander M.** 2013. "Benefit generosity and the income effect on labour supply: quasi-experimental evidence." *Economic Journal*, 123(571): 1059–1084.
- De Carvalho Filho, Irineu Evangelista.** 2008. "Old-age benefits and retirement decisions of rural elderly in Brazil." *Journal of Development Economics*, 86(1): 129–146.
- De Carvalho Filho, Irineu Evangelista.** 2012. "Household income as a determinant of child labor and school enrollment in Brazil: Evidence from a social security reform." *Economic Development and Cultural Change*, 60(2): 399–435.
- Deere, Carmen Diana, and Magdalena León.** 2001. *Empowering women: land and property rights in Latin America*. University of Pittsburgh Press: Pittsburgh, USA.
- Deere, Carmen Diana, and Magdalena León.** 2003. "The gender asset gap: land in Latin America." *World Development*, 31(6): 925–947.
- Delgado, Guilherme C, and José Celso Cardoso Jr.** 2005. "Ageing and rural social security: the recent experience of Brazilian universalization." In *Sixty plus: The elderly Brazilians and their new social roles.*, ed. A Camarano, 291–316. Instituto de Pesquisa Econômica Aplicada, Brasília.
- De Mello, Luiz, and Mombert Hoppe.** 2005. "Education attainment in Brazil: the experience of FUNDEF." OECD Economics Department Working Papers 424, OECD Publishing, Paris.

- De Paiva Abreu, Marcelo.** 2004. "Trade liberalization and the political economy of protection in Brazil since 1987." Working Paper SITI 8, Inter-American Development Bank, Washington, DC.
- Dias, Guilherme Leite da Silva, and Cicely Moitinho Amaral.** 2001. "Mudanças estruturais na agricultura brasileira, 1980-1998." In *Brasil: uma década em transição..*, ed. Renato Baumann, 223–253. Campus CEPAL, Rio de Janeiro.
- Dix-Carneiro, Rafael, and Brian K. Kovak.** 2017. "Trade liberalization and regional dynamics." *American Economic Review*, 107(10): 2908–2946.
- Duflo, Esther.** 2003. "Grandmothers and granddaughters: old-age pensions and intrahousehold allocation in South Africa." *World Bank Economic Review*, 17(1): 1–25.
- Ehrlich, Isaac, and Jian-Guo Zhong.** 1998. "Social security and the real economy: an inquiry into some neglected issues." *American Economic Review*, 88(2): 151–57.
- Ehrlich, Isaac, and Jinyoung Kim.** 2007. "Social security and demographic trends: theory and evidence from the international experience." *Review of Economic Dynamics*, 10(1): 55–77.
- Fenge, Robert, and Beatrice Scheubel.** 2017. "Pensions and fertility: back to the roots." *Journal of Population Economics*, 30(1): 93–139.
- Gaddis, Isis, and Janneke Pieters.** 2017. "The gendered labor market impacts of trade liberalization: evidence from Brazil." *Journal of Human Resources*, 52(2): 457–490.
- Galasso, Vincenzo, and Paola Profeta.** 2018. "When the state mirrors the family: the design of pension systems." *Journal of the European Economic Association*, 16(6): 1712–1763.
- Galasso, Vincenzo, Roberta Gatti, and Paola Profeta.** 2009. "Investing for the old age: pensions, children and savings." *International Tax and Public Finance*, 16(4): 538–559.
- Granger, Clive W.J.** 1969. "Investigating causal relations by econometric models and cross-spectral methods." *Econometrica*, 37(3): 424–438.
- Herzog, Lawrence A.** 2018. "Suburbanization in Latin America." In . , ed. Bernadette Hanlon and Thomas J. Vicino. *The Routledge Companion to the Suburbs*, Chapter 5. Routledge.
- Hoddinott, John.** 1992. "Rotten kids or manipulative parents: Are children old age security in Western Kenya?" *Economic Development and Cultural Change*, 40(3): 545–565.

- Hohm, Charles F.** 1975. "Social security and fertility: an international perspective." *Demography*, 12(4): 629–644.
- Holzmann, Robert, and Richard Hinz.** 2009. *Old age income support in the 21st Century: an international perspective on pension systems and reform*. Washington, DC: World Bank.
- Hunter, Wendy, and Natasha Borges Sugiyama.** 2009. "Democracy and social policy in Brazil: advancing basic needs, preserving privileged interests." *Latin American Politics and Society*, 51(2): 29–58.
- Jensen, Eric R.** 1990. "An econometric analysis of the old-age security motive for childbearing." *International Economic Review*, 31(4): 953–968.
- Jensen, Robert T.** 2004. "Do private transfers 'displace' the benefits of public transfers? Evidence from South Africa." *Journal of Public Economics*, 88(1-2): 89–112.
- Kumar, Anjali.** 2005. *Access to financial services in Brazil*. Washington, DC: World Bank.
- La Ferrara, Eliana, Alberto Chong, and Suzanne Duryea.** 2012. "Soap operas and fertility: evidence from Brazil." *American Economic Journal: Applied Economics*, 4(4): 1–31.
- Leibenstein, Harvey.** 1957. *Economic backwardness and economic growth*. New York: John Wiley.
- Leibenstein, Harvey.** 1975. "The economic theory of fertility decline." *Quarterly Journal of Economics*, 89(1): 1–31.
- Lui Gallassi, Ada Carolina.** 2012. "The impact of the Brazilian social insurance law on its people's retirement preparation." Lund University, Faculty of Social Sciences, Thesis.
- Martine, George.** 1996. "Brazil's fertility decline, 1965-95: a fresh look at key factors." *Population and Development Review*, 22(1): 47–76.
- Melo, Marcus André.** 2017. "Political and institutional drivers of social security universalization in Brazil." *Towards universal health care in emerging economies: opportunities and challenges*, , ed. Ilcheong Yi, 155–179. London: Palgrave Macmillan UK.
- Ministério da Saúde.** 2008. "Saúde da Família no Brasil, uma análise de indicadores selecionados 1998-2005/2006." Ministério da Saúde: Brasília.
- Mitchell, Olivia S.** 1998. "Administrative costs in public and private retirement systems." In *Privatizing Social Security*, , ed. Martin Feldstein, 403–456. University of Chicago Press.

- Neher, Philip A.** 1971. "Peasants, procreation, and pensions." *American Economic Review*, 61(3): 380–389.
- Neri, Marcelo Côrtes.** 2002. "Decent work and the informal sector in Brazil." FGV EPGE Economics Working Papers 461, EPGE Brazilian School of Economics and Finance, Rio de Janeiro.
- Nugent, Jeffrey B.** 1985. "The old-age security motive for fertility." *Population and Development Review*, 11(1): 75–97.
- Nugent, Jeffrey B., and R. Thomas Gillaspay.** 1983. "Old age pensions and fertility in rural areas of less developed countries: some evidence from Mexico." *Economic Development and Cultural Change*, 31(4): 809–829.
- Oliveira, Jaqueline.** 2016. "The value of children: inter-generational support, fertility, and human capital." *Journal of Development Economics*, 120: 1–16.
- Onsrud, Hazel, Silvane Paixao, and Sue Nichols.** 2006. "Women and land reform in Brazil." Department of Geodesy and Geomatics Engineering, Technical Report No. 239, University of New Brunswick, Fredericton, New Brunswick, Canada.
- Reynolds, Sarah Anne.** 2018. "Sex of children and family structure in Brazil: father & grandmother bias?" *Revista Brasileira de Estudos de População*, 35(1): 1–29.
- Rios-Neto, Eduardo L. G., Adriana Miranda-Ribeiro, and Paula Miranda-Ribeiro.** 2018. "Fertility differentials by education in Brazil: from the conclusion of fertility to the onset of postponement transition." *Population and Development Review*, 44(3): 489–517.
- Rocha, Romero, and Rodrigo R Soares.** 2010. "Evaluating the impact of community-based health interventions: evidence from Brazil's Family Health Program." *Health economics*, 19(S1): 126–158.
- Saad, Paulo Murad.** 1998. *Support transfers between the elderly and the family in Southeast and Northeast Brazil*. Dissertation. The University of Texas at Austin.
- Schwarz, Anita M., Omar S. Arias.** 2014. *The inverting pyramid: pension systems facing demographic challenges in Europe and Central Asia*. Washington, DC: World Bank.
- Schwarzer, Helmut.** 2000. "Impactos socioeconômicos do sistema de aposentadorias rurais no Brasil: evidências empíricas de um estudo de caso no Estado do Pará." IPEA Discussion Paper 729, Instituto de Pesquisa Econômica Aplicada (IPEA), Rio de Janeiro.

- Schwarzer, Helmut, and Ana Carolina Querino.** 2002. "Non-contributory pensions in Brazil: The impact on poverty reduction." ESS Paper 11, Social Security Policy and Development Branch, International Labour Office, Geneva.
- Swidler, Steve.** 1983. "An empirical test of the effect of social security on fertility in the United States." *The American Economist*, 27(2): 50–57.
- United Nations.** 2017. "World population ageing 2017." United Nations, Department of Economic and Social Affairs, Population Division, New York.
- Willmore, Larry.** 2007. "Universal pensions for developing countries." *World Development*, 35(1): 24–51.
- World Bank.** 2003. *Rural poverty alleviation in Brazil: toward an integrated strategy*. Washington, DC: World Bank.
- World Bank.** 2005. "Averting the old age crisis: policies to protect the old and promote growth." World Bank Report, Washington, DC: World Bank.
- World Bank.** 2017. "Pension funds & insurance." The World Bank Brief, Published on June 9, 2017, URL: <http://www.worldbank.org/en/topic/financialsector/brief/pension-funds>, retrieved November 3, 2017.
- Zockun, M.H.** 1983. "Custo operacional do sistema de Previdência Social." Informações FIPE 155, Fundação Instituto de Pesquisas Econômicas, Sao Paulo.