Persuasion: A Case Study of Papal Influences on Fertility-Related Beliefs and Behavior*

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Abstract

We study the persuasive impacts of non-informative communication on the short-run beliefs *and* long-run behavior of individuals. We do so in the context of the Papal visit to Brazil in October 1991, in which persuasive messages related to fertility were salient in Papal speeches during the visit. We use individual's exposure to such messages to measure how persuasion shifts: (i) short-run beliefs such as intentions to contracept; (ii) long-term fertility outcomes, such as the timing and total number of births. To measure the short run causal impact of persuasion, we exploit the fact the Brazil 1991 DHS was fielded in the weeks before, during and after the Papal visit. We use this fortuitous timing to identify that persuasion significantly reduced individual intentions to contracept by more than 40% relative to pre-visit levels, and increased the frequency of unprotected sex by 30%. We measure the long-run causal impacts of persuasion on fertility outcomes using later DHS surveys to conduct an event study analysis on births in a five year window either side of the 1991 Papal visit. Estimating a hazard model of fertility, we find a significant change in births nine months post-visit, corresponding to a 1.6% increase in the aggregate birth cohort. Our final set of results examine the *very long run* impact of persuasion and document the impacts to be on the timing of births rather than on total fertility. *JEL Codes: D83, J13, N36.*

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1 Introduction

The beliefs individuals hold are central to economic decision making. Economists have emphasized two channels for belief formation: (i) *direct observation*: where beliefs change through private and social learning; (ii) *persuasion*: where beliefs are altered through communication by motivated agents. This paper focuses on the second channel and provides evidence on the causal impact of persuasion on the beliefs *and* actual behavior of individuals. We do so by studying the persuasive impacts of national visits by Pope John Paul II, on the fertility-related beliefs and outcomes of individuals resident in the visited country.[1]

The Papal visits we study provide individuals with intense exposure to persuasive messages related to Catholic Church doctrine as embodied in Papal speeches, media coverage of the visit, and changes in behavior of other local church leaders in response to the visit. Such visits do not provide any *new* information to Catholics: the issues salient in Papal speeches are typically in line with mainstream Catholic doctrine. However, non-informative dimensions of communication can affect belief formation through salience, attention and framing [Mullanaithan *et al.* 2008].

We use this setting to address three research questions. First, do individual fertility-related beliefs, such as the intent to contracept and ideal family size, shift in response to exposure to persuasive messages during a Papal visit? Second, does this change in beliefs translate into actual changes in fertility behavior, as measured by a shift in births occurring nine months after the Papal visit? Third, are there *longer term* impacts of persuasion on total fertility, or do such visits only impact the timing of births?

The choice to study these questions in the context of the Papal visit to Brazil in October 1991 is driven by three factors. First, fertility related issues were salient in Papal speeches in this visit, with recurring themes being: (i) the condemnation of practices such as contraceptive use, abortion and family planning; (ii) the importance of marriage and generating offspring. Second, the Brazil 1991 Demographic and Health Survey (DHS) was *in the field* precisely in the weeks before, during and after the Papal visit in October 1991. The survey, that is fielded to women, records exact dates of interview, as well as detailed information on fertility-related beliefs. We exploit this fortuitous timing in a novel research design to identify the causal impacts of persuasion during the visit on women's fertility related beliefs. Third, the same Pope had visited Brazil on earlier occasions. We can thus document how the topics salient during the 1991 visit differed from those salient in other visits and use this variation across visits to isolate whether the mere *presence* of the Pope impacts fertility behaviors, as could be driven by media reporting of wider Catholic doctrine, or whether

[1] DellaVigna and Gentzkow [2010] define a persuasive communication to be a message provided by an agent (the sender) with a potential interest in changing the behavior of another agent (the receiver). Two frameworks exist to understand persuasive impacts. In the first, persuasion affects the beliefs individuals hold, where individuals can be Bayesian [Stigler 1961, Crawford and Sobel 1982, Gentzkow and Kamenica 2011], or non-Bayesian, say because either they think categorically [Fryer and Jackson 2008, Mullanaithan *et al.* 2008] or have limited memory/attention [Mullanaithan 2002, Eliaz and Spiegler 2011]. Alternatively, persuasion can affect behavior independent of beliefs as it directly enters utility functions [Stigler and Becker 1977, Becker and Murphy 1993].

there is a *specific* driving force on beliefs and behaviors of the persuasive messages recurring in Papal speeches during the 1991 visit.

To assess the impact of persuasion on actual fertility behaviors, we exploit the Brazil DHS 1996 survey, that records pregnancy histories including the month and year of each birth, to conduct an event study analysis on births in a five year window either side of the 1991 Papal visit. We estimate a hazard model of fertility to establish whether the probability of having a child nine months after the October 1991 Papal visit is significantly higher than otherwise predicted conditional on a non-parametric baseline hazard and other covariates. We also establish whether this shift in births nine months post-visit significantly differs from the hazard of giving birth eight and ten months post-visit.[2]

Any fertility response to persuasion using this identification strategy needs to be carefully interpreted: the nature of contraceptive technology implies not all households *should* be able to induce immediate changes in birth timing as a result of being persuaded. Only those *not contracepting*, or using *unreliable* methods at the time of the visit (such as abstinence, withdrawal or condoms), can plausibly respond. This interlinks with the earlier analysis where we measure whether persuasion impacts intentions to contracept (and the form of contraceptive used), thus potentially leading to a heaping of households onto the margin of being able to immediately respond to persuasion in terms of fertility outcomes. Furthermore, our research design *underestimates* the impact of persuasion on fertility outcomes if some households delay their fertility response to persuasive messages and respond ten or more months post-visit.

Finally, to understand whether Papal persuasion impacts *total* fertility in the long run (and not just the timing of births), we use DHS survey data from 1996 and 2006 to examine entire pregnancy histories of women that gave birth nine months after the 1991 Papal visit relative to those that gave birth in adjacent months.

Our main results are as follows. On the immediate impacts of persuasion on fertility-related beliefs we find women interviewed post-visit are 12.8pp more likely to report not using contraceptives and not planning to do so in the future, relative to those interviewed pre-visit. This corresponds to more than a 40% increase in intentions not to contracept relative to the pre-visit mean of 29.7%, with the impacts being driven by practising Catholics. Examining the *daily* pattern of intentions to contracept, we find a jump in the share of women stating an intent not to contracept that kicks in on the day the Papal visit starts and persists well after the visit ends. These documented impacts are unlikely to reflect mere reporting biases to survey enumerators because: (i) the impacts persist months after the visit actually ends; (ii) we find no post-visit change in in Catholics' responses to other religion-related questions, such as frequency of church attendance.

[2]Newman and McMulloch [1984] were among the first to use hazard models to estimate models of birth timing. This is now the standard empirical formulation for estimating fertility outcomes as it allows for duration dependence, and corrects for censoring bias without introducing selection bias.

As stated above, a second recurring theme of the visit emphasized the importance of producing offspring. We use self-reports on the 'frequency of sexual intercourse' in the DHS 1991 to document a significant increase on this margin among those interviewed post-visit. We then combine this outcome with intentions not to contracept to create a measure of the frequency of *unprotected sex*: this is the core outcome linking changes in fertility beliefs to fertility outcomes. We find the frequency of unprotected sex significantly increases among Catholics interviewed post-visit by 30%, and this effect is concentrated among practising Catholics.

To summarize, the estimated impacts of Papal persuasion operate through two channels: the disutility of contracepting leading to a lower intention to contracept, and an increased frequency of sexual intercourse. These impacts reinforce each other leading to a significantly higher frequency of unprotected sex. It is thus plausible that a positive fertility response could occur as a result of the persuasive messages during the Papal visit. On fertility responses to persuasion, we find a significant increase in the hazard rate for births nine months post-visit conditional on a non-parametric baseline hazard, month and year dummies, mother and household characteristics. We find no evidence of a significant increase in the hazard eight and ten months post-visit. The effect is largely driven by women whose number of children were below their ideal family size at the time of the visit. Taking our preferred estimate and scaling up using census data, the implied increase in the aggregate birth cohort for Brazil in 1992 is $51,971$. As the total birth cohort size was 3.3 million, this implies fertility responses to persuasion corresponded to a 1.6% increase in the size of the aggregate birth cohort.

Investigating further the inter-temporal shift in birth timing induced by persuasion, our estimates reveal there is a significant *reduction* in the hazard 13 and 15 months post-visit. This pattern suggests that among those on the margin of being able to respond to the visit in terms of fertility outcomes, there is a shift of around four to six months in birth *timing* relative to a counterfactual world in which households are not exposed to persuasion.[3]

On the long run impacts of persuasion as measured in the 1996 and 2006 DHS surveys, we find no significant differences between the total fertility outcomes of women that gave birth nine months post-visit relative to mothers that gave birth in adjacent months, albeit in relatively small samples. This long run null impact is in line with stated beliefs around the time of the Papal visit in 1991, where we find no impact of persuasion on respondents' stated *ideal* family size.

Our analysis provides novel contributions to three literatures: on persuasion, on determinants of fertility, and on the impacts of leaders. On persuasion, DellaVigna and Gentzkow [2010] review the evidence that has focused on the response to persuasion by consumers, donors, voters and investors. We contribute to this literature by providing evidence on the impacts of non-informative and highly salient communication from a credible source, on the short-run beliefs *and* long-run

[3]This shift in timing corresponds to unplannedness [Kearney 2009], rather than 'unwantedness' [Rosenzweig and Wolpin 1993, Pop-Eleches 1996].

behaviors of households.[4]

Our work contributes to the literature on the impact of media exposure on fertility and women's status [Chong and La Ferrara 2009, Jensen and Oster 2009, Chong *et al.* 2012, Kearney and Levine 2015]. We provide insights on the impacts on beliefs and behavior of messages of persuasion, and identify those households most susceptible to persuasion. Our analysis of persuasion driving fertility outcomes neatly complements existing work that focuses on how social learning impacts fertility within religious groups [Manski and Mayshar 2003, Munshi and Myaux 2006]. By documenting impacts of persuasion on fertility outcomes, we add to a nascent literature bridging behavioral and family economics [Card and Dahl 2011, Adams *et al.* 2014].

Finally, on the economics of leadership, while studies have shown the importance of leaders for firm and macroeconomic outcomes [Bertrand and Schoar 2003, Jones and Olken 2005], our study is among the first to measure the impact of leaders on follower households. We are able to do so tracing through a rich set of beliefs and behaviors that are impacted through a precise mechanism: the persuasive efforts of a leader. A related study is Stroebel and van Benthem [2013], who focus on measuring the influence of a local bishop in the Catholic Church on household's condom use using DHS data from Kenya. We complement this work by using multiple research designs to estimate and interpret casual impacts of persuasion on a rich set of fertility preferences and fertility behaviors.[5]

The paper is organized as follows. Section 2 discusses the recurrent persuasive messages of the Papal visit to Brazil in October 1991. Section 3 describes the DHS data and presents evidence of the impact of persuasion on fertility beliefs. Section 4 presents evidence on the impact of persuasion on the timing and total number of births. Section 5 concludes by discussing extending this work to other DHS samples to study the *supply of persuasion* by comparing messages in Papal speeches across country visits. The Appendix presents robustness checks and discusses the impacts of persuasion on additional early life outcomes.

[4]There is a body of research examining the impacts of cues/emotions on behavior, and a large literature studying belief formation in the lab [Loewenstein 2000, Andersen *et al.* 2009]. In our setting, the emotional cues triggering changes in beliefs and behavior all stem from persuasive messages. In public finance, the importance of salience has also been noted for responses to taxes [Chetty *et al.* 2009, Finkelstein 2009] or the take-up of benefits [Bhargava and Manoli 2014].

[5]Stroebel and van Benthem [2013] study whether the appointment of a local bishop, Boniface Lele, in Kenya, who was counter-doctrine in his assertions on use of condoms, impacted households self-reported condom usage. Using data from the 2003 and 2008-9 Kenya DHS surveys they estimate Lele's impact on condom usage using a triple-difference identification strategy: across time from 2003-8/9, across regions (as Lele was appointed to the coastal Mombasa region), and between Catholics and non-Catholics in Kenya. They find that condom usage increased by 7pp among married couples as a result of Lele's appointment. Relatedly, there are studies of *exemplars* in the public health literature, where the health-related actions of prominent individuals have been argued to cause others to follow suit. The mechanisms of persuasion we study are quite different to such work.

2 Papal Visits to Brazil

2.1 Background

Between 1979 and 2004, Pope John Paul II made 105 official trips outside Italy. We study the impact of one of the longest Papal visits, to Brazil in October 1991, during which he toured 10 cities over 10 days. To put the visit into perspective, we note that fertility rates in Brazil had been declining since at least the 1980s, in common with many countries. The fertility rate was 4.4 in 1980, was 2.9 by 1991, and further reduced to 2.3 by 2000 [Lam and Marteleto 2005]. These declines have been shown to be driven by: (i) increased rates of female sterilization [Merrick and Berquó 1983]; (ii) earlier stopping times, not delayed age at first birth [Martine 1996]; (iii) increased promotion of family planning services by the Brazilian government (for example, the first legal abortion service was created in Sao Paolo in 1989).[6]

The timing of the Papal visit to Brazil in 1991 is unlikely to be independent of these fertility trends, or liberalizations in family planning policy. However, our research design exploits *within country* comparisons of changes in fertility preferences over a time window overlapping the Papal visit in October 1991, and *within country* comparisons of cohort sizes born in adjacent months, around nine months after the Papal visit. To extrapolate our findings to understand the impact of Papal persuasion on fertility outcomes in other countries at other times, then the issue of how and when countries are selected for Papal visits becomes more important. We return to such issues in the conclusion where we discuss the supply of persuasive messages across visits.

2.2 Salient Topics in Papal Visits to Brazil

The Vatican Papal Archive provides complete transcripts of Papal speeches on each foreign visit including the 32 speeches made in Brazil during October 1991. Table A1 uses these archives to document the Papal itinerary for the 1991 visit: for each speech we detail its location (city) and state, the audience present, the topics covered, and its length in words.

Although we focus on documenting the fertility impacts of the October 1991 visit because of its

[6] Abortion in Brazil is covered in the 1940 Penal Code which states abortion is legal only if there is a serious risk to life for a woman or in cases of rape. However, until the end of the 1980s, there were no regulations regarding how this law should be implemented in public hospitals and doctors often refused to conduct abortions in practice. As a consequence, until the end of the 1980s, the number of legal abortions remained close to zero, while illegal abortions were frequent. Towards the end of the 1980s, following the end of the conservative military regime, there was the surge of a political movement aimed at increasing access to legal abortion services. In 1988 the Progressive Party, which embraced these ideas, won the elections in Sao Paolo, and the year after, in 1989, the first public hospital in Sao Paolo started carrying out legal abortions. The 1990s were characterized by a heated public debate on the abortion rights of women, with many political groups proposing to make the right to abortion unconditional. At the same time, an increasing number of hospitals finally started carrying out legal abortions in cases of life danger for the woman or rape. Despite rising public support for an unconditional right to abortion, legislation on abortion in Brazil remains restrictive today, and as a consequence, the cases of illegal abortion remain very frequent. Consequently, reliable information on abortion rates is only available from the mid 1990s onwards, so this margin of response is *not* one we can examine in the context of the Brazil 1991 visit.

coincidental timing with the Brazil DHS 1991 survey, Pope John Paul II had visited Brazil on two earlier occasions: (i) in July 1980 he travelled to 13 cities over 13 days, making 49 official speeches; (ii) in June 1982 he made a one-day stopover in Brazil on the way to Argentina. We can thus document how the topics salient during the 1991 Papal visit differed from those in the 1980 visit. We use these other visits to disentangle whether the mere *presence* of the Pope during a Papal visit impacts fertility behaviors, as could be driven by media reporting of broad Catholic doctrine, or whether there is a *specific* interaction between Papal visits and the persuasive messages that are most salient during a given visit.[7]

Table 1 provides a content analysis of Papal speeches during the visit in October 1991 (Panel A). This shows the number of times certain fertility-related keywords are used, and which speeches the keyword is used in. For example, contraceptives are mentioned four times, marriage is mentioned on 15 occasions, and children are referred to 48 times during the 1991 visit. To benchmark the frequency of these keywords, the lower half of the table shows the same data for keywords salient to the Catholic Church but unrelated to fertility. This reveals that family-related issues are central to the 1991 visit: 'family' is mentioned as many times as 'peace' and 'charity' combined. This also reveals that more specific *fertility*-related keywords are used relatively frequently in the 1991 visit: the total number of times 'contraceptives', 'abortion' and 'sterilization' are mentioned is greater than the number of times 'education' is mentioned. Moreover, the speeches in which fertility-related words (excluding family) are mentioned are significantly longer than other speeches, implying such themes might be more salient in important speeches.

Panel B of Table 1 repeats the analysis for the same Pope's 13-day visit to Brazil in 1980, during which 49 speeches were made. We see that although 'family' is mentioned even more frequently than in the 1991 visit, most fertility-related keywords are not mentioned at all during the 1980 visit despite there being more speeches than in 1991.

There is no precise algorithm to move from these keywords to categorizing the wider themes in Papal speeches during the 1991 visit, and of course there is an emerging related literature using other techniques to measure 'tone' or 'slant' in media or political communications [Gentzkow and Shapiro 2010]. Combining the simple word count with a reading of the speeches, we draw two conclusions on the salient topics of the 1991 visit. The first recurring fertility-related message is the importance of fully embracing Catholic values, including those relating to sexual and demographic behaviors. The speeches repeatedly condemn practices such as contraceptive use, abortion, sterilization, family planning, egotistical sex and divorce. The second recurring theme is to emphasize the importance of marriage and need to generate offspring within marriage.[8]

[7] October 12th and November 2nd are national holidays in Brazil. To the best of our knowledge, no additional holidays were announced to coincide with the Papal visit in 1991. The results we later show using placebo tests based on other visits help rule out this holiday channel.

[8] To indicate the tone of these messages, we provide three quotes from speeches: Natal, October 13: "today, when the Christian belief of millions of souls is endangered by new religious groups, by violence of all kinds – including the one generated by drug trafficking, consumerism and anti-natalist campaigns [...]"; Campo Grande, October

To be clear, given the high degree of media penetration in Brazil at the time of visit, we expect most individuals to be exposed to these messages through widespread media reports of the visit and information passed through religious organizations, and not through their attendance to the speeches. We later analyze whether church attendance responded to the visit, and so the likelihood this second channel might be driving some of the impacts on beliefs and behavior.

2.3 Conceptual Framework and Mapping to Data

In the Appendix we present a standard dynamic model of household behavior interlinking contraceptive use, sexual intercourse and the optimal timing of births. We modify this framework to make precise how (unanticipated) exposure to persuasive messages impacts behavior. The framework shows how the various channels through which persuasion operates can impact optimal contraceptive use and hence the timing of births, as well as making precise which households are most likely to be persuaded. The model highlights that messages salient during Papal speeches impact behaviors through two channels. First, the visit causes a preference-shock to individuals so that the marginal disutility of contracepting increases. Second, the Papal visit provides mixed messages with regards to the frequency with which couples should engage in sexual intercourse. On the one hand, egotistical sex is condemned; on the other hand, married Catholics are encouraged to produce numerous offspring. As is intuitive, the impacts through this second channel of persuasion can reinforce or offset those occurring through the first channel related to increased disutility of contracepting: what matters is thus the overall amount of unprotected sex engaged in, as this can then feed through to longer run impacts on the timing of births and total fertility over the life cycle.

Our empirical analysis uses Brazil DHS data from 1986, 1991, 1996 and 2006. Each surveys a cross-section of women aged 15-49 and records retrospective fertility histories including the month and year of birth of each child. The surveys also contain basic socio-demographic information on respondents such as their religion, race and education, and proxies for household wealth. The first part of our empirical analysis studies the impact of persuasion on fertility preferences using the 1991 survey. The 1991 visit took place from October 12th to the 21st. The DHS was in the field in the fourth quarter of 1991, with 95% of interviews being conducted between September and December 1991. Exploiting information on exact date of interview, we estimate how fertility *preferences* are causally impacted by exposure to persuasive messages, by comparing those interviewed before, during and after the Papal visit. As detailed below, the DHS data allows us to explore the impacts of Papal persuasion on self-reported intentions to contracept, and on self-reported frequency of

17: "think about the campaigns favouring divorce, contraceptive use and abortion, which destroy society"[...] "it is sad to observe a lack of respect for the divine law, which grows together with the diffusion of highly illicit contraceptive practices, [it is sad to observe] the alarming number of sterilized women and men, [...] the increase [..] in the use of abortion, a criminal offence against the first human right, [that is], the right to life"; Salvador, October 20: "the government does not have the right to promote abortion, mass sterilization and the widespread publicity of artificial methods to limit births."

sexual intercourse. We then combine these measures to study the impact of persuasion on the frequency of *unprotected sex*, that is the key segue into the second part of our analysis, where we study the long run fertility impacts of persuasion using the 1996 DHS survey.

Three further data related issues are of note. First, as we exploit multiple DHS surveys, it is important to be clear that the 1991 DHS sample only covers the Northeast region, while the other surveys have nationwide coverage (Table A2 provides more detail on this point). Hence when we exploit the surveys from 1986, 1996 and 2006, we show the robustness of our key findings to restricting these samples to the Northeast region.[9]

Second, almost 80% of Brazilians report being Catholic in 1991: a further 13% report being of no religion with the remainder being grouped into seven other religions. These non-Catholic religions are diverse, and no single one of them comprises more than 4.2% of the sample. Hence Brazil is not an ideal setting in which to analyze the differential impact of persuasive messages of Papal visits across individuals of different religions. Given the sample sizes involved, the impacts on other religions and the non-religious are never precisely estimated, and so we do not make strong claims on differential responses to persuasion across such groups in this setting. However, at some parts of the analysis it remains useful to show impacts specifically on Catholics, and to differentiate between practising and non-practising Catholics (where the latter are defined as Catholics that report never attending church).

Third, an alternative approach would be to use administrative records on births to measure the impacts on fertility outcomes with more precision than is possible using these DHS samples (although the DHS data uniquely allows the study of the impact of persuasion on beliefs). Publicly available Brazilian census data contains no information on month of birth. In contrast, the Brazilian Vital Statistics database (SINASC) collects information on all live births from birth certificates (plus some information on mothers also), but electronic records are only available from 1994 onwards. Hence we cannot use this data to conduct an event study around the 1991 visit, although we do use this data to examine natural season-of-birth effects, as detailed in the Appendix.

3 Persuasion and Fertility Preferences

3.1 Empirical Method

We use the 1991 DHS data to study the persuasive impacts of the Papal visit on fertility-related preferences in a narrow time window around the visit. To measure changes in preferences that map closely to the desire to contracept, we use two outcomes. In the first, all respondents were asked whether they are currently using contraceptives. All individuals who report currently *not* using

[9] Moreover, while regions can be identified in all survey waves, the 1986 and 2006 samples contain no information on states, while states are recorded in the 1991 and 1996 samples.

contraceptives are then asked a follow-up question about their *intention* to use contraceptives in the future (while those who report currently using contraceptives are asked a follow-up question about the contraceptive method currently used). We combine answers to both questions to create a dummy equal to one if the respondent is currently not using contraceptives and does not intend to do so in future. These individuals are those on the margin of having a child pre-visit. If they are impacted by persuasive messages, this opens up the possibility of such messages also impacting actual fertility outcomes. Hence the impact of the visit on the intent to contracept among those not contracepting is our key outcome, that links preference and behavioral change in response to persuasion.

For each outcome Y_i we estimate the following probit model,

$$\text{Prob}[Y_i = 1] = \Phi(After_i, \mathbf{X}_i, \mathbf{int}_i), \tag{1}$$

where $After_i$ is a dummy for whether the individual is interviewed after the Pope's arrival to Brazil, as identified from the exact interview date. $\mathbf{X}_i$ includes individual and household characteristics that might correlate with the intentions to contracept, and $\mathbf{int}_i$ includes interview-related characteristics.[10] Equation (1) is estimated using DHS sampling weights, and standard errors are clustered by week of interview. This clustering reflects that identification in our research design is based on time variation.

Of the 6223 women in the DHS 1991 sample, those that report being sterilized by survey date are not asked about their intent to contracept, and so are not used to estimate (1): 1520 sterilized women are removed from the sample, and a further 111 observations are dropped because of missing covariate data. Hence our baseline estimates use information from 4592 respondents: 17% were interviewed before the Papal visit started on October 12th; 10% were interviewed during the visit, and 73% were interviewed post-visit (after October 21st).[11]

3.2 Balancing Checks on Covariates

The coefficient of interest in (1) is the marginal impact of the $After_i$ dummy variable. The primary econometric concern is that there are time trends in fertility beliefs during the window in which the 1991 DHS is fielded (from September to December 1991). In such a narrow window, such time trends are unlikely to reflect societal wide changes in fertility beliefs. Rather such concerns might arise from the sampling strategy used for the survey, in particular if those states surveyed earlier

[10] Individual characteristics include the religion, race, education level, marital status, labor market status and age of the female respondent. Household characteristics include whether the household is female headed, the number of children alive on survey date, household size, whether the household resides in a rural area, the state of residence, and various measures of asset ownership to proxy household wealth. Interview characteristics include days since first interview, whether the interview started in the morning, the number of visits required, the interview length, and day of the week of interview.

[11] Women in the sample are on average aged 27 with 1.49 children. 79% of them have at most primary education, 36% are married, 46% are employed, 23% head their household and 32% reside in rural areas.

differ systematically in terms of fertility beliefs to those surveyed later. Alternatively, there might be changes in behavior of enumerators (intentional or not) that result in differences over time in what enumerators record as having been reported.

To assess this concern, Table 2 shows the balance in respondent characteristics between those interviewed pre- and post-arrival of the Pope. Panel A shows characteristics related to religion and fertility, and Panel B focuses on other characteristics of the respondent and household. The final column shows p-values of the test of equality between pre- and post-arrival samples (based on an OLS regression that clusters standard errors by interview week). The samples are balanced on 17 out of 21 characteristics considered.

Most importantly, in the two interview periods, respondents are equally likely to report being Catholic, and being Catholic and attending church. On the other hand, household size is slightly imbalanced: respondents surveyed pre-visit have significantly larger households than those surveyed after the visit starts, although the absolute magnitude of the imbalance is small (household sizes are 6% larger among those interviewed pre-visit). Two points are of note. First, the number of children in the household (or ever born) is balanced across samples; hence the difference in household sizes is driven entirely by the differential presence of adults. Second, the imbalance is caused by a few outliers (the median and 75th percentiles of the distribution of household size are the same in both groups of respondents). This imbalance disappears, for example, if we restrict the sample to households of size 10 or less (that covers 90% of respondents).

We address remaining concerns that the sample of women interviewed pre- and post-arrival could differ on dimensions that drive fertility preferences using three strategies: (i) controlling for a linear time trend in (1), defined as the number of days since the first interview took place in the DHS 1991 survey, to measure whether there is a break in outcomes coincident with the Papal visit over and above such a linear trend; (ii) using placebo checks based on DHS surveys in 1986 and 1996 to assess whether there are natural changes in responses to such questions with the length of time the survey is in the field; (iii) using methods proposed by Oster [2016] to produce bias-adjusted estimates assuming unobservables and observables are related in a precise way, and to bound our coefficient of interest in the presence of such omitted variables bias.[12]

3.3 Unconditional Impacts

Table 3 provides descriptive evidence to preview our findings on the impacts of Papal persuasion on fertility preferences and beliefs. The first row shows that among those interviewed pre-visit, 23% of women report using contraceptives and this falls significantly among those women interviewed post-arrival. To focus more closely on the intent to contracept, the next row shows that the

[12]The other DHS waves for Brazil do not overlap in terms of interview dates with the 1991 wave. In particular, the 1986 DHS was fielded from May to September 1986 (with no information on day of interview in the data set); the 1996 DHS was fielded between 26th February 1996 and 8th July 1996, and the 2006 DHS was fielded between the 31st October 2006 and the 12th May 2007.

intention *not* to contracept is significantly higher among those interviewed post-arrival. The unconditional impact is to raise such intentions by 10.9pp or 36.7% of the pre-visit mean. Figure 1 graphs the raw (unweighted) *three-day* moving average time series variation in this intention. This shows a discernible and permanent rise in the share of households reporting no intent to contracept that coincides precisely with the dates of the Papal visit.[13] Moreover, the impact on fertility preferences appears to persist months after the Papal visit itself, casting doubt that the effect is driven merely by households misreporting to DHS enumerators during the period of the visit itself or in its immediate aftermath.

The next row in Table 3 shows how the frequency of sexual intercourse shifts with the Papal visit. Those interviewed post-visit report significantly higher levels of sexual activity relative to those interviewed pre-visit. Finally, we combine this outcome with the earlier information on not using and not intending to use contraception: multiplying the two outcomes together effectively creates a measure for the frequency of unprotected sex, that is key to understanding any fertility response as the conceptual framework in the Appendix highlights. The final row shows this to significantly increase among those interviewed post-arrival relative to those interviewed pre-visit: the unconditional impact is to raise such behaviors by 37.1% of the pre-visit mean. This dramatic response opens up the possibility of persuasive impacts not only on the beliefs of individuals, but also on their real behaviors in the longer term.

Finally, in Column 4 we report tests of equality based on the Ibragimov and Mueller [2016] procedure (IM) for time series data that adjusts p-values for cases with few heterogeneous clusters. For our two key outcomes – on the intent to contracept and the overall frequency of unprotected sex – we continue to find significant differences in pre- and post-arrival survey responses even using this conservative IM procedure.[14]

3.4 Contraceptive Use and Intentions to Contracept

Table 4 presents estimates of (1), reporting only the coefficient of interest on $After_i$. To begin with, we focus on whether respondents report using any form of contraceptive (ignoring additional information on the intent to contracept). The result in Column 1 shows that controlling for individual and household characteristics, those interviewed after the Papal visit begins are slightly

[13] To reduce noise in the series, we omit those three-day periods that have the lowest 1% of respondents in any given three-day period (corresponding to having 16 or fewer responses in a consecutive three-day period) and stop the series just prior to Christmas 1991. Dropping this restriction gives another 5 data-points: the resulting time series is very similar to Figure 1.

[14] The IM procedure essentially comes down to treating each cluster as an independent observation (and is thus even more conservative than clustering by interview week). The procedure thus involves the following steps: (i) partitioning the sample into clusters: the 1991 DHS survey extends for 20 weeks and as the visit starts mid-week, we obtain 5 clusters pre-arrival and 16 clusters post-arrival.; (ii) compute the average response to the survey question in consideration in each cluster; (iii) treat the cluster averages as observations, and perform a t-test of equality of means between the 5 "observations" in the pre-arrival and the 16 "observations" in the post-arrival period, allowing for unequal variances.

less likely to report using any contraceptive method, but this is not a significant difference. The same remains true when interview controls are added. However, Column 3 shows this masks an impact that varies between those interviewed during the visit and those interviewed post-visit. Those interviewed during the visit are 4pp less likely to report using contraceptives, an effect significant at the 1% level and corresponding to a 17% decrease over the pre-visit mean of 23.3% of women reporting using any contraceptive method.[15]

The remainder of the Table focuses on the key outcome where individuals report not contracepting and not intending to contracept in the future. Column 4 shows that conditional on individual and household characteristics, those interviewed post-arrival are 10.2pp more likely to report not using contraceptives on survey date and not planning to do so in future, relative to those interviewed pre-visit. If we conduct a conditional IM test using this specification, the difference of interest remains significant [p-value = .003].

The result is robust to: (i) the inclusion of interviewer controls, int_i (Column 5); (ii) restricting the sample to states where interviews take place before *and* after the visit began (Column 6). The magnitude of the difference of interest varies from 10.2pp to 12.8pp across specifications, and throughout, it is significant at the 1% level. In both robustness checks, conducting the conditional IM procedure still implies the coefficient of interest is statistically significant [p-value = .022 and .057 respectively]. Adding a linear time trend in (1), we find a slight *downward* trend in reported intentions not to contracept. The trend has a point estimate of $-.001$ [p-value=.016], that obviously is of opposite sign as the coefficient of interest. We note further that including state-specific time trends in the baseline specification in Column 5 leaves the coefficient of interest almost unchanged in magnitude, which remains significant at the 1% level. Finally, Column 7 shows the impacts on the intent to contracept persist over time: the responses of those interviewed during and after the visit are not significantly different from each other [p-value =.771] and both are significantly different from the responses of those interviewed pre-visit.

Taking the results together suggests the salient messages in Papal speeches have very short term impacts on contraceptive use (Column 3), and more persistent impacts on the intent not to contracept among those not using contraceptives in the first place (Columns 4-7). The magnitude of the impact on intentions is of economic significance: taking the point estimate of 12.8pp from the full specification in Column 5, this corresponds to a 43% increase over the pre-visit mean of 29.7% of women reporting not using contraceptives and not intending to do so. This effect can be benchmarked against other estimates of persuasion effects in the literature. DellaVigna and

[15] We further note the changes in contraceptive technologies employed among those that report using *some* form of contraception on survey date in the DHS 1991 survey. Among this sample there is a reduction in the percentage of contracepting women that report using the contraceptive pill (66% to 60%), and an increase in those reporting using withdrawal (4% to 11%). There is however no change in the percentage of those using condoms, IUDs, or contraceptive injections. Hence any fertility response, as documented later, likely comes from those that no longer contracept, or those that switch to more unreliable forms of contraception.

Kaplan [2007] propose the following persuasion rate to compare estimates across studies:

$$PR = 100 \times \frac{y_T - y_C}{e_T - e_C} \times \frac{1}{1 - y_C}. \tag{2}$$

y_T (y_C) denotes the outcome in the treatment (control) group that are the targets of persuasion, and e_T (e_C) refers to the share in each group that is actually exposed to persuasion. In our setting, assuming individuals are not subject to persuasion pre-visit (as confirmed below), and all individuals are subject to persuasion post-visit (so $e_T - e_C = 1$), taking the estimated impact from Column 5 of Table 4, we derive a persuasion rate of 18.2%. Figure A1 plots this against other estimates in the literature, that has largely focused on the persuasion of consumers, voters and donors. Relative to these studies, Papal persuasion is a quantitatively important phenomenon.[16]

Probing further to identify households most susceptible to persuasion we note that among Catholics, the coefficient of interest is .117 and significant at the 1% level (implying a persuasion rate of 24.4% among Catholics), and among the non-religious the coefficient of interest is .088 and not significantly different from zero. However the effect in this small sub-sample of non-religious women is imprecisely estimated. Among Catholics, Columns 8 and 9 show those most impacted by Papal persuasion are those women attending church; the intent to contracept among Catholics that never attend church is unaffected by the visit. These results mirror a specific implication of the Becker and Murphy [1993] preference-based model of persuasion, that those who consume a given good the most are most impacted by persuasive advertising related to that good. This result also runs counter to the notion that Bayesian-persuasion best explains outcomes in this context: those attending Church are likely better informed on Catholic doctrine, and so should be *less* impacted by messages re-affirming this knowledge.[17]

3.4.1 Robustness

Appendix Tables A3 and A4 present additional evidence directly addressing the concern that there might be time trends or omitted variables driving changes in the intent to contracept in the narrow window around the Papal visit. Column 1 of Table A3 bins interview periods into quarters, splitting pre- and post-visit periods in two equal parts. The omitted category is the first half of interviews prior to the visit. This specification shows no evidence of any significant pre-visit trends in intentions to contracept. If a channel through which Papal visits impact preferences is *media* reporting of issues generally related to Catholic doctrine (rather than the specific contents

[16]The assumption that individuals are not subject to persuasion pre-visit, so $e_C = 0$, is consistent with the evidence presented later in Table A3 that examines the dynamic pattern in the intent not to contracept, and finds a jump in such intentions exactly timed with the start of the visit. Moreover, we assume all women are exposed to the persuasive messages post-visit: media penetration in Brazil in the early 1990s is very high with the vast majority of households reporting having access to TV, radio or newspapers.

[17]We document in Table A5 that the frequency of attendance to the church by Catholics is unaffected by the visit, so there is less concern that we are here splitting the sample by an endogenous outcome.

of actual speeches), and if such media reports start pre-visit, we expect to see shifts in beliefs pre-visit. This does not match the evidence, implying the persuasion embodied in Papal speeches is the key trigger leading to changes in fertility beliefs (in line with the raw time series evidence in Figure 1). Moreover, intentions not to contracept remain 12.5pp higher even a month or two after the visit has ended (near identical to our baseline estimate), when presumably the *daily* flow of information to persuade individuals has diminished. The likelihood that misreporting intentions to enumerators drives such persistent effects also becomes increasingly implausible.

Columns 2 to 5 in Table A3 perform placebo checks using the DHS data from 1986 and 1996 respectively. In each survey wave we define a placebo $After_i$ dummy: this is constructed to replicate the number of days into the survey being fielded when the Papal visit occurred in 1991 (26 days) but applied to these other two survey waves. The 1986 data only contains the month of interview, so we construct the placebo to be switched on one month into the surveys being fielded. When estimating these specifications we note that the 1986 and 1996 DHS surveys cover all regions (not just the Northeast region as in the 1991 DHS data), but that the 1986 only contains region identifiers, while the 1996 data contains region and state identifiers (as shown in Table A2). Hence when using the 1986 DHS survey, we consider two placebos: (i) using all regions and controlling for region fixed effects (Column 2); (ii) using just observations from the Northeast region and calculating robust standard errors (Column 3). When using the 1996 DHS survey for the placebo check it is not possible to restrict the sample only to the Northeast region because only two interviews take place in the placebo pre-visit period. Hence, we base the placebo check on all regions but consider two alternative specifications: (i) controlling for region fixed effects (Column 4); (ii) controlling for state fixed effects (Column 5).

The results show that in all four placebo checks using the 1986 and 1996 DHS samples, there is no evidence of a natural upward jump in responses that occurs around a month into the survey period, although one of the coefficient point estimates is large but imprecisely estimated.

A final strategy to address omitted variable bias is to use methods developed in Oster [2016] for linear models, that allow the coefficient of interest to be bounded under assumptions on the nature of omitted variables.[18] To implement the method, we need to make assumptions regarding: (i) the coefficient of proportionality between selection on observables and selection on unobservables (δ); (ii) the hypothetical R-squared from a regression including all controls influencing the outcome, even those actually unobserved ($R_{\max}$). We follow Oster's [2016] recommendation and set $\delta = 1$ and $R_{\max} = 1.3R$ where R is the R-squared from (1) when all observables are controlled for.

Table A4 reports bias-adjusted estimates for our coefficient of interest on the treatment effect of persuasion on fertility preferences, using a linear probability model for (1). At the foot of each specification we report the R-squared and the identified set for the coefficient of interest. We see a

[18] More precisely, following Altonji *et al.* [2005], it is assumed that unobservables follow a proportional selection rule, with some factor of proportionality δ. Intuitively, $\delta \leq 1$ then suggests that unobservables are not more important than observables in explaining the treatment effect of the Papal visit on fertility preferences.

very similar pattern of coefficient estimates and significances across specifications and samples as in the baseline results presented in Table 4. Moreover, in Table A4 whenever significant treatment effects of being interviewed post-arrival are found, the identified set *never* includes zero and the coefficient of interest is tightly bounded throughout.

3.5 Sexual Intercourse and Unprotected Sex

Given the salient messages in Papal speeches during the 1991 visit, the second channel through which the Papal visit can impact individuals is through respondents' self-reported frequency of sexual intercourse. We can map this to data because DHS 1991 respondents were asked, "Normally, how many times a month do you have sex?". We use a Tobit model to estimate the impacts of persuasion on this margin. Column 1 of Table 5 shows that on average, respondents report having significantly more sexual intercourse post-visit. The magnitude of the impact is .886 relative to a pre-visit mean of 7, corresponding to a 13% increase. Column 2 shows that among Catholics, those interviewed post-visit report having sexual intercourse significantly more frequently than Catholics interviewed pre-visit, with the magnitude of the impact being 16%. Columns 3 and 4 further split this sample between practising and non-practising Catholics, and reveal the latter group are those that significantly respond on this margin.[19]

Multiplying together the frequency of sexual intercourse outcome with our earlier outcome on not intending to contracept effectively measures the frequency of unprotected sex. This is the key outcome that helps pin down the set of households that drive any actual fertility impact of persuasion. Column 6 shows the frequency of unprotected sex significantly increases among Catholics interviewed post-visit, with the magnitude being almost doubling the impact of sexual intercourse *per se*. In proportionate terms, the frequency of unprotected sex increases by 30% among Catholic women interviewed post-arrival relative to those interviewed pre-arrival. Columns 7 and 8 reveal that within Catholics, the frequency of unprotected sex increases entirely among practising Catholics. This follows naturally from the earlier results: practising Catholics lower intentions to contracept and have no change in the frequency of sexual intercourse, thus increasing the overall amount of unprotected sex. In contrast, non-practising Catholics do not change their contraceptive behaviors or intentions to contracept, and so despite them increasing the frequency of sexual intercourse, this does not lead the amount of unprotected sex taking place to alter among this group.

To summarize, the estimated impacts of Papal persuasion appear to operate for Catholics through the two channels described earlier: an increased marginal disutility of contracepting, and the increased frequency of sexual intercourse. Given the two marginal impacts reinforce each

[19] When the sample is restricted to the non-religious, we find no significant impact on self-reported sexual intercourse (the coefficient of interest is actually negative, $-.541$ with a standard error of .750). The question on sexual intercourse is not asked to those women that report never having had a sexual intercourse in their life. Hence these impacts are measured from sexually active women.

other, leading to an increased frequency of unprotected sex, it is plausible that a positive fertility response could exist as a result of the persuasive messages of the Papal visit.[20]

3.6 Married and Single Women

We can probe further how different women are heterogeneously impacted by persuasion. An important margin we can consider is marital status, comparing the response of married and single women. The comparison is of note because of two reasons. First, individuals engaging in sex out-of-wedlock (against Catholic doctrine) might be, *a priori*, less susceptible to persuasive messages from Papal speeches. Second, the mixed messages of the Papal visit related to sex might cause differential responses among single and married women. As discussed in Section 2, single women might be more impacted by messages condemning sex out-of-wedlock, while married women might be more susceptible to messages encouraging households to produce numerous offspring.

Table 6 presents the findings, where we split the impacts of persuasion along all the channels considered: the intent to contracept, the frequency of sexual intercourse, and the frequency of unprotected sex. We note first that the data clearly suggests out-of-wedlock sex occurs: 73% of single women report having sexual intercourse in the month prior to the survey (compared to 99% for married women), and single women report having intercourse almost as frequently as married women (6.1 times per month versus 7.6 times). Among single women interviewed post-arrival, although they report being less likely to contracept in future, they also reduce their frequency of sexual intercourse so that overall there is no change in the frequency of unprotected sex. Among married women, there is no change in the intent to contracept but a significant increase in the frequency of sexual intercourse so that overall, they do engage in significantly more unprotected sex. The magnitude of this impact corresponds to an increase of 30% over pre-arrival levels.

These results show that even those single women who do not adhere to Catholic norms are impacted by persuasion: they shift their use of contraceptives in a way that is consistent with the specific persuasive messages targeted towards those engaging in out-of-wedlock. However, given the impacts on unprotected sex reported in Columns 5 and 6, any fertility impact is likely more driven by married women. This pattern of heterogenous responses across married and single women further suggest individuals are responding to specific messages of persuasion, rather than responding to any general phenomena related to a Papal visit (such as being exposed more to Catholic doctrine, changes in the availability of leisure time etc.).

[20] These results help mitigate against the concern that the visit impacts behavior merely by increasing the time devoted to leisure, and that leads to more sexual activity. There is no reason to expect increased leisure time to affect fertility beliefs as previously documented, nor to have such persistent impacts on those preferences, nor to impact the frequency of *unprotected* sex. In other empirical settings, there is anecdotal evidence of the impact of short run phenomena that operate through changes in time allocation, such as blackouts, on fertility, although the formal evidence of such effects remains weak.

3.7 Alternative Mechanisms

The impacts on fertility-related beliefs we have documented in response to the 1991 visit reflect impacts of the *salient content* of the Papal speeches, the associated media coverage of traditional Catholic doctrine, and potential changes in behavior/information of other members of the Church hierarchy. The next two results probe further which of these underlying mechanisms drive these observed behavioral changes. We first check whether the Papal visit increases religiosity among women, so that the documented impacts might be driven by increased exposure to Catholic doctrine as expressed by local leaders, as in Stroebel and van Benthem [2013]. We do so exploiting questions in the 1991 DHS about the weekly frequency of attendance to church services, and using an ordered probit model otherwise analogous to (1). Column 1 in Table A5 shows that among Catholics, there is no change in church attendance between those interviewed pre- and post-visit. This is despite there being scope for church attendance to increase over pre-visit levels, and the result further bolsters the evidence against Catholics merely misreporting to enumerators in the post-visit period on religion-related questions. Among the small sample of non-Catholics, Column 2 also shows no time pattern in attendance to religious services.

Second, we consider attitudes related to HIV-AIDS: as shown in Table 1, this was *not* a salient topic of Papal speeches in 1991, but might have been raised in wider discussion of Catholic doctrine by the media or other members of the church hierarchy, around the time of the visit. Respondents to the 1991 DHS were asked whether they agreed with the statement that, 'condoms reduce the risk of getting HIV'. Column 3 shows that there is no difference in responses to the question between Catholics interviewed pre- or post-visit. Similarly, Column 4 shows no impacts for the non-religious. This again suggests it is precisely those themes that are salient in Papal speeches that persuade Catholics to change fertility preferences, not other information that might have been conveyed by the media or local church leaders.

Third, to assess whether longer term fertility responses might be impacted we exploit the fact that interviewees were also asked about their "ideal number of children". We then use a negative binomial model to estimate a specification otherwise analogous to (1). Column 5 of Table A5 shows no impact among Catholics, and Column 6 shows a small positive impact among the non-religious. This is unsurprising given that the persuasive messages during the visit did not proscribe any such ideal number of children. This result has two implications for our later analysis. First, we can validate these responses by examining actual longer term impacts on lifetime fertility. Second, taking as given the consistency of stated preferences and fertility outcomes over the life cycle, the result suggests any fertility response to the salience of Catholic doctrine will likely be concentrated among those *early* in their fertility cycle, who have greater scope to modify their later behavior in order to leave total fertility unchanged in the long run. We also validate this implication in the next stage of analysis.

Finally, we examine whether women report regretting being sterilized, as reported in the 1991

DHS survey. Table A7 shows that those interviewed during the Papal visit express significantly more regret about being sterilized than those interviewed pre-visit. Regret is a short run phenomena though in response to the visit: those interviewed post-visit do not respond significantly differently to those interviewed pre-visit. Among those interviewed during the visit, the expression of regret is concentrated among practicing Catholics (Columns 4 and 5).

4 Persuasion and Fertility Outcomes

4.1 Empirical Method

We now study the impacts of the Papal visit on actual fertility *outcomes* using the 1996 Brazil DHS (that covers all regions in Brazil), exploiting complete retrospective pregnancy histories of respondents, where month and year of birth of each child are reported. We thus reshape the cross-sectional data to form a monthly panel of women spanning the period since they turned age 15, the assumed age at menarche, and are thus considered at risk of giving birth. We can then estimate the hazard rate for the likelihood a women gives birth in any given month-year conditional on her pregnancy history. Each woman is included in the estimation only for time periods when she is at risk of pregnancy, so we exclude the eight months preceding each birth (when women are temporarily infecundable), and drop sterilized women from the sample from the month they report becoming sterilized. Finally, we examine potential conceptions occurring in a window that covers a balanced number of months pre- and post visit (from January 1987 to December 1995). Our working sample then covers $10,347$ women who are observed over an aggregate of $698,296$ months in which they could potentially have given birth. We use a discrete form of the proportional hazard model, the complementary log-log hazard model, to estimate the likelihood of women i reporting a birth in month-year t,

$$\text{cloglog}[\theta(t, \mathbf{Z}_{it})] = \theta_0(\mathbf{t}) + \boldsymbol{\beta}\mathbf{Z}_{it}. \tag{3}$$

The baseline hazard, $\theta_0(\mathbf{t})$, depends non-parametrically on the number of months since the last birth. The time varying controls conditioned on include the number of boys alive, the number of children alive, whether the woman is ever married, her age and age squared. The time invariant covariates include the woman's employment status, her education, religion, race, dummies for various asset holdings, whether the household resides in a rural area, and dummies for region of residence (as the 1996 DHS data covers all regions in Brazil). We account for serially correlated shocks within a women by clustering standard errors by woman i. We also control for month of birth dummies to capture the fact that children are not equally likely to be born across the year, and year of birth dummies to capture common shifters of the baseline hazard by year.

Conditional on all other factors, our coefficient of interest is whether births are significantly

more likely to occur nine months after the 1991 October Papal visit, in July 1992. To be clear, the DHS 1996 data records the month and year of birth, not the exact date of birth. Assuming full term pregnancies, those born in July 1992 are most likely to have been conceived in the period October 5th through to November 12th 1991. Our research design then measures fertility impacts among households that likely conceived around a week prior to the visit to one month after the visit officially ends. This measurement error attenuates our coefficient of interest.

It is well recognized for many countries that there are seasonal patterns in births [Lam *et al.* 1994]. We address this issue for Brazil using two approaches. To first identify any natural variation in birth timing across months of the year, we estimate (3) only controlling for the baseline hazard, month and year dummies for all years excluding 1992. Figure 2A then plots the month dummies (translated into month of conception dummies assuming full term pregnancies) along with their associated 95% confidence intervals. The omitted month of conception dummy is October, the month of the Papal visit. We see that there are no changes in the hazard of being conceived in October relative to adjacent months.

A second approach is based on Vital Statistics Data: the advantage is that far larger samples are available, and the key disadvantage is that such data are only available for 1994 onwards. The Vital Statistics dataset is known as the SINASC (*Sistema de Informação sobre Nascidos Vivos*), and contains birth certificate microdata from the Brazilian Health Ministry. Figure A2 provides evidence from this data. Panel A shows data from the first year these records are available: 1994. This is constructed from over 2 million records. The figure shows a very similar seasonal pattern to conceptions in Brazil as that found in Figure 2A, based on the DHS sample that excluded 1992, with no natural jump in the proportion of children conceived in October 1994 relative to adjacent months (if anything, the opposite is true). We further bolster the evidence from administrative records using statistics provided in Pinedo and Bermudez [2016]: they report months of birth for the 2002-2012 period using data from over 32 million birth records from the SINASC. We use this to construct Panel B in Figure A2 and again show the seasonal pattern of conception over this long post period. We again see a pattern of month of conception that is very similar to what is observed in the 1994 data, and indeed is found in the DHS data used for Figure 2A.

Finally, it is important to link any findings on birth outcomes back to the results on intentions to contracept and reiterate the set of households driving any fertility response. The nature of contraceptive technology implies not all households *should* be able to induce immediate changes in birth timing as a result of persuasive messages: only those *not contracepting* or using *unreliable* methods at the time of the visit (such as abstinence, withdrawal or condom use), can plausibly respond. The earlier findings suggested qualitatively important increases post-visit in the share of households on this precise margin: (i) a near 40% increase in women not contracepting, and not intending to do so in the future; (ii) a near 30% increase in households reporting using methods such as condoms, abstinence or withdrawal; (iii) a 30% increase in unprotected sex among Catholics.

4.2 Fertility Responses

Table 7 presents the core results from estimating (3). Column 1 presents a specification in which we only control for the underlying hazard, month and year dummies, as well as our variable of interest: a dummy equal to one if a women gives birth in July 1992 (nine months post-visit), and zero otherwise. We see there is a significant increase in the hazard rate for births in July 1992 relative to what would have been expected conditional on the underlying hazard rate, month and year dummies. The sign, significance and magnitude of the coefficient of interest remains stable in Column 2 when we control for the full set of covariates described above.

In Column 3 we examine whether there is a significant rise in births in months adjacent to when a fertility response to persuasion is most likely: we find no significant impact on fertility outcomes eight or ten months after the visit. The coefficient of interest remains significant at the 5% level, and is also significantly different to the eight month impact. Column 4 then shows all these core results to be robust to clustering standard errors by religion-time period (the most relevant dimension of unobserved shocks given the hypothesis under scrutiny), and Column 5 shows the result to be robust to additionally controlling for a further lead and lag. Across all specifications, the pattern of coefficients eight to ten months post-visit in 1992 is *contrary* to the natural pattern in birth timings across months identified for years outside of 1992 (Figures 2A and A2).

To make precise the quantitative interpretation of our baseline result, we focus on our preferred specification in Column 3 of Table 7. This implies the hazard rate increases by $\exp(.238) = 1.27$ so that a woman is 27% more likely to give birth nine months after the Papal Visit, everything else equal. To convert this into the implied increase in cohort size, we take a 27% random sample of women that gave birth in July 1992, corresponding to .2% of all women in 1996 DHS sample. IPUMS Brazilian census data [Minnesota Population Center 2015] suggests that in 1991 there were $29,262,727$ women aged 15-49 that were non-sterilized. Hence the implied number of *additional* births in July 1992 relative to what otherwise would be predicted from (3) is $.002\times\ 29,262,727 = 51,971$. The total birth cohort in 1991 was 3.3 million, so this implies fertility responses to the persuasive messages households were exposed to during the visit led to a 1.6% increase in the aggregate birth cohort.[21]

To place these quantitative effects of persuasion into a wider context, we can compare them to estimates of factors impacting birth cohort sizes in other studies. For example, Miller and Urdinola [2010] measure how exogenous changes in coffee prices impact fertility among rural households in Colombia, because changes in coffee prices translate into changes in household income in coffee growing regions. They find for a county with median coffee cultivation, a 25% price decrease in the year of birth is accompanied by a .4 to 2% percent increase in cohort size. Jayachandran

[21] An alternative way to approach the same calculation is to assume births are constant over months. Hence the 27% increase in one month (July 1992) corresponds to an annual increase of $\frac{27}{100} \times \frac{1}{12} = 2.3\%$, or $75,900$ children.

[2009] studies the impact of wildfire related air pollution on infant mortality in Indonesia. She documents that fire-induced air pollution is associated with a 1% reduction in cohort-size, averaged across Indonesia for the five-month period of high exposure to these events. Against these benchmarks, the impacts of Papal persuasion on fertility outcomes are large, especially so given they are generated by temporary, but highly salient, interventions. We reiterate that our research design *underestimates* the impact of persuasion on fertility outcomes if some households delay their fertility response to persuasive messages and respond ten or more months post-visit.[22]

As it is not possible to give birth in consecutive months, the coefficients on the dummies for eight, nine and ten months after the visit are identified from *different* women. Hence the remaining Columns of Table 7 shed light on which women are most impacted. Column 6 shows the result to be maintained in the sample of Catholic women. We next probe differential responses of women at different parts of the fertility cycle. To do so we use information on the ideal number of children expressed in the 1996 DHS. Taking as given the visit had no significant impact on this fertility preference (as shown in Table A5), we split our sample in Columns 7 and 8 into those that were below or above their ideal family size at the time of the Papal visit in October 1991. This shows the entire fertility response to persuasion being driven by women that were *below* their ideal family size at the time of the visit. Such dynamics are at the heart of the conceptual framework described in the Appendix: those earlier in the fertility cycle likely have lower capitalized values of *preventing* a birth in a given period t given some parity, and hence are more likely to respond to persuasion all else equal.[23]

Further mapping the findings to the framework, these documented fertility responses are most likely to arise from those not contracepting or using unreliable methods at the time of the visit.

[22] The lack of a ten month impact is entirely consistent with the time pattern of changes in intentions to contracept found earlier (that lasted many months after exposure to persuasive messages). The reason is that once a couple switch to unprotected sex (through a combination of changes in contraception and changes in sexual activity), a women can only get pregnant once. If couples continue to engage in unprotected sex during pregnancy this will obviously not have an additional impact on fertility beyond the time at which they first switched contraceptive behaviors. Moreover, the fact that the nine and ten month impacts are not significantly different from each other might reflect some couples have a delayed fertility response to persuasion even with immediate changes in contraceptive use, as shown earlier, because it can take time to become pregnant after a switch to having more unprotected sex.

[23] It is not straightforward to use the 1996 DHS data to identify the marital status of women around the time of the visit in 1991: the wording of the relevant question is, "in what month and year did you start living with your (first) husband/partner?". Hence, date at first marriage might also refer to the date at which a first cohabiting relationship started. Furthermore, for those that might have married and separated prior to the visit, the 1996 DHS does not record separation dates. Similarly, we cannot split among Catholics as church attendance is only measured in 1996 (not around the time of the visit in 1991) and because there is evidence of a significant age gradient in Church attendance. We have examined additional fertility specifications split by mother's education and age. These show the impacts to be driven by more educated women. However, this is difficult to interpret because practicing Catholics have significantly higher education levels (this is true both in a simple comparison of means as well as when looking at the coefficient on the education variable in a regression predicting whether Catholics are practicing or not, where also all other individual, household and interview controls are included). The age split is not informative as neither split is precisely estimated (and so further suggests it is parity relative to ideal family size rather than age that is the important source of heterogeneity).

Hence in the counterfactual scenario absent the visit, we might expect such households to have given birth in *slightly* later time periods. To investigate further this inter-temporal shift in births induced by Papal persuasion, we estimate our baseline hazard specification (3), additionally allowing for a complete sequence of dummy variables to measure impacts over and above the baseline hazard for *each* month, for between four and nineteen months post-visit. Figure 2B plots these coefficients: with so many coefficients estimated the precision of each one is less than that reported throughout Table 7, as expected. Nevertheless, two features emerge: (i) there remains a positive and significant impact on the hazard nine months after the visit, and this is the *only* month post-visit for which this is the case; (ii) there is a significant *reduction* in the hazard 13 and 15 months post-visit. This switching of impacts around these months suggests that among those that can realistically respond to the visit in terms of fertility outcomes, there is a shift, of four to six months, in birth timing as a result of Papal persuasion.

4.2.1 Robustness

Table A6 presents robustness checks on the core fertility result from Column 3 of Table 7. Column 1 of Table A6 considers a wider window for potential births from December 1974 onwards. Column 2 assumes the age of menarche is 12, and in Column 3 we weight observations by the DHS sample weights multiplied by the fraction of time periods the woman is in the sample. The baseline results are robust to all three modifications. In Column 4 we address concerns over recall error: we do not find any evidence of DHS respondents heaping births in the month *of* the Papal visit. We next check whether the visit caused sterilizations to fall. This would be most likely to occur in the month of the visit: we find no such impact (Column 5). Column 6 checks that sterilization rates are not moving eight to ten months post-visit, that might be indicative of other shocks to family planning services that might be driving the birth timing results: we find no such pattern of changes.

Columns 7 and 8 of Table A6 present the placebo checks based on the other Papal visits to Brazil: the major visit of July 1980 (that as documented in Table 1 placed less emphasis on fertility-related issues), and the one day stopover in June 1982. Estimating placebo fertility impacts of these visits among our same sample of women, we find no significant responses to either event. As with the earlier results on fertility preferences, these placebo results suggest responses are not driven by the mere presence of the Pope *per se*, but are related to the specific issues salient during the 1991 visit.

The final set of robustness checks re-estimate (3) using just observations from the Northeast region in the 1996 DHS and then allowing the hazard to shift by state (Column 9), or using all regions but allowing the hazard to shift by state (Column 10): the core fertility results are robust to both modifications.

4.3 Total Fertility

To investigate whether total fertility in the long-run is impacted by persuasion, we use the 1996 and 2006 DHS to compare completed fertility in those survey years, between women that gave birth eight and nine months after the Papal visit. In the latter group, the earlier results on fertility outcomes suggest a quarter of women were susceptible to persuasion. Panel A (B) of Table 8 reports fertility outcomes by 1996 (2006). Each row corresponds to a different outcome: we show its mean value in the two groups of women (Columns 1 and 2), and the difference in outcomes (Column 3). As the tests in Table 8 involve small sample sizes, we provide the differences in outcomes that can be ruled outside a 95% confidence interval. Column 4 shows the p-value on the null that the outcomes are the same against a two-sided alternative, and Column 5 shows the p-value from the same hypothesis test conditional on observables.

Comparing these two groups of women reveals few differences in total fertility by 1996 or 2006: the number of children ever born, the number alive on survey date, the number born since the visit and the month of birth of the youngest child are not significantly different between the groups. This remains the case conditional on observables. Column 3 reveals that we can reject that the total fertility effects are larger than .669 by 2006 for example (corresponding to around a 15% increase in children ever born). The next two outcomes in each Panel examine the gender composition of children ever born as a more subtle route through which longer term impacts might exist. We again find no evidence of long run effects of persuasion. The final row checks whether there are differential impacts on the likelihood of being sterilized by the 1996 or 2006 surveys: again no significant differences emerge.

In summary, the evidence suggests the first order impact of persuasion is in the timing of births rather than the long run number of births. This is consistent with the earlier documented impacts on fertility preferences, where we found no impact of persuasion on respondent's ideal family size (Table A5). Such null impacts are as expected given that any notion of an ideal number of children was *not* communicated in Papal speeches during the 1991 visit.

In the Appendix we provide suggestive results on the early life outcomes of the birth cohort impacted by persuasion. We use the 1996 and 2006 DHS surveys to trace birthweight outcomes, a marker for later childhood development. It is natural to examine whether the earlier documented impact of persuasion on birth timing then impacts the birthweights of affected cohorts, especially in a developing country context such as Brazil in the early 1990s. Moreover, the null impacts found on total fertility suggest we identify the impacts of such marginal changes in birth timing on early life outcomes, *holding constant* total family size. The Appendix documents tentative evidence linking persuasion and early life outcomes. In short, those results suggest a negative impact of persuasion on the birthweight of the most affected cohort, and that this is driven predominantly by cross sectional differences *across* mothers between those more and less susceptible to persuasion, rather than by within-mother impacts of changes in birth timing due to persuasion.

5 Conclusions

We study the persuasive impacts of non-informative communication on the preferences *and* actual behaviors of households. We do so in the context of the Papal visit to Brazil in October 1991, in which there were recurring fertility-related messages of persuasion in Papal speeches. We thus extend the realm of empirical studies of persuasion in the field, both in terms of who is being persuaded (households when making decisions over fertility) and the ultimate source of persuasion [DellaVigna and Gentzkow 2010]. The analysis extends the frontier of empirical evidence on persuasion because: (i) the dimension of persuasion studied, on fertility, has a rich set of associated short-run *beliefs* (intent to contracept, ideal family sizes) and longer-run *behaviors* (births and total fertility) that we provide novel evidence on; (ii) variation in content across Papal speeches allows us to pin down the impacts of salient messages of persuasion versus other factors common to Papal visits, such as media reports, that have been the focus on previous studies of persuasion; (iii) fertility is an intrinsically important dimension on which to measure persuasive impacts due to the consequences of the timing and number of births on female labor supply and welfare.

We highlight two directions for future research. First, our research design, exploiting significant events that occur *while* major surveys are fielded, can be extended to study other fortuitously-timed interventions. While we have focused on the particular meta-influence of Papal visits, persuasive messages provided by politicians or cultural icons might also influence behavior, that can be relevant for both macro and micro outcomes. The empirical challenge for future work remains to: (i) identify and link a core set of beliefs and behaviors that should be open to persuasion; (ii) exploit data sources that allow for short and long run impacts of persuasion to be measured.

Second, in this paper we have focused entirely on the response of households in Brazil to persuasion. However, there are a wider range of DHS samples fielded globally around the time of Papal visits that allow extension of our analysis on the impacts of Papal persuasion on fertility outcomes: Table A8 shows other DHS country samples fielded in a five year window subsequent to a Papal visit. This opens up the possibility to empirically study a rich set of research questions on the *supply* of persuasive messages around the world. In ongoing work, we are exploring how the number and content of Papal speeches vary depending on the characteristics of countries visited. This sheds light on the link between long run trends in fertility in a country and the provision of persuasive fertility-related messages, and how the supply (and response to) persuasion vary with levels of economic development, access to and competition in media markets, as well as competition in the market for religion. This future agenda also potentially allows the separate identification of such channels related to the characteristics of message receivers, from those related to the tenure and reputation building desire of the message sender. This takes us one step closer to being able to simultaneously study the supply of, and response to, persuasion, and so to provide new insights on the equilibrium effects of persuasion.

A Appendix

A.1 A Dynamic Model of Fertility

A.1.1 Set-Up

We present a model of a households' decision making over the timing of births, closely following the exposition of Arroyo and Zhang [1997]. This can be used to understand the channels through which persuasive messages impact fertility behaviors, and the types of household most affected. Households maximize their expected discounted value of utility over the life cycle $\tau = t, ..., T$,[24]

$$\max \ \mathbf{E}_\tau \sum_{t=\tau}^{T} \beta^t U(N_t, M_t, X_t, H_t, u_t), \tag{4}$$

where uncertainty could arise from shocks to wages or non-earned income (as has been the focus of the earlier literature), or preference shocks, that are more relevant in this study. $\beta < 1$ is a discount factor, $U(.)$ is the period utility function at time t, N_t are current surviving births (assumed to be zero or one), M_t is current family size (so $M_{t+1} = M_t + N_t$), X_t is the quantity of market goods consumed, and H_t is the amount of non-work (leisure) time enjoyed. We assume $U_N = 0$ so current births only enter utility through next period's family size M_{t+1}, and that U is concave in X_t. u_t measures contraceptive use, where $u_t \in [u^-, u^+]$, $u^- \geq 0$, $u^+ \leq 1$, and there is a disutility from contracepting such that $U_u < 0$ and $U_{uu} < 0$, that might partly stem from knowing such behaviors violate Catholic doctrine. This framework allows us to make predictions about equilibrium contraceptive use, and so links the first set of empirical results on changes in intended contraceptive use expressed by individuals in a narrow time window around the time of the Papal visit in October 1991, to the second set of results on the fertility impacts of the Papal visit nine months later.[25]

Households maximize (4) subject to a sequence of budget constraints for each period t,

$$I_t + w_t(\bar{H} - H_t) = X_t + p_t^M M_t + p_t^u u_t, \tag{5}$$

where I_t is non-earned income, $\overline{H}$ is the total amount of time available for work, w_t is the market wage, p_t^M is the period cost of family size M_t, p_t^u is the period cost of contraception u_t and X_t is the numeraire good. Contraceptive use, u_t, and the expected number of surviving births in period

[24] We follow the tradition in demography in attributing household fertility decisions to women rather than couples.

[25] As Arroyo and Zhang [1997] discuss, this formulation of preferences encompasses many other dynamic models of fertility including Heckman and Willis [1976], Wolpin [1984], Hotz and Miller [1984], Rosenzweig and Schultz [1985] and Leung [1991]. In this framework there are no explicit peer influences on fertility, as our focus is on persuasion rather than social learning driving changes in beliefs and behavior. Manski and Mayshar [2003] structurally estimate a dynamic fertility model where one component of female utility is the difference between her fertility level and that of her religious peers.

t, π_t, are related as follows,

$$\pi_t = \pi_b(1 - u_t), \tag{6}$$

where π_b measures behaviors that are complementary to non-contraceptive use in producing children. π_b would correspond to the likelihood of a birth assuming no contraceptive use if $u_t = u^- = 0$, i.e. an individual's natural fecundity. We might also think of π_b as the frequency with which a couple have sex, or the care taken to correctly use any given form of contraception.[26]

As Arroyo and Zhang [1997] emphasize, in this framework, contraceptive use over the life cycle is the critical behavior determining the onset and spacing of births over the life cycle. To focus in on the dynamics of contraceptive use, we first define the value function V as the maximized value of (4) when N_t, X_t, H_t and u_t are chosen optimally,

$$V(.) = \mathbf{E}_\tau \sum_{t=\tau}^{T} \beta^t U(N_t^*, u_t^*, X_t^*, H_t^*, M_t). \tag{7}$$

Bellman's optimality principle allows us to rewrite $V(.)$ as,

$$\begin{aligned} V(M_t, t) &= \max \{U(M_t, .) + \beta E_t V(M_{t+1}, t+1)\} \\ &= \max \{U(M_t, .) + \beta [\pi_t V(M_t + 1, t+1) + (1 - \pi_t) V(M_t, t+1)]\}, \end{aligned} \tag{8}$$

where we note that, starting from family size M_t, family size increases to M_t+1 in period $t+1$ with probability π_t, and remains at M_t with probability $1 - \pi_t$. Substituting in the budget constraint (5), treating M_t as fixed, and taking the partial derivative of the right hand side of (8) with respect to u_t, we derive the household's optimal contraception rule,

$$U_{X_t} p_t^u - U_{u_t} = \beta \pi_b [V(M_t, t+1) - V(M_t + 1, t+1)] \tag{9}$$

The left hand side corresponds to the marginal cost of contraception (MCC): as one more unit of contraception is used the household has to give up some consumption of market goods ($-U_{X_t} p_t^u$), and there is a disutility cost associated with marginal increases in contraception (U_{u_t}). The term in brackets on the right hand side corresponds to the capitalized value (at $t+1$) of *preventing* a birth in period t given parity M_t, denoted $\Delta V(M_{t+1}, t+1)$. Hence the right hand side as a whole captures the expected marginal benefit of contraception ($EMBC$) so that (9) can be rewritten as,

$$MCC = \beta \pi_b \Delta V(M_{t+1}, t+1) = EMBC. \tag{10}$$

While the MCC is unambiguously positive, the $EMBC$ can be of either sign depending on the sign of $\Delta V(M_{t+1}, t+1)$. Figure A3A illustrates a solution where the value of preventing a birth in

[26] Rosenzweig and Schultz [1985] assume individuals have incomplete knowledge of π_b. In any given period, their beliefs about π_b then inform the decision to contracept.

period t given parity M_t, is positive and the $EMBC$ is sufficiently positive to generate an interior solution for contraceptive use, u_t^*. For this household, the expected number of surviving births in period t is $\pi_t^* = \pi_b(1 - u_t^*)$. The other case is when $EMBC$ is so low (or negative if $\Delta V(.) < 0$), so that it is everywhere below MCC. The household is then at a corner solution for contraceptive use, so $u_t^* = u^-$, and the expected number of surviving births is $\pi_t^* = \pi_b(1 - u^-)$.

The model highlights that optimal contraceptive use varies over the life cycle with changes in: (i) wages and non-earned income; (ii) the relative price of contraception; (ii) the value of preventing a birth given family size M_t. The framework also makes precise that 'unplanned births' in period t are unanticipated shocks to the expected number of surviving births, π_t^*. Such shocks occur through two channels: (i) changes in optimal contraceptive use, u_t^*; (ii) changes in the frequency of sex, π_b. Given the salient themes of the Papal visit to Brazil in 1991 described in Section 2, it is precisely through these channels that we model persuasive messages as operating.

A.1.2 Channels of Persuasion

The first salient theme of the Papal visit is the condemnation of practices such as contraceptive use, abortion, sterilization and family planning. This can be modelled as a preference shock whereby Catholic households face an increased disutility of contracepting, $\Delta U_{u_t} < 0$. The second set of salient persuasive messages are on sexual behaviors, but these are more mixed: on the one hand, egotistical sex is condemned; on the other hand, followers are encouraged to produce offspring. This translates as $\Delta\pi_b \neq 0$, with its sign depending on whichever message prevails.

Preference Shocks Figure A3B shows the change in optimal contraceptive use occurring through the first channel of persuasion: an *unanticipated* increase in the disutility of contracepting at the start of period t. In the counterfactual scenario without persuasion, the household would have been at an interior solution, u_t^*. Such households are those for whom the value of *preventing* a birth in period t given parity M_t is sufficiently high. Persuasion causes the MCC curve to rise, but there is no change in the $EMBC$. Figure A3B shows the optimal contraceptive use decreases from u_t^* to u_t^{**}, and the change in the expected number of surviving (or unplanned) births is,

$$\Delta\pi_t = -\pi_b \Delta u_t > 0. \tag{11}$$

For households that have a sufficiently low value of preventing a birth, and so are at the corner solution $u_t = u^-$, the Papal visit has no impact on fertility outcomes through this channel of persuasion, as Figure A3C shows. Hence if the only channel through which persuasion impacts fertility choices is through such preference shocks, then unplanned pregnancies will rise according to (11) and this impact will be concentrated among households that would *a priori* have been less likely to have a child in period t in the counterfactual scenario absent persuasion.

Sexual Intercourse and Unprotected Sex On the second channel through which persuasion operates, consider first the case where $\Delta\pi_b > 0$. Figure A3D shows the impact on households that would otherwise be at an interior solution for contraceptive use, if this channel operates in addition to preference shocks. The MCC curve rises as before but now the $EMBC$ also rises because of $\Delta\pi_b > 0$. The two channels have *offsetting* impacts on Δu_t^*: on the one hand the household has incentives to contracept less because of the higher disutility of contracepting, but on the other hand the household has incentives to increase contraceptive use because the benefits of preventing a birth have also risen. Thus the change in contraceptive use, and hence the impact on the number of unplanned births, is ambiguous:

$$\Delta\pi_t = \Delta\pi_b(1 - u_t) - \pi_b\Delta u_t, \tag{12}$$

The number of unplanned births increases if the responsiveness to persuasion of sexual frequency, $\frac{\Delta\pi_b}{\pi_b}$, is greater than the responsiveness of contraceptive use, $\frac{\Delta u_t}{u_t}$, so that the amount of *unprotected sex* increases. In the empirical analysis this is then a key outcome linking persuasive impacts on fertility-related beliefs through to actual fertility outcomes.

For households that are initially at the lower corner solution with regards to contraceptive use absent persuasion ($u_t^* = u^-$), if persuasion also causes $\Delta\pi_b > 0$ then such households can also be impacted (which is not true for such households if persuasion operates only through shocks to the disutility of contracepting). Figure A3E shows that if the increase in the $EMBC$ is sufficiently large then the household finds it optimal to *increase* its contraceptive use from u^- to u_t^{**} and the overall change in the expected number of unplanned births is,

$$\Delta\pi_t = \Delta\pi_b(1 - u^-) - \pi_b\Delta u_t, \tag{13}$$

the sign of which is ambiguous, and again depends on the relative responsiveness to persuasion of π_b and optimal contraceptive use, i.e. whether the frequency of unprotected sex rises or falls.

Finally, given the tone of some messages related to sexual behavior in the Papal speeches in 1991, especially related to sex out-of-wedlock, some individuals – especially singles – could plausibly respond by *reducing* π_b (that would be consistent with the point estimate reported in Column 3 of Table 6). In this case the $EMBC$ falls. For those households initially using some contraception above u^-, this effect *reinforces* the incentives to reduce contraceptive use caused by persuasive messages increasing the disutility of contracepting. Overall this has ambiguous impacts on the change in the expected number of unplanned births. This ambiguity arises because although less contraception is being used, less sexual intercourse (say) is also taking place. Again, this increases the number of unplanned births if the net frequency of unprotected sex increases, namely the responsiveness in terms of sexual frequency, $\frac{\Delta\pi_b}{\pi_b}$, is greater than the response in terms of equilibrium contraceptive use, $\frac{\Delta u_t}{u_t}$. This case is shown in Figure A3F when the impacts are

constructed to be of similar magnitude so that although equilibrium contraceptive use falls, there is little change in the expected number of unplanned children.

A.2 Early Life Outcomes

To provide some tentative evidence on the impact of persuasion on the early life outcomes of those born nine months after the Papal visit, we use the 1996 DHS data where we examine mortality and birthweight outcomes. The motivation for doing so is that we have previously shown persuasion to impact preferences to contracept and subsequently the timing of fertility outcomes. This change in birth timing can potentially affect early life impacts both through established links between birth-spacing, mortality and the biological ability to breast-feed [Millman and Palloni 1986], as well as economic channels such as a decreased ability of households to smooth consumption (if capital markets are imperfect) or fully exploit scale economies relative to the optimal path of births absent persuasion [Newman and McCulloch 1984]. As described in Figure 2B, births appear to be shifted forward four to six months relative to a counterfactual absent any persuasion. Moreover, the evidence presented in Table 8 suggests in this context we identify the impacts of such marginal changes in birth timing on early life outcomes, *holding constant* total fertility.

It is important to first understand any potential selection into mortality before other outcomes are considered. Hence we first use the 1996 DHS data to estimate the likelihood of survival until survey date, and whether this differs by birth cohort. The DHS 1996 data records mortality histories of all children born to surveyed mothers. We use a probit model to estimate whether a child born nine months post-visit has a differential survival rate than adjacent birth cohorts. To reiterate, as the data only contains month and year of birth (but not exact date of birth), we define those born in July 1992 to be born nine-months post-visit. Assuming *full term* pregnancies, such individuals would have been conceived between October 5th and November 12th 1991. However, we might expect any mortality impacts to be concentrated among those conceived around the time of the visit but who are born prematurely, typically defined to be pregnancies of length around 37 weeks. Such premature births would, if actually conceived during the period of October 12-21, occur between June 27th and July 6th. More generally, premature births conceived during or a few weeks after the Papal visit will largely be recorded as occurring *eight* months post-visit.

Column 1 of Table A9 reports marginal effects from a probit model where the outcome is a dummy equal to one if child is alive on DHS 1996 survey data. We condition on child controls (birth order and gender), the time invariant mother controls used earlier in the fertility analysis, mother's age at birth and age squared, and whether the mother was ever married at birth, as well as month and year of birth dummies. We cluster standard errors by religion-region to account for common shocks to women of the same religious group and geographic location. We find that there is no impact on the likelihood of survival for children born nine months post-visit: these children if conceived around the time of visit experienced full term pregnancies. On the other hand, we find

those born eight months post-visit are significantly less likely to survive to 1996: these children if conceived around the time of visit were likely born premature. Future research based on exact date of birth and large samples of administrative records needs to probe this further: for our purposes, we note this mortality selection, and unobservable dates of conception, are important caveats to be borne in mind for the subsequent analysis.

A.2.1 Administrative Birthweight Records

The 1996 DHS asks respondents to report the birthweight of each child born in the five years prior to survey date. Birthweights are recorded from administrative health card data for women with such information. We use this data to estimate the following OLS specification,

$$\begin{aligned} \log b_{ijmy} &= \beta \mathbf{I}(MoB = \text{Papal Visit}_{my+9}) + \gamma_0 \mathbf{X}_i + \gamma_1 \mathbf{X}_j \\ &\quad + \sum \gamma_m \mathbf{I}(born\ in\ month_m) + \sum \gamma_y \mathbf{I}(born\ in\ year_y) + u_{ijmy}, \end{aligned} \tag{14}$$

where b_{ijmy} is the administratively recorded birthweight (in grams) of child i born to mother j in month-year my, $\mathbf{X}_i$ and $\mathbf{X}_j$ are the same child controls and time invariant mother controls used above in the mortality specification, and (14) also includes a full set of month and year of birth dummies. Our coefficient of interest is β, that measures the percentage impact on birthweight of having been born nine-months post-visit. We continue to cluster standard errors by religion-region. Our working sample covers 4117 children born to 3198 mothers.

Column 2 in Table A9 shows that unconditionally, the birthweight of the cohort born nine months post-visit is on average 5.7% lower than other cohorts. Column 3 shows once child and mother characteristics are controlled for, this difference in birthweight is 7.1% and statistically significant at the 6% level. This reiterates a theme throughout the earlier documented impacts of persuasion: there is heterogeneity across individuals in their susceptibility to persuasion, so it is vital to control for mother characteristics. Column 4 shows birthweight impacts for adjacent month-year birth cohorts: it is only those born nine months post-visit that have significantly lower birthweights. The marginal effect of being born nine months post-visit is statistically different from the adjacent cohort born ten months post-visit. It is not however different, at conventional levels, from those born eight months later, that as the earlier results hinted at, might capture some fraction of premature births among those conceived around the time of the visit.

We next consider quantile regression estimates to examine how the conditional birthweight distribution varies by birth cohort. Figure A4A shows that among those born nine months post-visit, the negative mean impacts in Table A9 are driven by the left tail of the birthweight distribution. We note that the 50th (20th) percentiles in the distribution correspond to birthweights of 3300g (2800g) and the very lowest percentile corresponds to 1500g, the typical definition of a low birth weight. Hence exposure to persuasive fertility-related messages shifts births from the me-

dian birthweight to around the 35th percentile. As detailed below, this change in the birthweight distribution is predominantly driven by cross sectional differences in mothers that are susceptible to persuasion to those that are not, and hence not driven by within-mother differences in birth timing.[27]

Figure A4B shows a similar distributional pattern for those born eight-months post visit, and Figure A4C shows less evidence of such distributional impacts are found for the cohort born ten months post-visit (for whom no mean impact was found either).[28]

The 7% reduction in mean birthweight found in our baseline estimate in Column 4 picks up combined effects of cross sectional differences across mothers in their susceptibility to persuasion, and within-mother impacts of a changed timing of births (holding constant total fertility). To probe the relative importance of each channel we exploit the subsample of 810 mothers that give birth *multiple* times between 1991 and 1996. Column 5 estimates our baseline specification in this subsample. The earlier results are qualitatively replicated: the cohort of children born nine months post-visit have, on average, birthweights that are 12.2% lower than otherwise predicted. There is no significant impact on birthweight of having been born eight or ten months post-visit, and both these estimates are significantly different from the nine month impact. This magnitude of impact corresponds to an average reduction in birthweight of 395g, or equivalent to shifting births from the median birthweight (3300g) to the 26th percentile. The quantitative impacts of persuasion are then similar to the impacts documented in other studies examining cross sectional differences across mothers driving birthweights, such as smoking [Almond *et al.* 2005: -6%, Lien and Evans 2005: -5.4%], and black-white differentials in the US: -11% [Pitts *et al.* 2011].

Column 6 then repeats the estimation in this subsample but additionally controlling for mother fixed effects in (14): this isolates the within-mother impact of differentially timed births in response to persuasion. We find no significant impacts on the birthweight of the cohort born nine months post-visit.[29] In short, these tentative results suggest the documented impacts of persuasion on early life outcomes are driven predominantly by cross sectional differences across mothers between those more and less susceptible to persuasion, rather than within-mother impacts of changes in birth timing due to persuasion.

[27] If we take the view that the entire effect is driven by around 27% of those actually born nine months post-visit, then the impact on those children is approximately the equivalent of moving from the median birthweight to birthweights at around the 8th percentile.

[28] Robust standard errors are shown. Applying the methods for extremal quantile regression in Chernozhukov and Fernandez-Val [2011] is likely to lead to wider confidence intervals at the tails of the conditional distribution. This further highlights the need to revisit these findings with larger administrative data sets.

[29] We can compare this effect to those of shocks *in utero* on birthweights: assuming selection into pregnancy is uncorrelated with shocks, these typically identify within-mother effects. This literature, reviewed in Almond and Currie [2011], has, for example, documented the impacts of 9/11 via stress on mothers to reduce birthweights by between zero and 1% among US, Colombian and Dutch neonates. In terms of nutrition during pregnancy, Almond and Mazumdur [2011] document a -1.2% ITT impact on birthweights of fasting during Ramadan.

A.2.2 Self-reported Birthweights

To bridge the last set of results on the impacts of persuasion on birthweights, to its impact on later life outcomes, we document whether mothers' *self-reports* of each child's birthweight also vary across birth cohorts. If parents are aware of the relative birthweight of children, this has implications for how to interpret later life outcomes – these would be driven both by direct effects of birthweight, as well as endogenous changes in parental behavior (compensating or reinforcing) towards the child, conditional on their birthweight. In the 1996 DHS mothers were asked to self-report the birthweight of each child born in the five years prior to the survey using a five-point scale (1 = very small,...,5 = very large). We use this as our dependent variable in an ordered probit specification that is otherwise analogous to (14). Column 7 of Table A9 reports the result: mothers self report children born nine and ten months post-visit to be significantly smaller at birth than in other cohorts, including those born eight months post-visit. Column 8 extends the cohorts considered to also run to 11 months post-visit and it remains the case that mothers self-report those children born nine or ten months post-visit to be significantly smaller than in other cohorts. This certainly suggests that mothers most susceptible to persuasion might be aware of any differences in birthweight among children born in the nine-ten month post-visit window, and thus they have the possibility to respond to this information during the child's early years. We leave for future research, with the potential use of larger administrative data sets, the goal of further tracing this cohort through their life cycle.

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Table 1: Keywords from Papal Visits to Brazil in 1991 and 1980

The number of times each word was pronounced during the visit is shown below
The number in parentheses refers to speech number, as recorded on the Pope's 1991 itinerary

	Panel A: 1991 Visit		Panel B: 1980 Visit	
Keyword	**Total times said**	**Speeches**	**Total times said**	**Speeches**
Contraceptives	4	Campo Grande (18, 19), Salvador (27- twice)	0	
Abortion	4	Campo Grande (18, 19), Salvador (27 - twice)	0	
Sterilization	2	Campo Grande (19), Salvador (27)	0	
Anti-natalist campaigns	1	Natal (3)	0	
Divorce	1	Campo Grande (18)	0	
Marriage	15	Natal (5, 6), Cuiaba (16), Campo Grande (18 - 10 times, 19 - twice)	4	Rio de Janeiro (3 times), Porto Alegre
Children	48	Brasilia (8 - twice), Goiania (11), Cuiaba (14 - twice, 15), Vitoria (23, 24, 25 - twice), Salvador (27 - thirty six times, 28), Salvador da Bahia (30)	18	Rio de Janeiro (five times), Sao Paolo, Aparecida (twice), Porto Alegre (five times), Curitiba (twice), Salvador da Bahia, Teresina Airport, Belem
Family	82	Numerous	123	Numerous
Peace	44		50	
Charity	39		49	
Education	9		8	
Poverty/Poor	43		130	
Faith	130		148	
HIV/AIDS	0		0	
Average length of speeches (words) that include keywords related to fertility	1847			
Average length of speeches (words) that DO NOT include keywords related to fertility	1224			

Notes: Transcripts of each speech were obtained from the Papal Archives of the Vatican, http://w2.vatican.va/content/john-paul-ii/it.html (accessed April 2015). Panel A for the 1991 Visit to Brazil is based on all 32 speeches pronounced by the Pope (including three speeches that were translated from Portuguese by the authors as no official translation was provided in the Archives). In the speeches column, we record which speech in the itinerary the keyword was said in, and the total number of times the keyword was said during the speech. Panel B for the 1980 visit is based on all 49 speeches pronounced by the Pope during the visit (including one speech that was translated from Portuguese by the authors as no official translation was provided in the Archives). Fertility related keywords include: contraceptives, abortion, sterilization, anti-natalist campaigns, divorce, marriage, children.

Table 2: Balance, by 1991 DHS Interview Timing

Means, standard deviations in parentheses, p-values in brackets

	(1) Interviewed Pre-arrival	(2) Interviewed Post-arrival	(3) P-value on test of equality
A. Religion and Fertility Related			
Catholic	.751	.799	[.360]
	(.433)	(.401)	
Other Religion	.095	.072	[.679]
	(.293)	(.258)	
Non Religious	.154	.130	[.144]
	(.361)	(.336)	
Catholic and Attending Church	.594	.639	[.815]
	(.491)	(.480)	
Number of Children Ever Born	1.47	1.83	[.172]
	(2.49)	(2.91)	
Number of Children Alive	1.25	1.54	[.212]
	(1.96)	(2.38)	
Number of Children Living in the Same Household as Respondent	1.04	1.25	[.346]
	(1.69)	(1.92)	
Household Size	6.31	5.96	[.008]
	(2.91)	(2.69)	
B. Respondent and Household Related			
No Education	.117	.166	[.623]
	(.321)	(.372)	
Primary Education Level	.627	.634	[.729]
	(.484)	(.482)	
Secondary Education Level	.223	.161	[.099]
	(.416)	(.368)	
Married	.321	.366	[.789]
	(.467)	(.482)	
Employed	.506	.453	[.176]
	(.500)	(.498)	
Female Headed Household	.228	.229	[.993]
	(.420)	(.420)	
Age	25.9	26.7	[.025]
	(9.22)	(9.72)	
White	.241	.219	[.780]
	(.428)	(.414)	
Parda/Mulata/Morena Race	.663	.705	[.696]
	(.473)	(.456)	
Other Race (Black/Oriental/Indian)	.096	.076	[.569]
	(.295)	(.266)	
Rural Location	.228	.341	[.884]
	(.420)	(.474)	
Owns Refrigerator	.702	.509	[.089]
	(.458)	(.500)	
Owns Car	.189	.127	[.288]
	(.392)	(.333)	

Notes: All statistics are based on the sample of non-sterilized women in the Brazil DHS 1991 data. Column 1 reports characteristics of women interviewed prior to the start of the Papal visit (so from September 16th 1991 to 11th October 1991), and Column 2 reports characteristics of women interviewed post-arrival (so from October 12th 1991 to 6th February 1992). Column 3 shows p-values of the test of equality from an OLS regression (that weights using the DHS sample weights) and allows the error term to be clustered by week of interview.

Table 3: Fertility Related Preferences, by 1991 DHS Interview Timing

Mean, standard deviation in parentheses and p-value on tests of equality in square brackets

	(1) Interviewed Pre-Arrival	(2) Interviewed Post-Arrival	(3) Test of Equality [Col 1. = Col. 2]	(4) Test of Equality using Ibragimov and Mueller [2016] Procedure [Col 1. = Col. 2]
Currently Using Contraceptives	.233	.192	[.041]	[.865]
	(.423)	(.394)		
Does Not Use Contraceptives and Does Not Plan To Use Them in the Future [yes=1]	.297	.406	[.000]	[.002]
	(.457)	(.491)		
How Many Times A Month Do You Usually Have Sexual Intercourse?	6.07	7.12	[.000]	[.309]
	(5.65)	(6.31)		
Monthly Frequency of Unprotected Sex	1.67	2.29	[.000]	[.069]
	(4.39)	(4.64)		

Notes: All statistics are based on the sample of non-sterilized women in the Brazil DHS 1991 data. We report the mean of each statistic, and its standard deviation in parentheses below. The third outcome considered is based on respondent's response to the question, "How many times a month do you usually have sexual intercourse?". The final outcome multiplies the second and third outcomes together, creating a measure for the frequency of unprotected sex. Interview dates range from September 16th 1991 to February 6th 1992. The Pope arrived to Brazil on October 12th 1991 and left on October 21st 1991. In Column 3, the p-value on the test of equality is based on an OLS regression of the outcome of interest regressed against a dummy for whether the respondent is interviewed pre or post-arrival of the Pope to Brazil. The regression uses DHS sample weights and allows the error term to be clustered by week of interview. Column 4 reports p-values from the testing procedure for inference with few heterogeneous clusters described in Ibragimov and Mueller [2016].

Table 4: Persuasion, Contraceptive Use and Intentions to Contracept

Marginal probit estimates reported throughout
Standard errors clustered by interview week

Dependent Variable:	Dummy = 1 if respondent currently uses contraceptives			Dummy = 1 if respondent does not use contraceptives and does not plan to use them in the future					
	(1) Individual and Household Controls	(2) Interview Controls	(3) Decay	(4) Individual and Household Controls	(5) Interview Controls	(6) Limited States	(7) Decay	(8) Catholics, Attending Church	(9) Catholics, Not Attending Church
Interviewed After Pope's Arrival	-.015	-.030		.102***	.128***	.115***		.129***	.079
	(.014)	(.022)		(.018)	(.025)	(.037)		(.021)	(.090)
Interviewed During Pope's Visit			-.040***				.133***		
			(.009)				(.037)		
Interviewed After Pope's Departure			-.005				.135***		
			(.031)				(.020)		
Mean of dependent variable in pre-arrival period	.233	.233	.233	.297	.297	.297	.297	.314	.250
Test of equality of reported coefficients [p-value]			[.083]				[.771]		
Individual and household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interview controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Number of observations	4592	4592	4592	4592	4592	3060	4592	2513	1117

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. All specifications use data from the 1991 DHS survey for Brazil. Women sterilized before interview date are excluded from the analysis. The dependent variable in Columns 1 to 3 is a dummy equal to one if the respondent currently uses contraceptives, and the dependent variable in Columns 4 to 9 is a dummy equal to one if the respondent reports that they do not currently use contraceptives and do not plan to use them in the future. Marginal probit estimates are reported throughout. Standard errors allowing for clustering by week of interview are reported in parentheses in all Columns. All observations are weighted using DHS sampling weights. The Pope arrived to Brazil on October 12th 1991 and left on October 21st 1991. Interview dates range from September 16th 1991 to February 6th 1992. The individual and household controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), dummy variables for whether married and currently employed, gender of household head, age of respondent, the number of children alive, household size, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and state dummies. The interview controls include the number of days since the first interview was conducted in the DHS 1991 Brazil survey, whether the interview started in the morning, the interview length, a dummy for whether multiple interview visits were required, and the day of the week of the interview. In Column 6 the sample excludes those states where all interviews took place after the arrival of the Pope to Brazil in the 1991 visit: the excluded states are Piaui (438 observations), Paraiba (307 observations) and Pernambuco (787 observations). In Columns 8 and 9, to separate Catholics between those Attending and Not Attending Church, we use answers to a question about frequency of church attendance: we define as Not Attending Church those Catholics that report never attending church; we define as Catholics and Attending Church those Catholics that report attending church at least sometimes.

Table 5: Persuasion, Sexual Intercourse and Unprotected Sex

Tobit estimates
Standard errors clustered by interview week

Dependent Variable:	**How Many Times a Month Do You Usually Have Sexual Intercourse?**				**Monthly Frequency of Unprotected Sex**			
Sample:	**(1) All Respondents**	**(2) Catholics**	**(3) Catholics, Attending Church**	**(4) Catholics, Not Attending Church**	**(5) All Respondents**	**(6) Catholics**	**(7) Catholics, Attending Church**	**(8) Catholics, Not Attending Church**
Interviewed After Pope's Arrival	.886*	1.09**	.575	3.39***	1.98*	2.09*	2.35***	1.85
	(.501)	(.543)	(.700)	(.609)	(1.11)	(1.08)	(.884)	(2.13)
Percentage of women reporting some intercourse in pre-arrival period	.867	.870	.872	.868	.867	.870	.872	.868
Mean of dependent variable in pre-arrival period, conditional on being strictly positive	7.00	7.01	7.05	6.96	7.27	6.92	6.63	7.65
Controls	Individual, Household and Interview							
Number of observations	2,787	2201	1439	762	2,787	2201	1439	762

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. All specifications use data from the 1991 DHS survey for Brazil. Women sterilized before interview date are excluded from the analysis. The dependent variable in Columns 1 to 4 is the respondent's response to the question, "How many times a month do you usually have sexual intercourse?". Tobit estimates, censored at zero, are reported. This question is not asked to those women that report never having had a sexual intercourse in their life. Hence all impacts are measured from sexually active women. The dependent variable in Columns 5 to 8 multiplies this previous outcome with a dummy equal to one if the respondent reports that they do not currently use contraceptives and do not plan to use them in the future, and zero otherwise. Multiplying the two outcomes together creates a measure of the frequency of unprotected sex. Standard errors allowing for clustering by interview week are in parentheses. All observations are weighted using DHS sampling weights. The pope arrived to Brazil on October 12th 1991 and left on October 21st 1991. Interview dates range from September 16th 1991 to February 6th 1992. The individual and household controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), dummy variables for whether married and currently employed, gender of household head, age of respondent, the number of children alive, household size, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and state dummies. The interview controls include the number of days since the first interview was conducted in the DHS 1991 Brazil survey, whether the interview started in the morning, the interview length, a dummy for whether multiple interview visits were required, and the day of the week of the interview.

Table 6: Persuasive Impacts by Marital Status

Standard errors clustered by interview week

Dependent Variable:	=1 if respondent does not use contraceptives and does not plan to use them in the future		How Many Times a Month Do You Usually Have Sexual Intercourse?		Monthly Frequency of Unprotected Sex	
Estimation Method:	**Probit**		**Tobit**		**Tobit**	
Sample:	**(1) Single**	**(2) Married**	**(3) Single**	**(4) Married**	**(5) Single**	**(6) Married**
Interviewed After Pope's Arrival	.210***	.025	-1.56	2.01***	4.24	2.06***
	(.031)	(.036)	(.974)	(.550)	(3.66)	(.762)
Mean of dependent variable in pre-arrival period	.292	.306				
Percentage of women reporting some intercourse in pre-arrival period			.729	.988	.729	.988
Mean of dependent variable in pre-arrival period, conditional on being strictly positive			6.14	7.56	8.23	6.81
Controls			Individual, Household and Interview			
Number of observations	2945	1647	1150	1637	1150	1637

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. All specifications use data from the 1991 DHS survey for Brazil. Women sterilized before interview date are excluded from the analysis. The dependent variable in Columns 1 and 2 is a dummy equal to one if the respondent reports that they do not currently use contraceptives and do not plan to use them in the future, and zero otherwise. The dependent variable in Columns 3 and 4 is the respondent's response to the question, "How many times a month do you usually have sexual intercourse?". Tobit estimates, censored at zero, are reported. This question is not asked to those women that report never having had a sexual intercourse in their life. Hence all impacts are measured from sexually active women. The dependent variable in Columns 5 and 6 multiplies this previous outcome with a dummy equal to one if the respondent reports that they do not currently use contraceptives and do not plan to use them in the future, and zero otherwise. Multiplying the two outcomes together creates a measure of the frequency of unprotected sex. Standard errors allowing for clustering by week of interview in parentheses. All observations are weighted using DHS sampling weights. The Pope arrived to Brazil on October 12th 1991 and left on October 21st 1991. Interview dates range from September 16th 1991 to February 6th 1992. The individual and household controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), dummy variables for whether married and currently employed, gender of household head, age of respondent, the number of children alive, household size, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and state dummies. The interview controls include the number of days since the first interview was conducted in the DHS 1991 Brazil survey, whether the interview started in the morning, the interview length, a dummy for whether multiple interview visits were required, and the day of the week of the interview.

Table 7: Persuasion and Fertility Outcomes

Discrete Proportional Hazard Model: Complementary Log-Log regression coefficients

Dependent variable: dummy =1 if woman gave birth at time t

Standard errors (in parentheses) clustered at the individual level in all columns except Column 4 where standard errors are clustered by religion-time period

	(1) Baseline Hazard	(2) Controls	(3) Lead and Lag	(4) Lead and Lag, Alternative Clustering	(5) More Leads and Lags	(6) Catholics	(7) Below Ideal Family Size	(8) Above Ideal Family Size
Nine Months After Pope's Visit	.245**	.237**	.238**	.238**	.273**	.245*	.501***	-.127
	(.119)	(.119)	(.120)	(.101)	(.122)	(.138)	(.150)	(.205)
Eight Months After Pope's Visit			-.053	-.053	-.018	-.021	.140	-.390*
			(.132)	(.095)	(.134)	(.147)	(.163)	(.234)
Ten Months After Pope's Visit			.055	.055	.090	-.018	.106	-.046
			(.131)	(.099)	(.132)	(.148)	(.168)	(.211)
Seven Months After Pope's Visit					.200			
					(.122)			
Eleven Months After Pope's Visit					.109			
					(.130)			
t-test: nine month = eight month [p-value]			[.087]	[.022]	[.087]	[.166]	[.082]	[.384]
t-test: nine month = ten month [p-value]			[.278]	[.160]	[.278]	[.172]	[.064]	[.771]
t-test: nine month = seven month [p-value]					[.648]			
t-test: nine month = eleven month [p-value]					[.322]			
Month and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time since last birth dummies [baseline hazard]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of women	10347	10347	10347	10347	10347	8106	6714	3543
Number of observations [women x time]	698296	698296	698296	698296	698296	549519	447387	242204

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. All specifications use data from the 1996 DHS survey for Brazil. The data is reshaped to create a month-year panel of fertility histories for each respondent. Each respondent is included in the sample only for time periods when she is at risk of pregnancy. Hence we exclude eight months preceding each birth, and drop sterilized women from the sample from the month they report becoming sterilized. The dependent variable is a dummy equal to one if the respondent reports a birth in that month-year, and zero otherwise in all Columns. A complementary log-log hazard model is calculated, where standard errors are clustered by respondent in all Columns except Column 4 where they are clustered by religion-time period. In all specifications a complete series of dummies for month since last birth are included, to flexibly capture the baseline hazard for births of order two and above. For births of order one, the dummies capture the time since the woman turns 15 or enters the panel. The time period considered runs from January 1987 to December 1995. Columns 7 and 8 split the sample into those that were below or above their ideal family size at the time of the Papal visit in October 1991. Month and year dummies are included in each specification. The additional time invariant controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), a dummy variable for whether currently employed, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and region dummies. The time varying controls are the age of the respondent in month-year t and age squared, whether the respondent has ever married by month-year t, the number of boys alive at month-year t, and the total number of children alive at month-year t. At the foot of the table we report p-values on the test of equality between the coefficient on those born nine months after the Pope's visit with those born eight months after the visit, and those born ten months after the visit.

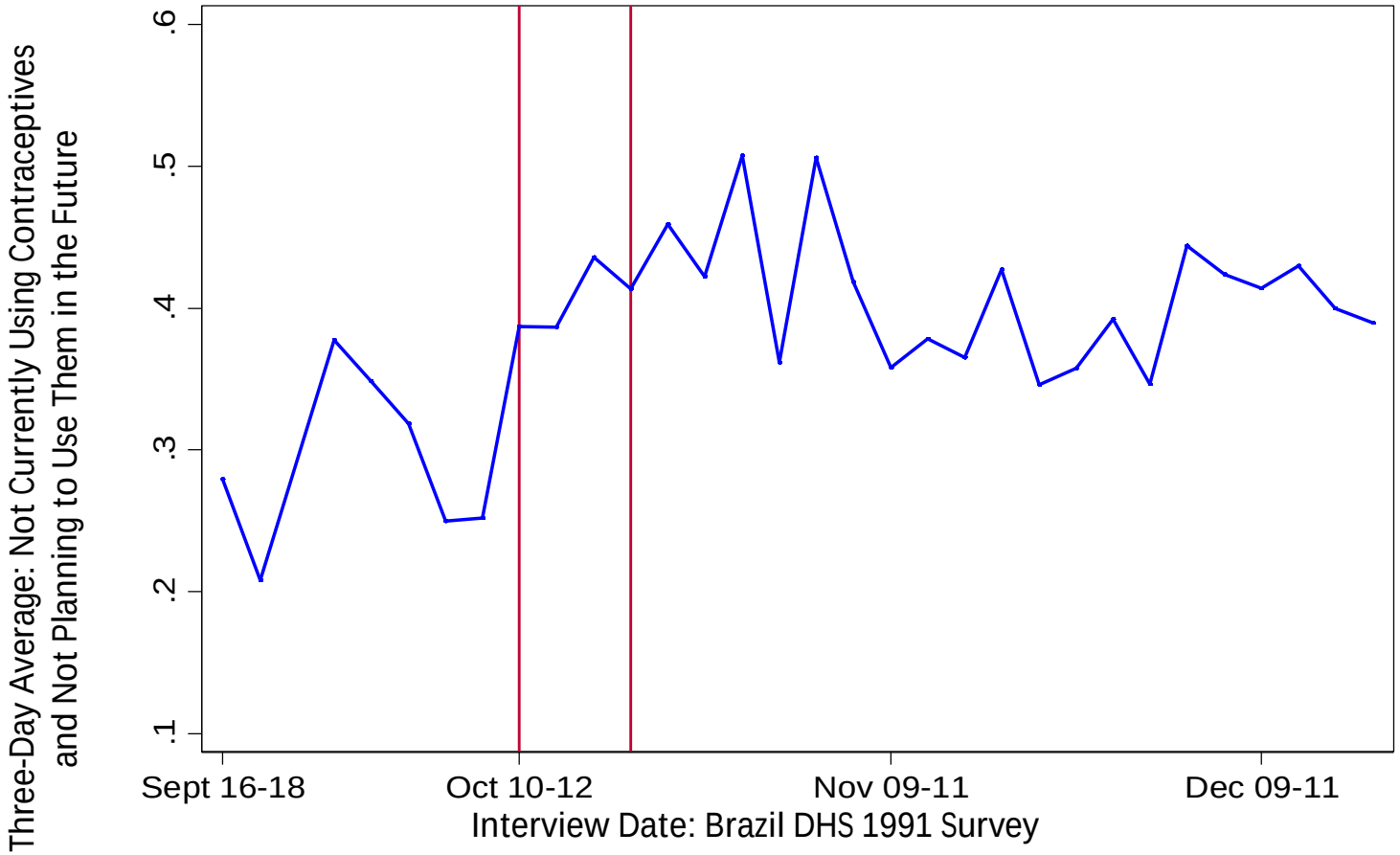
Table 8: Persuasion and Long Run Total Fertility

Means and standard deviations in parentheses in Columns 1 and 2
p-values on tests of equivalence in brackets in Columns 4 and 5

Panel A: Outcomes in Brazil 1996 DHS Survey	(1) Gave Birth Nine Months After the Pope's 1991 Visit	(2) Gave Birth Eight Months After the Pope's 1991 Visit	(3) Difference [95% CI]	(4) Two-sided t-test of Equality of Mean [p-value]	(5) Conditional Difference [p-value]
Number of Women	91	70			
Children Ever Born	3.35	3.27	.080	[.811]	[.982]
	(2.26)	(1.90)	[-.583, .743]		
Children Alive	3.05	2.93	.126	[.667]	[.853]
	(1.97)	(1.66)	[-.453, .706]		
Additional Number of Children Born Since Pope's Visit	1.54	1.70	-.162	[.162]	[.450]
	(.638)	(.823)	[-.389, .066]		
Additional Number of Girls Born Since Pope's Visit	.769	.943	-.174	[.116]	[.632]
	(.634)	(.759)	[-.391, .043]		
Month-year of Birth of Youngest Child [CMC]	1124	1125	-1.05	[.680]	[.726]
	(15.6)	(16.7)	[-6.10, 3.99]		
Sterilized [yes=1]	.385	.329	.056	[.466]	[.623]
	(.489)	(.473)	[-.095, .207]		
Panel B: Outcomes in Brazil 2006 DHS Survey					
Number of Women	49	42			
Children Ever Born	4.14	4.52	-.381	[.473]	[.911]
	(2.31)	(2.73)	[-1.43, .669]		
Children Alive	3.98	4.17	-.187	[.700]	[.987]
	(2.14)	(2.48)	[-1.15, .774]		
Additional Number of Children Born Since Pope's Visit	3.08	3.26	-.180	[.647]	[.603]
	(1.71)	(2.04)	[-.960, .599]		
Additional Number of Girls Born Since Pope's Visit	1.57	1.48	.095	[.732]	[.825]
	(1.22)	(1.42)	[-.455, .646]		
Month-year of Birth of Youngest Child [CMC]	1080	1069	11.1	[.287]	[.858]
	(45.9)	(53.1)	[-9.49, 31.7]		
Sterilized [yes=1]	.347	.262	.085	[.387]	[.803]
	(.481)	(.445)	[-.109, .279]		

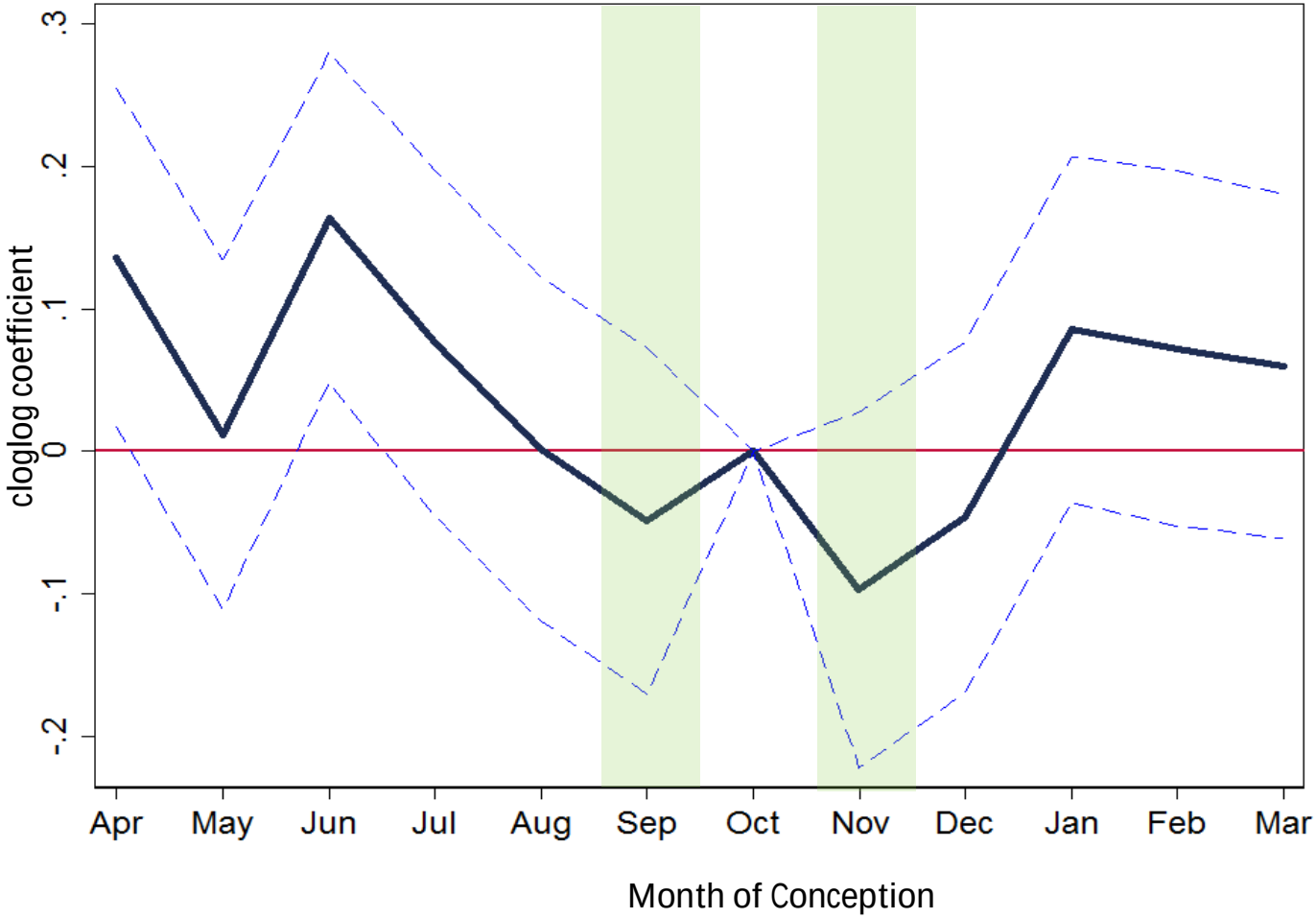
Notes: Panel A (B) uses data from the 1996 (2006) DHS survey for Brazil: this is the time at which all fertility related outcomes are measured. The month-year of birth of the youngest child variable is in DHS century month codes [CMC]. Means and standard deviations in parentheses are shown in Columns 1 and 2. Column 1 refers to the women in the sample that have a birth exactly nine months after the Pope's 1991 visit to Brazil. Column 2 refers to the women in the sample that have a birth exactly eight months after the Pope's 1991 visit to Brazil. Column 4 shows the p-value on a t-test of the equality of means assuming equal variances. Column 5 shows the p-value on the equality of the means conditional on a range of individual characteristics. These are, for Panel A: religion (dummies for Catholic, other religion, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), dummy variables for whether married and currently employed, gender of household head, age of respondent, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, region dummies, the age of the respondent at first birth, and date of first marriage. The individual characteristics controlled for in Panel B are the same as in Panel A, except the following: (i) Panel B controls for years of education instead of dummies for the education level of the respondent (as only years of education are available in the 2006 DHS data), and (ii) Panel B controls for age at first marriage instead of date of first marriage (as no information on date of first marriage is available in the 2006 DHS data). This p-value is obtained from a linear regression, where observations are weighted using DHS sampling weights and standard errors are clustered by week of interview (there are 16 clusters in 1996, and 23 clusters in 2006).

Figure 1: Persuasion and Fertility Preferences, by Interview Date, Brazil 1991 DHS



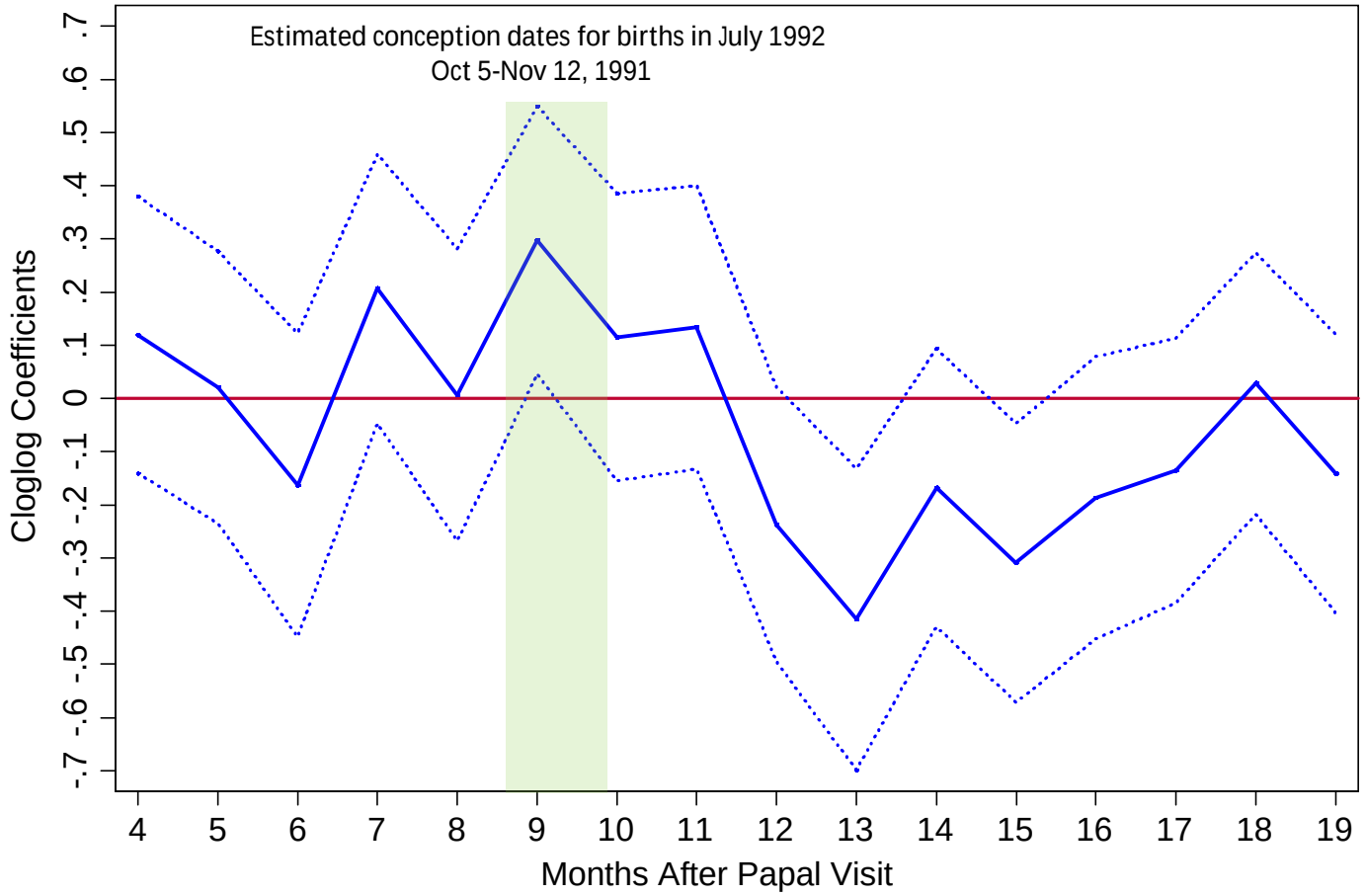
Notes: The y-axis shows the average intent to contracept in the Brazil DHS 1991 sample, based on women who are not sterilized on the interview date. This outcome is constructed from a dummy equal to one if the respondent reports that they do not currently use contraceptives and do not plan to use them in the future, and zero otherwise. The figure plots the three-day moving average of this variable (averaged over all respondents). To reduce noise in the series, we omit those three-day periods that have the lowest 1% of respondents in any given three-day period (corresponding to having 16 or fewer responses in a consecutive three-day period) and stop the series just prior to Christmas 1991. The vertical lines indicate the start and end dates of the Papal visit.

Figure 2A: Hazard Model Coefficients on Month Dummies
Excludes births in 1992



Notes: Figure 2A reports the cloglog coefficients from similar fertility specifications based on the 1996 DHS survey for Brazil (excluding observations from 1992). The data is reshaped to create a month-year panel of fertility histories for each respondent. Each respondent is included in the sample only for time periods when she is at risk of pregnancy. Thus, for each women, the time intervals in which she is (i) sterilised, (ii) younger than 15 are excluded from the analysis. The eight months following each conception are also excluded from the analysis (calculated retrospectively from the date of birth of each child). The dependent variable is a dummy equal to one if the respondent reports a birth in that month-year, and zero otherwise. A complementary log-log hazard model is calculated, where standard errors are allowed to be clustered by respondent. The time period considered runs from January 1987 to December 1995, excluding observations from 1992. Figure 2A reports the coefficients on month dummies for a baseline specification which only controls for the baseline hazard, month and year dummies. A complete series of dummies for month since last birth are included, to flexibly capture the baseline hazard for births of order two and above. For births of order one, the dummies capture the time since the women turns 15 or enters the panel. The month dummies are translated into month of conception dummies assuming full term pregnancies. The omitted month of conception dummy is October, the month of the Papal visit.

Figure 2B: Hazard Model Coefficients on Fertility Impacts



Notes: Figure 2B reports the cloglog coefficients from similar fertility specifications based on the 1996 DHS survey for Brazil. The data is reshaped to create a month-year panel of fertility histories for each respondent. Each respondent is included in the sample only for time periods when she is at risk of pregnancy. Thus, for each women, the time intervals in which she is (i) sterilised, (ii) younger than 15 are excluded from the analysis. The eight months following each conception are also excluded from the analysis (calculated retrospectively from the date of birth of each child). The dependent variable is a dummy equal to one if the respondent reports a birth in that month-year, and zero otherwise. A complementary log-log hazard model is calculated, where standard errors are allowed to be clustered by respondent. The time period considered runs from January 1987 to December 1995. A complete series of dummies for month since last birth are included, to flexibly capture the baseline hazard for births of order two and above. For births of order one, the dummies capture the time since the woman turns 15 or enters the panel. The month dummies are translated into month of conception dummies assuming full term pregnancies. The omitted month of conception dummy is October, the month of the Papal visit. Figure 2B graphs the estimated impact on the fertiltiy hazard of being born various months before and after the Papal visit to Brazil. Month and year dummies are in each specification. The additional time invariant controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), a dummy variable for whether currently employed, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and region dummies. The time varying controls are the age of the respondent in month-year t and age squared, whether the respondent has ever married by month-year t, the number of boys alive at month-year t, and the total number of children alive at month-year t.

Table A1: The Itinerary of the Pope's 1991 Visit to Brazil

Speech	Date	Location	State	Venue	Audience	Topics	Number of Words
1	12-Oct-91	Natal	Rio Grande do Norte	Airport	Minister of Foreign Affairs, Cardinals, Bishops and general public	General introduction. Importance that Brazilians follow God, respect human dignity and live in peace. Importance of spreading Catholicism in Brazil.	1245
2	12-Oct-91	Natal	Rio Grande do Norte	Public venue	Cardinals, Bishops and general public	Importance of following God. Strong relationship between the Church and South America.	398
3	**13-Oct-91**	**Natal**	Rio Grande do Norte	**Public venue**	**Cardinals, Bishops and general public**	**Importance of following God. Importance of spreading Catholicism in Brazil. Need to fight new religious groups, drugs, consumerism and anti-natalist campaigns. Need to go back to traditional moral Catholic values. Specifically addresses young Catholics.**	**1679**
4	13-Oct-91	Natal	Rio Grande do Norte	Public venue	Cardinals, Bishops and general public	Importance of spreading Catholicism in Brazil. Praises Holy Mary.	479
5	**13-Oct-91**	**Natal**	Rio Grande do Norte	**Private venue**	**Bishops**	**Importance of spreading Catholicism in Brazil and difficulties associated with it. Problems posed by the upsurge of new religious groups. Talks about the state of the Brazilian economy. Bishops must set the example for the Catholic people.**	**2636**
6	**13-Oct-91**	**Natal**	Rio Grande do Norte	**Cathedral**	**Priests**	**Importance of the role of priests in the Catholic community. Priests must be examples.**	**2210**
7	14-Oct-91	Sào Luis	Maranhao	Public space	General public	Promotes Catholicism. Importance of not focusing on earthly pleasures. Says that the fruits of the earth must be used to enhance the living conditions of everyone in the society. Defends private property but advocates land redistribution.	2127
8	14-Oct-91	Brasilia	Federal District	Prime Minister's palace	Prime minister	Importance of fostering social-economic progress of Brazil. Importance of education. Focus on youth.	910
9	14-Oct-91	Brasilia	Federal District	Private venue	Diplomats	Importance of promoting peace and international cooperation.	1185
10	15-Oct-91	Brasilia	Federal District	Church	General public	Defines what it means to believe in God. Need for Brazil to have faith in God. Holy Mary as a model to follow.	1770
11	15-Oct-91	Goiania	Goias	Public Space	General public	Importance of spreading Catholicism in Brazil. Defines the role of the Church as central in the challenge to spread Catholicism and to bring together Catholic people.	2002
12	15-Oct-91	Brasilia	Federal District	Private venue	Young priests	Importance of following God and of studying hard to get to know him. Need to have solid Christian values and moral. No earthly vices.	2390
13	15-Oct-91	Brasilia	Federal District	Private venue	Jewish community representatives	Need to strengthen relationship between Catholic Church and Jewish Church. Need to respect each other.	591
14	16-Oct-91	Cuiaba	Mato Grosso	Public space	General public	Talks about problems faced by migrants. Tackles environmental problem.	1988
15	16-Oct-91	Cuiaba	Mato Grosso	Public space	Indios communities	God loves everyone. Invites them to follow the examples of missionaries.	1549
16	**16-Oct-91**	**Cuiaba**	Mato Grosso	**Public space**	**Young Brazilians**	**They need to have God as a reference point in their lives. The young generations face the following challenges: egoist sex, alcoholism, drugs, easy money. They have to help their friends in fighting those sins and in embracing God. Importance of working.**	**2164**

…continued on next page

Table A1 Continued: The Itinerary of the Pope's 1991 Visit to Brazil

Speech	Date	Location	State	Venue	Audience	Topics	Number of Words
17	17-Oct-91	Campo Grande	Mato Grosso do Sul	Hospital	Inferms	Prays for the inferms and invites them to have confidence in Christ.	760
18	**17-Oct-91**	**Campo Grande**	Mato Grosso do Sul	**Aeroport**	**General public**	**Importance of marriage. Importance of mutual respect between husband and wife. Importance of family and of creating offspring. "Divorce, contraceptives and abortion are practices that destroy society".**	**2249**
19	**17-Oct-91**	**Campo Grande**	Mato Grosso do Sul	**Church**	**Religious people of no precise denomination**	**Importance of dedicating one's life to family, work and political participation. Importance of marriage. "Contraceptive behaviors are illicit". Abortion is a criminal practice. Importance of caring for the children.**	**2101**
20	18-Oct-91	Florianopolis	Santa Caterina	Church	General public	Importance of helping the poor. Importance of generosity. Need to fight consumerism and hedonism.	1745
21	18-Oct-91	Florianopolis	Santa Caterina	Private venue	Priests	Importance of charitable dialogue and of getting to know God through the study of theology. Need to work hard to spread the word of God.	1225
22	18-Oct-91	Florianopolis	Santa Caterina	Public space	Religious women	Need to practice chastity, poverty and obedience to God. Importance of spreading the word of God especially among the poor, fighting drugs and corruption.	2065
23	19-Oct-91	Vitoria	Espirito Santo	Church	General public	Praises God and Holy Mary.	1666
24	19-Oct-91	Vitoria	Espirito Santo	Church	General public	Praises Holy Mary.	210
25	19-Oct-91	Vitoria	Espirito Santo	Favela	General public	The church is fighting to eradicate poverty. Extreme wealth of the few is unjust, especially if coupled with the extreme poverty of the majority of the people. Need to redistribute wealth but Marxism and Communism must be avoided. Importance of international cooperation.	1817
26	19-Oct-91	Maceio	Alagoas	Public space	General public	Importance of generating offspring and of caring for the family. Importance of working. Difficulties faced by rural workers and urban workers: poverty, safety, drugs.	1832
27	**20-Oct-91**	**Salvador**	**Bahia**	**Public space**	**General public - Children**	**Speaks to children: importance of studying. Need to fight abortion. Need to help young mothers. Importance of education. The state does not have the right to promote abortion and artificial contraceptives.**	**1417**
28	20-Oct-91	Salvador	Bahia	Public space	Representatives of culture	Importance of culture. Invites them to protect the Catholic traits of the Brazilian culture. Importance of education.	2900
29	20-Oct-91	Salvador	Bahia	Church	General public	Praises God and Holy Mary. Invites women to follow God.	473
30	20-Oct-91	Salvador da Baia	Bahia	Public space	General public	Importance of spreading the word of God and of following God.	2216
31	20-Oct-91	Salvador da Baia	Bahia	Public space	General public	Importance of promoting peace.	271
32	21-Oct-91	Salvador	Bahia	Aeroport	Political authorities. General public	He thanks everyone who attended his speeches and who followed his travels on TV or radio. Importance to defend life and family values.	1198

Notes: Information on each of the 32 speeches was found in the Papal Archives of the Vatican. http://w2.vatican.va/content/john-paul-ii/it.html (accessed April 2015). Speeches highlighted in bold are those that mention fertility and family keywords (contraceptives, abortion, sterilization, anti-natalist campaigns, divorce, marriage).

Table A2: The Geographic Coverage of DHS Surveys

Number of observations in the 1986, 1991, 1996 and 2006 DHS surveys, by state and region

Region	State	DHS 1986	DHS 1991	DHS 1996	DHS 2006
North	Acre	709	0	89	2594
	Amazonas		0	370	
	Rondonia		0	165	
	Roraima		0	44	
	Amapa		0	49	
	Para		0	525	
	Tocantins		0	98	
Northeast	Maranhao	1792	579	349	3166
	Piaui		622	206	
	Ceara		870	946	
	Rio Grande do Norte		510	511	
	Paraiba		426	259	
	Pernambuco		1104	924	
	Alagoas		496	210	
	Sergipe		489	153	
	Bahia		1127	1214	
Rio de Janeiro	Rio de Janeiro	749	0	800	3343
Sao Paolo	Sao Paolo	769	0	1355	
Southeast	Minas Gerais	1027	0	1013	
	Espirito Santo		0	355	
Central-West	Mato Grosso		0	420	3162
	Mato Grosso do Sul		0	317	
	Federal District		0	280	
	Goias		0	389	
South	Parana	846	0	569	3310
	Santa Caterina		0	339	
	Rio Grande do Sul		0	663	
Total		5892	6223	12612	15575

Notes: In the 1986 DHS survey it is not possible to separately identify observations in the Central-west region from observations in the Minas Gerais and Espirito Santo States of the Southeast region.

Table A3: Robustness and Placebo Checks on Intended Contraceptive Use

Dependent Variable: =1 if does not use contraceptives and does not plan to use them in the future, 0 otherwise
Marginal probit estimates reported throughout
Standard errors clustered by interview week, apart from Columns 2 and 3 where standard errors are robust

	1991 DHS	Placebo 1986 DHS		Placebo 1996 DHS	
	(1) Quarters	(2) All Regions, Region Dummies	(3) North-East Region	(4) All Regions, Region Dummies	(5) All Regions, State Dummies
Interviewed After Pope's Arrival		.013	.049	-.010	-.002
		(.026)	(.047)	(.022)	(.024)
Before Pope Arrival, Second Half of Interviews	-.023				
	(.022)				
After Pope's Arrival, First Half of Interviews	.120***				
	(.034)				
After Pope's Arrival, Second Half of Interviews	.125**				
	(.058)				
Mean of dependent variable in pre-arrival period	.297	.259	.335	.152	.152
Test of equality of coefficients after Pope's Arrival [p-value]	[.898]				
Individual and household controls	Yes	Yes	Yes	Yes	Yes
Interview controls	Yes	No	No	Yes	Yes
Number of observations	4592	4747	1470	8704	8704

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. The specification in Column 1 uses data from the 1991 DHS survey for Brazil. In Columns 2 and 3 we use data from the 1986 DHS Brazil survey, and in Columns 4 and 5 we use data from the 1996 DHS Brazil surveys. Women sterilized before interview date are excluded from the analysis. The dependent variable is a dummy equal to one if the respondent reports that they do not currently use contraceptives and do not plan to use them in the future, and zero otherwise. Marginal probit estimates are reported throughout. Standard errors are reported in parentheses and are clustered by week of interview in Columns 1, 4 and 5, while they are robust in Columns 2 and 3 (as no information on week of interview is available in the 1986 DHS survey). All observations are weighted using DHS sampling weights. The Pope arrived to Brazil on October 12th 1991 and left on October 21st 1991. Interview dates in the 1991 DHS survey range from September 16th 1991 to February 6th 1992. The individual and household controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), dummy variables for whether married and currently employed, gender of household head, age of respondent, the number of children alive, household size, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and state dummies. The interview controls include the number of days since the first interview was conducted in the DHS 1991 Brazil survey, whether the interview started in the morning, the interview length, a dummy for whether multiple interview visits were required, and the day of the week of the interview. For Columns 2 and 3, interview dates for the 1986 wave range from May to September 1986. No information is available on the day of interview for people interviewed in the 1986 wave, so we are able to control for days since the start of the survey (assuming interviews all happened on the first day of each month), but cannot include any additional interview controls. Also, no information on female headship, race and ownership of refrigerator is available. The "Interviewed After Pope's Arrival" dummy takes value 1 if the person was interviewed in July 1986 or later. The regression in Column 2 controls for a set of region dummies instead of state dummies. The sample for the regression in Column 3 is limited to the Northeast region of Brazil, and does not include state dummies (as these are not available in the 1986 DHS survey). For Columns 4 and 5, interview dates for the 1996 wave range from February 26th 1996 to July 8th 1996. For observations from 1996, the variable "Interviewed After Pope's Arrival" dummy takes value 1 if the woman was interviewed 26 days after the first interview or later. Column 4 controls for region dummies. Column 5 instead controls for state dummies rather than region dummies.

Table A4: Oster [2016] Correction for Impacts of Persuasion on Intended Contraceptive Use

Dependent Variable: =1 if does not use contraceptives and does not plan to use them in the future, 0 otherwise
OLS estimates reported throughout, asymptotic standard errors in parentheses

	(1) Unconditional	(2) Individual and Household Controls	(3) Interview Controls	(4) Limited States	(5) Catholic, Attending Church	(6) Catholic, Not Attending Church
Interviewed After Pope's Arrival	.113***	.079***	.101***	.092**	.103*	.051
	(.029)	(.029)	(.039)	(.041)	(.054)	(.062)
Mean of dependent variable in pre-arrival period	.297	.297	.297	.297	.314	.250
Individual and household controls	No	Yes	Yes	Yes	Yes	Yes
Interview controls	No	No	Yes	Yes	Yes	Yes
R-squared	.007	.214	.227	.231	.214	.279
Identified set for coefficient of interest: Interviewed After Pope's Arrival [Oster 2016 bias correction]		[.061, .079]	[.087, .101]	[.044, .092]	[.103, .109]	[-.064, .051]
Number of observations	4592	4592	4592	3060	2513	1117

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. All specifications use data from the 1991 DHS survey for Brazil. Women sterilized before interview date are excluded from the analysis. The dependent variable is a dummy equal to one if the respondent reports that they do not currently use contraceptives and do not plan to use them in the future, and zero otherwise. OLS regression coefficients are reported throughout. Asymptotic standard errors are reported in parentheses throughout. All observations are weighted using DHS sampling weights. The Pope arrived to Brazil on October 12th 1991 and left on October 21st 1991. Interview dates range from September 16th 1991 to February 6th 1992. The individual and household controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), dummy variables for whether married and currently employed, gender of household head, age of respondent, the number of children alive, household size, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and state dummies. The interview controls include the number of days since the first interview was conducted in the DHS 1991 Brazil survey, whether the interview started in the morning, the interview length, a dummy for whether multiple interview visits were required and the day of the week of the interview. The second to last row reports the bounds on the coefficient on the dummy for being interviewed after the Pope's arrival. These are computed following Oster [2016]. For the computation of the bounds: (i) the coefficient of proportionality between selection on observables and selection on unobservables is assumed to be one; (ii) the maximum R-squared is assumed to be 1.3 times the R-squared from the corresponding regression with the full set of control variables.

Table A5: Alternative Mechanisms

Standard errors clustered by interview week

Dependent Variable:	How Often Attended Religious Services		=1 if agree with statement that condoms reduce the risk of getting HIV		Ideal Number of Children	
Estimation Method:	**Ordered Probit**		**Probit; Marginal effects reported**		**Negative Binomial**	
Sample:	**(1) Catholic**	**(2) Not Catholic**	**(3) Catholic**	**(4) Not Religious**	**(5) Catholic**	**(6) Not Religious**
Interviewed After Pope's Arrival	.101	.091	-.045	-.035	.085	.107*
	(.134)	(.333)	(.048)	(.093)	(.062)	(.062)
Mean of dependent variable in pre-arrival period	-	-	.553	.538	2.16	2.09
Mode of dependent variable in pre-arrival period	Never	Once a week				
Controls	Individual, Household and Interview Controls					
Number of observations	3630	347	3630	614	3567	597

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. All specifications use data from the 1991 DHS survey for Brazil. Women sterilized before interview date are excluded from the analysis. The dependent variable in Columns 1 and 2 is an ordered categorical variable for how often the individual reports attending religious services (1=never attends, 2=less than once a month, 3=once a month, 4=twice a month, 5=once a week). Non-religious individuals are not asked this question. Ordered probit estimates are reported. The dependent variable in Columns 3 and 4 is a dummy equal to one if the respondent agrees with the statement that condoms reduce the risk of getting HIV, and zero otherwise. Marginal probit estimates are reported. The dependent variable in Columns 5 and 6 is the number of children expressed as the ideal family size. Negative binomial regression coefficients are reported. Standard errors allowing for clustering by week of interview in parentheses. All observations are weighted using DHS sampling weights. The pope arrived to Brazil on October 12th 1991 and left on October 21st 1991. Interview dates range from September 16th 1991 to February 6th 1992. The individual and household controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), dummy variables for whether married and currently employed, gender of household head, age of respondent, the number of children alive, household size, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and state dummies. The interview controls include the number of days since the first interview was conducted in the DHS 1991 Brazil survey, whether the interview started in the morning, the interview length, a dummy for whether multiple interview visits were required, and the day of the week of the interview.

Table A6: Robustness Checks on Persuasive Impacts on Fertility Outcomes

Discrete Proportional Hazard Model: Complementary Log-Log regression coefficients
Dependent variable: dummy =1 if woman gave birth at time t in Columns 1 to 4, 7 to 10
Dependent variable: dummy =1 if woman was sterilized at time t in Columns 5 and 6
Standard errors (in parentheses) clustered by individual

	(1) Wide Time Frame	(2) Lower Age at Menarche	(3) Weighting	(4) Recall Error	(5) Sterilized	(6) Sterilized	(7) Placebo 1: 1980 Papal Visit	(8) Placebo 2: 1982 Papal Stopover	(9) Northeast Region, State Dummies	(10) State Dummies
Nine Months After Pope's Visit	.204*	.219*	.262*			-.011	-.066	.077	.405**	.237**
	(.115)	(.119)	(.143)			(.253)	(.124)	(.114)	(.175)	(.120)
Eight Months After Pope's Visit	-.080	-.043	-.091			-.226	-.101	.085	-.080	-.054
	(.128)	(.130)	(.152)			(.281)	(.120)	(.118)	(.202)	(.132)
Ten Months After Pope's Visit	-.040	.051	-.011			-.055	-.006	.063	.076	.055
	(.126)	(.128)	(.156)			(.264)	(.112)	(.118)	(.192)	(.131)
Month of Pope's Visit				.119	.174					
				(.117)	(.251)					
t-test: nine month = eight month [p-value]	[.081]	[.117]	[.073]			[.552]	[.829]	[.962]	[.057]	[.087]
t-test: nine month = ten month [p-value]	[.129]	[.309]	[.174]			[.900]	[.709]	[.925]	[.178]	[.279]
Month and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time since last birth dummies [baseline hazard]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of women	11935	10915	10347	10347	10303	10303	7244	7917	3976	10347
Number of observations [women x time]	1374253	832207	698296	698296	561601	561601	495218	541141	261185	698296

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. All specifications use data from the 1996 DHS survey for Brazil. In Columns 1 to 4, and 7 to 10, the data is reshaped to create a month-year panel of fertility histories for each respondent. Each respondent is included in the sample only for time periods when she is at risk of pregnancy. Hence we exclude eight months preceding each birth, and drop sterilized women from the sample from the month they report becoming sterilized. In Columns 1 to 4, and 7 to 10 the dependent variable is a dummy equal to one if the respondent reports a birth in that month-year, and zero otherwise in all Columns. A complementary log-log hazard model is calculated, where standard errors are clustered by respondent in all Columns. In all specifications a complete series of dummies for month since last birth are included, to flexibly capture the baseline hazard for births of order two and above. Month and year dummies are included in each specification. The additional time invariant controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), a dummy variable for whether currently employed, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and region dummies. The time varying controls are the age of the respondent in month-year t and age squared, whether the respondent has ever married by month-year t, the number of boys alive at month-year t, and the total number of children alive at month-year t. Columns 1 to 3 vary one dimension of the baseline specification. In Column 1 a wider time window is considered, running from December 1974 onwards. In Column 2 the age at menarche is considered to be 12, and so all women respondents are included from that age onwards. In Column 3 observations are weighted by the DHS sample weights multiplied by the fraction of time periods the female is in the sample. In Column 2 onwards, the sample period runs from January 1987 to December 1995, with the exception of Column 7, where it runs from January 1976 to December 1984, and of Column 8, where it runs from January 1978 to December 1986. In Column 7, the variable "Nine months after Pope's visit" is equal to one in April 1981 (following the Pope's visit to Brazil in June-July 1980), and in Column 8 it is equal to one in March 1983 (following the Pope's stopover in June 1982). In Columns 5 and 6 the outcome variable is whether the respondent reports being sterilized in time period t. In Column 9 the sample is restricted to women resident in the Northeast region, and includes state (rather than region) dummies. In Column 10 all respondents are included and the baseline hazard includes state (rather than region) dummies. At the foot of the table we report p-values on the test of equality between the coefficient on those born nine months after the Pope's visit with those born eight months after the visit, and those born ten months after the visit.

Table A7: Regret over Being Sterilized

Dependent Variable : =1 if respondent reports regretting being sterilized
Marginal probit estimates reported throughout
Standard errors clustered by interview week throughout

	(1) After Arrival	(2) Visit Periods	(3) Catholic	(4) Catholic, Attending Church	(5) Catholic, Not Attending Church
Interviewed After Pope's Arrival	.044				
	(.031)				
Interviewed During Pope's Visit		.072**	.114***	.194***	-.047
		(.037)	(.053)	(.056)	(.028)
Interviewed After Pope's Departure		.009	-.013	-.015	-.049
		(.062)	(.066)	(.068)	(.090)
Mean of dependent variable in pre-arrival period	.139	.139	.140	.122	.188
Test of equality of reported coefficients [p-value]		[.203]	[.035]	[.001]	[.784]
Individual and household controls	Yes	Yes	Yes	Yes	Yes
Interview controls	Yes	Yes	Yes	Yes	Yes
Number of observations	1462	1462	1174	839	335

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. Data from the 1991 DHS survey for Brazil in all columns. The dependent variable is a dummy=1 if the woman regrets having been sterilized. Marginal probit estimates are reported throughout. Standard errors are reported in parentheses and are clustered by week of interview throughout. All observations are weighted using DHS sampling weights. The Pope arrived to Brazil on October 12th 1991 and left on October 21st 1991. Interview dates range from September 16th 1991 to February 6th 1992. The individual and household controls include the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), dummy variables for whether married and currently employed, gender of household head, age of respondent, the number of children alive, household size, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, state dummies and time since sterilization (months). The interview controls include the number of days since the first interview was conducted in the DHS 1991 Brazil survey, whether the interview started in the morning, the interview length, a dummy for whether multiple interview visits were required, and the day of the week of the interview.

Table A8: DHS Survey Samples and Other Visits of Pope John Paul II

Country	Dates of Visit	# Speeches	# Places Visited	Date Previous Visit	DHS sample	Male Survey?
Azerbaijan	22-23 May 2002	3	1	-	2006	Yes
Nigeria	21-23 Mar 1998	8	5	1982	2003	Yes
Kenya	18-20 Sep 1995	5	1	1985	1998	Yes
South Africa	16-18 Sep 1995	5	1	-	1998	No
Cameroon	14-16 Sept 1995	4	1	1985	1998	Yes
Philippines	11-16 Jan 1995	14	1	1981	1998	No
Uganda	5-10 Feb 1993	17	5	-	1995	Yes
Benin	3-5 Feb 1993	8	2	1982	1996	Yes
Dominican Republic	9-15 Oct 1992	19	2	1984	1996	Yes
Senegal	19-23 Feb 1992	16	4	-	1997	Yes
Tanzania	1-5 Sep 1990	15	5	-	1996	Yes
Rwanda	7-9 Sep 1990	15	2	-	1992	Yes
Chad	30 Jan - 1 Feb 1990	10	3	-	1996-97	Yes
Burkina Faso	29-30 Jan 1990	8	3	1980	1993	Yes
Mali	28-29 Jan 1990	7	1	-	1995-96	Yes
Indonesia	9-13 Oct 1989	13	6	1970	1991	No
Malawi	4-6 May 1989	10	2	-	1992	Yes
Zambia	2-4 May 1989	11	2	-	1992	No
Madagascar	28 Apr - 1 May 1989	13	3	-	1992	No
Paraguay	16-19 May 1988	14	5	-	1990	No
Peru	14-16 May 1988	13	1	1985	1991-92	No
Bolivia	9-14 May 1988	22	8	-	1989	No
Colombia	1-8 Jul 1986	36	13	-	1990	No
Togo	8-10 Aug 1985	8	4	-	1988	No
Kenya	16-18 Aug 1985	9	1	1980	1989	No
Morocco	19 Aug 1985	2	1	-	1987	No
Trinidad and Tobago	5 Feb 1985	3	2	-	1987	No
Peru	1-5 Feb 1985	15	8	-	1986	No
Ecuador	29 Jan - 1 Feb 1985	16	4	-	1987	No
Thailand	10-11 May 1984	8	3	-	1987	No
Guatemala	6-7 Mar 1984	7	1	-	1987	No
El Salvador	6 Mar 1984	5	1	-	1985	No

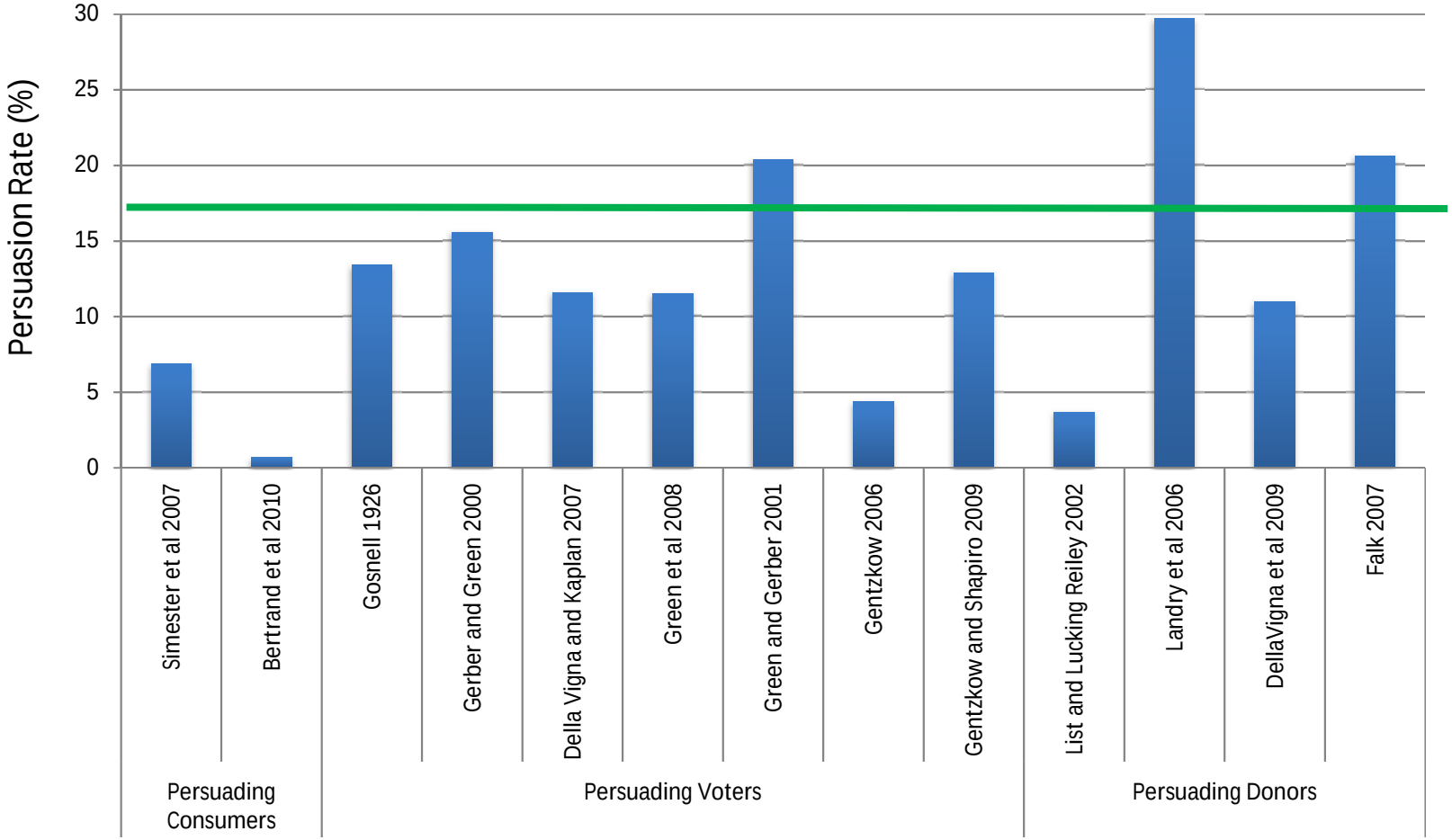
Table A9: Persuasion and Birthweights

Standard errors in parentheses clustered by region-religion

Dependent Variable:	Dummy = 1 if child is alive	Log of the birthweight of child (grams)					Mother's self-reported birthweight of child in categories (1=very small, ..., 5=very large)	
Method:	Probit	OLS					Ordered Probits	
	(1) Alive	(2) Unconditional	(3) Baseline	(4) Lead and Lag	(5) Mothers With Multiple Births	(6) Mother FE	(7) Self-reported Birthweight (Mothers With Multiple Birthweights)	(8) Self-reported Birthweight (Mothers With Multiple Birthweights)
Born Nine Months After Pope's Visit	-.031	-.057	-.071*	-.070*	-.122**	-.042	-.386**	-.391***
	(.037)	(.038)	(.037)	(.037)	(.056)	(.054)	(.150)	(.148)
Born Eight Months After Pope's Visit	-.097***			-.002	.021	-.017	.126	.122
	(.030)			(.034)	(.046)	(.047)	(.203)	(.204)
Born Ten Months After Pope's Visit	.022			.017	.026	-.016	-.425**	-.429**
	(.041)			(.021)	(.041)	(.057)	(.175)	(.186)
Born Eleven Months After Pope's Visit								-.035
								(.253)
Mean of dependent variable	.912	3257			3241		3.18	
t-test: nine month = eight month [p-value]				[.178]	[.082]	[.657]	[.001]	[.001]
t-test: nine month = ten month [p-value]				[.022]	[.028]	[.745]	[.848]	[.848]
Month and year dummies	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	No	Yes	Yes	Yes	Time Varying	Yes	Yes
Number of women	7965	3198	3198	3198	810	810	810	810
Number of observations [mother x child]	24810	4117	4117	4117	1729	1729	1724	1724

Notes: *** denotes significance at 1%, ** at 5%, and * at 10% level. All specifications use data from the 1996 DHS survey for Brazil. The dependent variable in Columns 2-6 is the log of the birth weight of the child (in grams) as reported on the birth card. The dependent variable in Columns 7-8 is the mother's self-reported birth size of the child in five categories: 1=very small, 2=smaller than average, 3=average, 4=larger than average, 5=very large. Anthropometrics at birth are reported only for children born in the five years prior to the 1996 survey, so that the dates of birth for children range from 1991 to 1996. OLS regressions are estimated in Columns 2-6, ordered probits are estimated in Columns 7-8. In Column 5 onwards the sample is limited to those mothers having multiple births (each with birthweight data). Standard errors are clustered by region-religion in all columns. In Column 1 and 2 onwards we control for a complete series of month of birth dummies, and year of birth dummies are included. The following controls are also included in all specifications in Column 1 and from Column 3 onwards: the birth order of the child, the child's gender, the age of the mother at birth and its square, whether the mother was ever married at the time of birth, the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), a dummy variable for whether currently employed, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and region dummies. At the foot of the table we report p-values on the test of equality between the coefficient on those born nine months after the Pope's visit with those born eight months after the visit, and those born ten months after the visit.

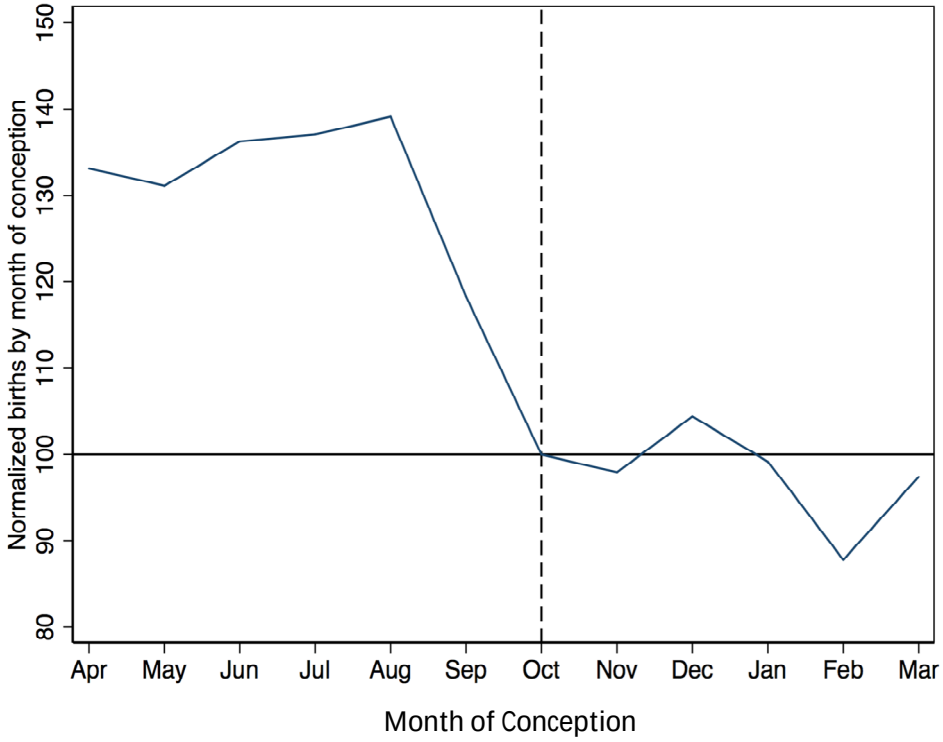
Figure A1: Persuasion Rate Estimates



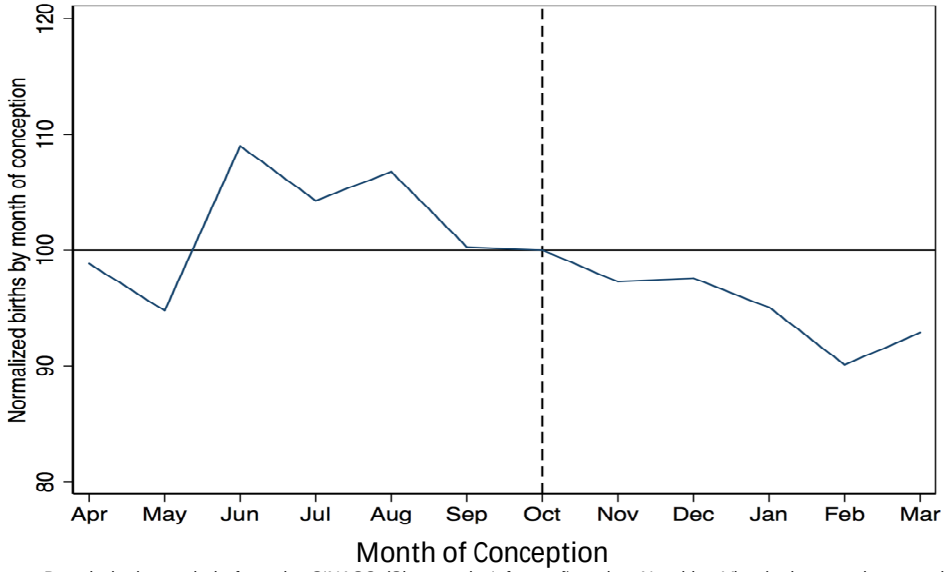
Notes: The Figure shows various estimates of persuasion rates from the literature. The horizontal line shows the persuasion rate from our baseline estimate. Source: DellaVigna and Gentzkow [2010, Annual Reviews].

Figure A2: Normalized Number of Births by Month of Conception in Vital Statistics Data

Panel A: 1994 SINASC

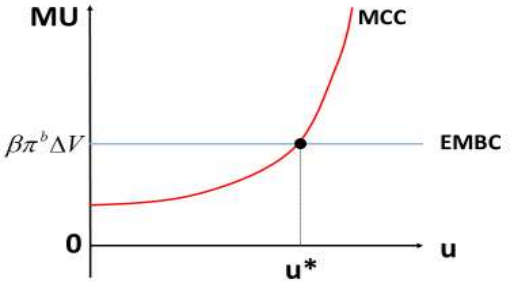


Panel B: 2002-2012 SINASC



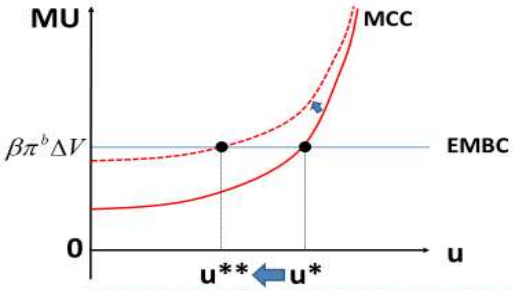
Notes: Data in both panels is from the SINASC (Sistema de Informação sobre Nascidos Vivos), that translates as the Information System on Live Births, established in the early 1990s. This is a national system which automatically sends the data from birth certificates from the municipalities (which are supervised by the state health secretariats) to the states and finally to SINASC at the Federal level. Panel A uses data for birth records for 1994, the first year for which the SINASC data are publicly available. The sample in Panel A includes 2,070,907 individual birth records (the 1994 SINASC data includes information on 2,457,570 birth records, but 386,663 of these are removed as no information on date of birth is available). Panel B presents the statistics reported in Pinedo and Bermudez [2016] - who translate the SINASC name as the NSIBR (National System of Information on Birth Records). These include 32,492,779 birth records for the period 2002-2012 from the SINASC natality files. Births are normalized to 100 in July (and so conceptions are normalized to October) in both panels.

Figure A3A: MCC=EMBC



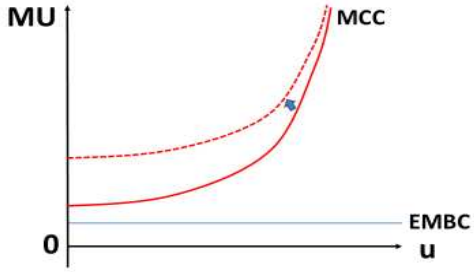
$\pi_t^* = \pi^b(1-u_t^*)$

Figure A3B: MU_U Decreases, ΔV High



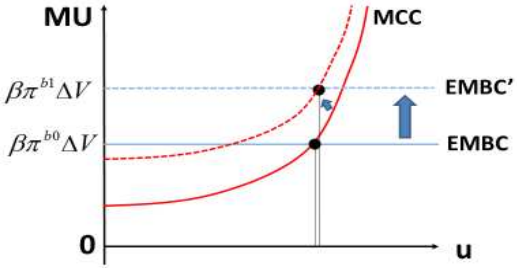
$\Delta\pi^t = -\pi^b\Delta u_t > 0$

Figure A3C: No Impact on ΔV Low



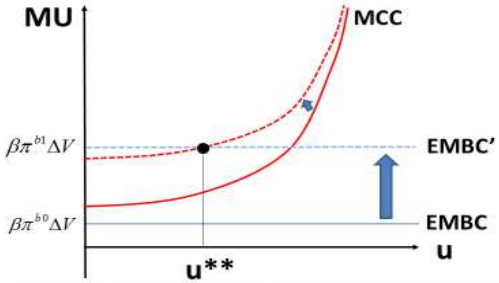
$\Delta\pi^t = -\pi^b\Delta u_t = 0$

Figure A3D: π^b Also Increases, ΔV High



$\Delta\pi^t = \Delta\pi^b(1-u_t) - \pi^b\Delta u_t \approx \Delta\pi^b(1-u_t) > 0$

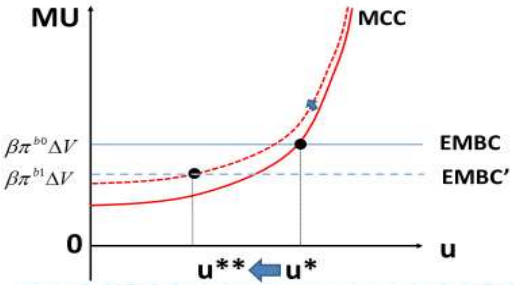
Figure A3E: Impact on ΔV Low



$\Delta\pi^t = \Delta\pi^b(1-u^-) - \pi^b\Delta u_t$

Increase in contraceptive use and ambiguous change in expected no. births

Figure A3F: $\Delta\pi_b<0$, $\Delta u<0$

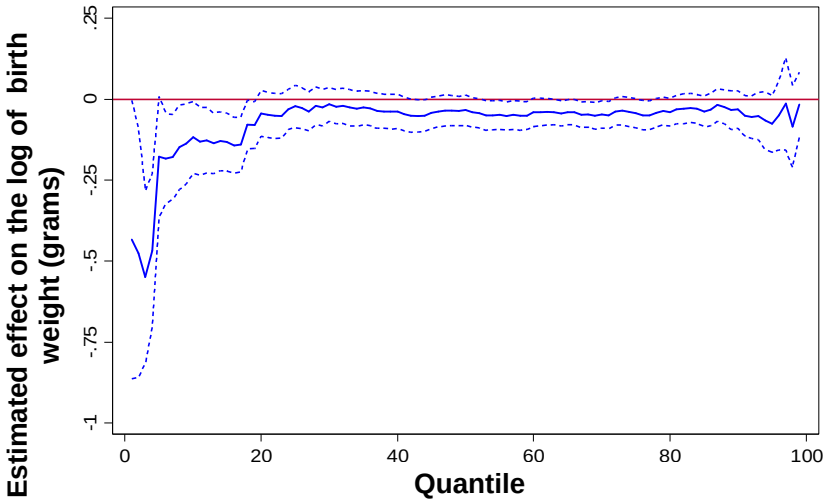


$\Delta\pi^t = \Delta\pi^b(1-u_t) - \pi^b\Delta u_t$

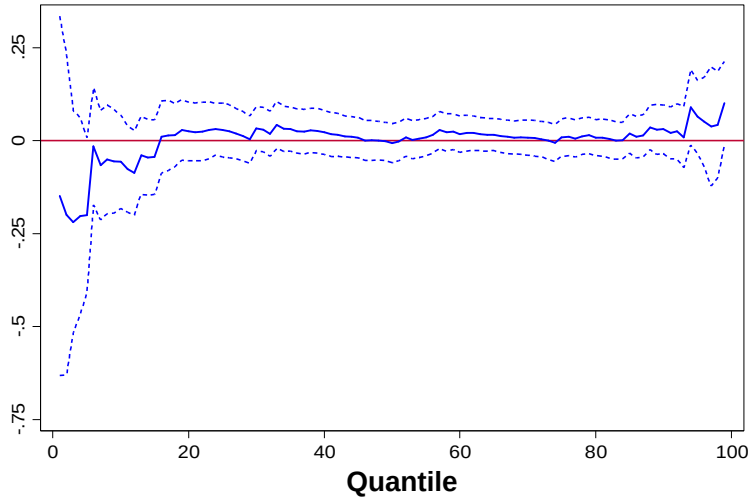
Less sex, less contraceptive use, overall little change in expected no. births

Figure A4: Quantile Regression Estimates of Persuasion on Birth Weights

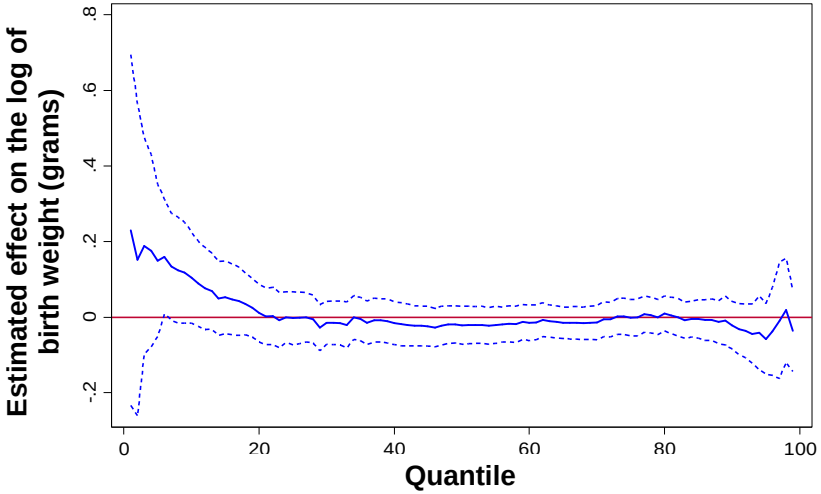
A. Cohort Born Nine Months After Papal Visit



B. Cohort Born Eight Months After Papal Visit



C. Cohort Born Ten Months After Papal Visit



Notes: Each figure graphs the estimated effect of being born nine months after the Pope's October 1991 visit to Brazil, on the log of birth weight (in grams) at each quantile of the conditional distribution of the log of birth weight, and the associated 90% confidence interval, with robust standard errors. We control for a complete series of month of birth dummies, year of birth dummies, the birth order of the child, the child's gender, the age of the mother at birth and its square, whether the mother was ever married at the time of birth, the religion of the respondent (dummies for Catholic, other, with no religion the omitted category), education level of respondent (dummies for primary, secondary, higher education with no education the omitted category), a dummy variable for whether currently employed, race dummies (Parda/Mulata/Morena, Other (Black/Oriental/Indian), with White the omitted category), an indicator for rural location, whether the household owns a refrigerator, whether the household owns a car, and region dummies.