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EVALUATING THE IMPACT OF COMMUNITY-BASED HEALTH INTERVENTIONS: EVIDENCE FROM BRAZIL'S FAMILY HEALTH PROGRAM

ROMERO ROCHA[a] and RODRIGO R. SOARES[b,*]

[a]*World Bank, Brasília, Brazil*
[b]*Pontificial Catholic University of Rio de Janeiro, NBER, and IZA, Brazil*

SUMMARY

This paper analyzes the direct and indirect impacts of Brazil's Family Health Program, using municipality level mortality data from the Brazilian Ministry of Health, and individual level data from the Brazilian household survey. We estimate the effects of the program on mortality and on household behavior related to child labor and schooling, employment of adults, and fertility. We find consistent effects of the program on reductions in mortality throughout the age distribution, but mainly at earlier ages. Municipalities in the poorest regions of the country benefit particularly from the program. For these regions, implementation of the program is also robustly associated with increased labor supply of adults, reduced fertility, and increased school enrollment. Evidence suggests that the Family Health Program is a highly cost-effective tool for improving health in poor areas. Copyright © 2010 John Wiley & Sons, Ltd.

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1. INTRODUCTION

This paper analyzes the direct and indirect impacts of Brazil's Family Health Program. Direct impacts are related to the effects of the program on health outcomes. Indirect impacts refer to the effects of the program, through changes in health, on household behavior related to child labor and schooling, employment of adults, and fertility. The Family Health Program ('Programa Saúde da Família,' from now on PSF) is a project from the Brazilian Ministry of Health. It targets prevention and provision of basic health through the use of professional health-care teams directly intervening at the community level. Each team is responsible for a predetermined number of families, located at a specific geographic area. The teams provide health counseling, prevention, orientation related to recovery, and advice for fighting frequent diseases and for overall health protection in the community. The supply of basic health care at the community level and the assignment of responsibility to the team of health professionals changed the traditional definition and form of health-care provision in Brazil. This change shifted health-care provision from a centralized model structured around public hospitals in main urban areas to a decentralized one, where the first point of contact between population and the public health system

*Correspondence to: Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro Rua Marquês de São Vicente, 225-Gávea, 22451-900 Rio de Janeiro, RJ, Brazil. E-mail: soares@econ.puc-rio.br

is shifted to local communities. This new approach potentially opens space for the inclusion of a large number of poor families, in one way or another, in the public health system.

This type of intervention has the potential of being extremely relevant for poor developing countries. It is relatively cheap and technologically simple, and can be used to extend access to basic health care to a large fraction of the disadvantaged population. At the same time, it lessens the pressure on the more traditional providers of public health (public hospitals, clinics, etc.).

Community- and family-based approaches have been identified in the demographic literature as one of the key factors promoting improvements in health even under very poor economic conditions. Classic examples include the Indian state of Kerala, Jamaica, and Costa Rica, where the use of community-level interventions as instruments to improve health education and to deliver services is believed to have led to major reductions in mortality (Caldwell, 1986; Riley, 2005). Different mechanisms have been suggested as driving forces behind the impact of this type of intervention: instruction of families about the main health risks and other potentially simple changes in health behavior; easy access to primary health care and its role in prevention and early detection of diseases; and engagement of the community in public campaigns related to immunization and fight against endemic conditions (see Caldwell, 1986; Riley, 2005, 2007; Soares, 2007b). Still, despite being widely regarded as a major tool in the fight for improved health, there is little sound econometric evidence on the efficacy of such community-based interventions. There is also no explicit cost–benefit analysis of the viability of implementation of this type of strategy in contexts different from those analyzed in the historical experiences mentioned above.

In particular, the few empirical studies on the Family Health Program stem from the public health literature. Macinko *et al.* (2006) evaluate the impact of the program on infant mortality, using state level data (27 states). Their results show a significant impact on mortality, but the type of data and the econometric techniques used raise concerns in relation to identification. Macinko *et al.* (2007) conducted a survey to assess the effect of the presence of the program on subjective health assessments. They showed that the presence of the program in a municipality is associated with better perceived health on the part of the population. Finally, Aquino *et al.* (2009) analyze the effect of PSF coverage on infant mortality in 771 municipalities from 1996 to 2004, finding a robust association between program coverage and mortality reduction.[1]

In parallel to the demographic and public health literature, a recent line of theoretical and empirical research in economics has suggested that improvements in health conditions may lead to important changes in household behavior (see, for example, Meltzer, 1992; Miguel and Kremer, 2004; Kalemli-Ozcan, 2002, 2006; Soares, 2005; Bobonis *et al.*, 2006; Bleakley and Lange, 2009; Lleras-Muney and Jayachandran, 2009; Lorentzen *et al.*, 2007). As immediate impacts, better health increases physical strength and improves the performance of a series of biological mechanisms, from the fight against infections to the nourishing of fetuses in the womb. In particular, community-based health interventions may give families access to technologies that were previously too expensive or unknown, such as birth control methods or rehydration therapy, directly changing household production technologies. In the long-run, these changes may increase the return to investments in human capital and attachment to the labor market, shifting the quantity–quality trade-off toward fewer and better educated children. From this perspective, improvements in health could also bring together increased schooling and reduced fertility.

The goal of this paper is therefore twofold. First, we use the recent experience of Brazil's Family Health Program to assess the effectiveness of community-based health interventions as instruments for improvements in health conditions in less-developed areas. Second, we evaluate whether health improvements associated with the program also brought about changes in household behavior predicted by economic theory and noticed in other contexts.

[1]Fernández *et al.* (2006) analyze the efficacy of targeting of a health program (PROMIN) focused at improving primary medical attention in Argentina. The program implemented health care centers in poor areas, similar to the Family Health Program.

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As a case study, Brazil's PSF presents a series of advantages, partly derived from the fact that the program was implemented only very recently and was consistently expanded through time: (i) there is reasonably detailed intervention data available at the municipality level almost since initial implementation; (ii) municipality coverage expanded from zero to more than 90% in less than 15 years, as part of an explicit effort from the central government; and (iii) there are comparable data sets available in Brazil, which allow the analysis of different dimensions of potential impacts. For these reasons, we are able to document and analyze the impact of the PSF in a level of detail and with a statistical care that was not possible in the more famous historical experiences of community-based interventions. In principle, the setup and the techniques involved in the program are adaptable to other developing countries. Also, the human and geographic heterogeneity within Brazil allow investigation of how the program performs under different circumstances and against different types of health conditions, and provides a good laboratory for the likely effectiveness of the strategy in other contexts.

Our specific contribution is to use municipality-level data to conduct an extensive analysis of the effects of the PSF on mortality by age group and cause of death, and to evaluate whether presence of the program also induced changes in household behavior, along dimensions of labor supply of adults and children, school attendance, and fertility. We exploit the staggered process of implementation of the program since 1994 and use a difference-in-difference strategy to estimate its effects. Our results show that implementation of the Family Health Program was significantly associated with reductions in mortality. Municipalities 8 years into the program are estimated to experience an additional reduction of 5.4 per 1000 in mortality before age 1, when compared to municipalities not covered by the program. The PSF seems to be most effective in the north and northeast regions of Brazil, and also in municipalities with a lower coverage of public health infrastructure. In the poorest regions of the country, we find that exposure to the program is associated with increased labor supply of adults, increased school enrollment, and reduced fertility.

The remainder of the paper is structured as follows. Section 2 outlines a brief history of the Family Health Program and its organizational structure. Section 3 describes the various data sets used in our statistical analysis. Section 4 discusses our empirical strategy. Section 5 presents the results on the effects of the Family Health Program on mortality. Section 6 presents the results on individual behavior. Finally, section 7 concludes the paper.

2. OVERVIEW AND BRIEF HISTORY OF THE FAMILY HEALTH PROGRAM

The Family Health Program is an ongoing project of the Unified System of Health ('Sistema Único de Saúde'), from the Brazilian Ministry of Health. Since its origins in the mid-1990s, the program has been constantly expanded, with the progressive adhesion of new municipalities. Particularly since the beginning of the 2000s, there has been an expressive growth in the number of municipalities covered.

The PSF targets provision of basic health care through the use of professional teams placed inside the communities. The teams are composed by, at least, one family doctor, one nurse, one assistant nurse, and six health community agents. Some expanded teams also include one dentist, one assistant dentist, and one dental hygiene technician. Each team is responsible for following about 3000–4500 people, or 1000 families of a pre-determined area. The actual work of the teams takes place in the basic health units and in the households. The key characteristics of the program identified by the Brazilian Ministry of Health are: (i) to serve as an entry point into a hierarchical and regional system of health; (ii) to have a definite territory and delimited population of responsibility of a specific health team, establishing liability (co-responsibility) for the health care of a certain population; (iii) to intervene in the key risk factors at the community level; (iv) to perform integral, permanent, and quality assistance; (v) to promote education and health awareness activities; (vi) to promote the organization of the community and to act as a link between different sectors of civil society; and (vii) to use information systems to monitor decisions and health outcomes (Secretaria de Políticas de Saúde – Departamento de Atenção Básica,

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2000; Brazilian Ministry of Health, 2006a). The yearly cost of maintaining a PSF team was estimated, in 2000, to be between R$ 215 000 and R$ 340 000, or between US$ 109 610 and US$ 173 400 (Fundação Getúlio Vargas and EPOS Health Consultants, 2001). Assuming team coverage of roughly 3500 individuals, this would correspond to a yearly cost between US$ 31 and US$ 50 per individual covered.

In reality, the main focuses of the program are on improvement of basic health practices, prevention, early detection, and coordination of large-scale efforts. By following families through time on a recurrent basis, health-care professionals can teach better practices and change habits, leading to better health management at home (through handling and preparation of foods, diet, cleanliness, strategies to deal with simple health conditions, etc.). This strategy should reduce the occurrence of simpler health conditions and improve the management of other types of diseases that may be endemic to certain areas. In addition, by interacting on a systematic basis with the same families, health-care professionals are able to detect early symptoms that may require a more specific type of care. In these cases, families are referred to hospitals or specialists. Finally, the network of PSF professionals, once established in a certain area, can be used to implement any type of health intervention that demands some degree of coordination across large areas or different agents (immunizations, campaigns against endemic conditions, etc.).

In this manner, simpler conditions can be dealt with in the community itself, lessening the pressure on public hospitals, which then would be left to deal with more serious medical conditions. One of the advantages of having such a focused program implemented at the national level is that the various experiences across different teams and areas can quickly lead to improved practices and better health outcomes in other communities, with successful strategies being diffused throughout the entire system.

The PSF is a federal program that is implemented at the municipality level. Implementation therefore requires coordination across different spheres of government. The institutional design of the program is such that, ideally, implementation would involve all three levels of government (municipality, state, and central government), but there are stories of programs implemented without support or interference of the state government. In simple terms, the program is a package designed by the Ministry of Health and implementation requires voluntary adhesion of a municipality administration, preferably with support from the state government (see Brazilian Ministry of Health, 2006a, for a description of the official attributions of the different spheres of government).

The history of growth of the program is portrayed in Figure 1. It was expanded from a minor pilot project covering very few selected areas in 1994 to a nationwide large-scale intervention in 2006 (present in more than 90% of municipalities and estimated to cover more than 85 million people; see Brazilian Ministry of Health, 2006b). The federal budget was concomitantly expanded, from R$ 280 million in 1998 to R$ 2679 million in 2005 (or from US$ 233 million to US$ 1175 million). The accelerated expansion of the PSF starting in 1998 was a result of an explicit effort on the part of the central government, associated with the intensification of federal support and the development of a more standardized 'package.'

The federal nature of the program and the goal of the central government to expand it to virtually the entire country are, from an empirical perspective, convenient features of the Brazilian experience. Almost every municipality was eventually incorporated into the PSF, so adhesion to the program does seem to have an exogenous dimension of variation. Still, as will be clear later on, the timing of adoption did depend on initial socioeconomic conditions, and this constitutes one of the main concerns in our empirical analysis.

3. DATA

Data related to implementation of the program at the municipality level is available from the Brazilian Ministry of Health, through its Basic Attention Department ('Departamento de Atenção Básica'). These data provide the date of implementation in each municipality (starting from 1996). Our treatment

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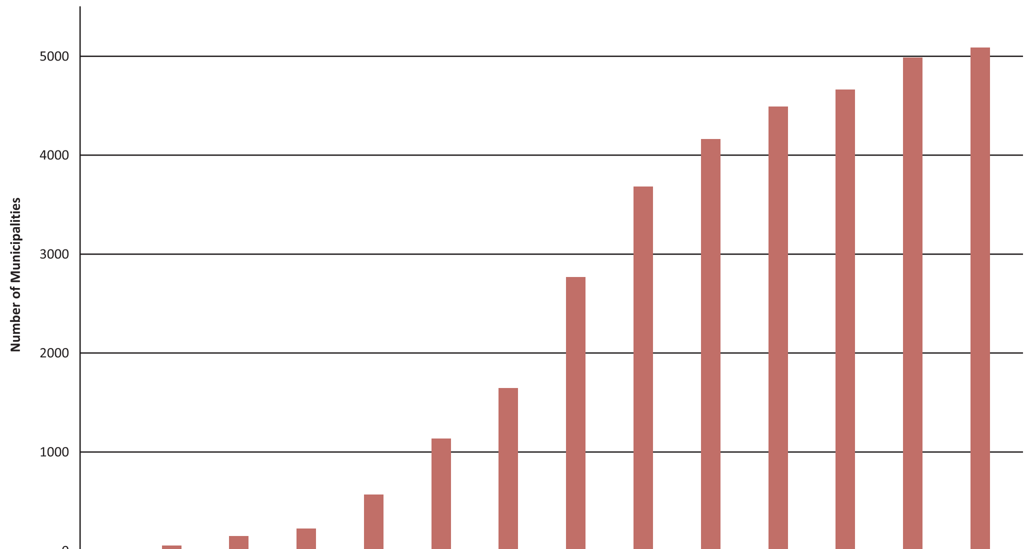

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
N. Munic.	0	55	150	228	567	1134	1647	2766	3684	4161	4488	4664	4986	5087
% Munic.	0	0.0110575	0.0301568	0.0458384	0.1029599	0.2059197	0.2990739	0.5022698	0.6689668	0.7555838	0.8149628	0.8469221	0.9053931	0.9237334

Figure 1. Municipality coverage of the Family Health Program Brazil, 1993–2006

variables are either a dummy indicating whether a municipality is covered by the PSF in a given year, or dummies indicating for how many years a municipality has been covered by the PSF.

Data on various dimensions of mortality at the municipality level are also available from the Brazilian Ministry of Health, through its integrated system of information (DATASUS). These data are used to evaluate the direct impact of the program on health outcomes. Our dependent variables in this analysis are mortality rates per 1000 inhabitants by age group and, in some cases, cause of death. Though mortality records in some of the poorest states can be considered deficient (see Paes and Albuquerque, 1999), our econometric strategy – to be explained later on – controls for any systematic difference in levels of measured mortality across states in a given year, so that this concern should not affect the results.

Other municipality level data required as controls in the statistical analysis – such as public health policies, education infrastructure, and immunization – are obtained from the Ministry of Health, from the Brazilian Census Bureau ('Instituto Brasileiro de Geografia e Estatística'), from the Institute for Applied Economic Research ('Instituto de Pesquisa Econômica Aplicada'), and from the National Institute of Research on Education ('Instituto Nacional de Pesquisa em Educação').

Assessments of the impact of the PSF on household and individual decisions require the use of micro-data from the Brazilian National Household Survey (PNAD). This data set provides information at the household and individual level on a series of demographic and economic characteristics. We use 10 rounds of the PNAD to create two data sets: one focused on adults and another on children. Our dependent variables in this analysis are dummies indicating whether an adult participates in the labor force, whether a woman experienced a birth in the 21 months previous to the interview, whether a child is enrolled in school, and whether a child works.

The period covered in our analysis is constrained by data availability. We do not have information on the very few municipalities covered by the program in 1994 and 1995, so we simply assume that coverage did not start until 1996.[2] When we include our full set of controls, this leaves us with a sample

[2]In these cases, we ignore the small coverage that already existed in 1994 (1.1%) and 1995 (3%). In reality, most of our estimations cover only the period between 1995 and 2003.

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Table I. Descriptive statistics, Brazilian municipalities covered and not covered by the Family Health Program, 1993–2004

		Mort. before 1		Mort. between 1 and 4		Mort. between 15 and 59		Mort. above 59		GDP per capita	
Year	No. municip. covered	Not covered	Covered	Not covered	Covered	Not covered	Covered	Not covered	Covered	Not covered	Covered
1993	0	27.1		1.1		3.4		40.9			
1994	55	26.0		1.1		3.4		40.7			
1995	150	23.8		1.0		3.5		40.6			
1996	228	23.0	27.9	1.0	1.1	3.2	3.9	37.9	41.0		
1997	567	21.3	25.1	0.9	1.0	3.2	3.6	37.6	39.6		
1998	1134	20.2	25.3	0.9	1.1	3.3	3.3	39.0	40.3		
1999	1647	19.1	23.3	0.8	1.0	3.3	3.2	39.6	40.0	6134	5335
2000	2766	18.4	22.3	0.8	0.9	2.9	3.2	34.2	36.6	6127	6546
2001	3684	16.4	19.6	0.8	0.8	2.9	3.2	34.8	37.1	7302	6770
2002	4161	15.1	18.2	0.7	0.8	3.0	3.2	35.9	37.7	8537	7447
2003	4488	15.3	17.4	0.7	0.8	3.0	3.1	36.8	38.5	10 283	8448
2004	4664	14.4	16.0	0.7	0.7	2.9	3.1	38.2	39.3	11 624	9547

Notes: Mortality rates by 1000 population of relevant age group. We do not have information on the specific municipalities covered in 1994 and 1995. Municipality GDP is not available on an annual basis before 1999.

spanning the period between 1995 and 2003. Table AI in the Appendix contains a description of the variables included in our analysis, as well as their sources and availability in terms of years of coverage.

Table I presents descriptive statistics for each year between 1993 and 2004, for both municipalities covered and not covered by the PSF. It becomes clear from the table that the program was first implemented in municipalities that were poorer and had worse health conditions. This is one of the concerns that guide our empirical strategy. It is also clear the declining trend in mortality and increasing income per capita, both in municipalities covered and not covered by the PSF.[3]

4. EMPIRICAL STRATEGY

We take advantage of the staggered process of implementation of the program since 1994 and use a difference-in-difference estimator to allow the effect of the program to be heterogeneous according to time of exposure. For the household data, we concentrate the analysis on the poorest regions of the country, where the health impacts of the PSF turn out to be strongest.

4.1. Health impacts

In the analysis of the health impacts of the program, our unit of observation is a municipality at a point in time. Our main approach is based on the difference-in-difference estimator. An important point is that the effect of the program may vary with time of exposure, both because of logistical considerations in the initial phases of implementation and because some of the health impacts may be felt only after some lag. Therefore, we allow for heterogeneous effects of the PSF according to the number of years a municipality has spent in the program.

In this context, there are two main econometric concerns in the evaluation of public policy interventions. First, adoption of the PSF may depend on a municipality's health conditions or performance and, therefore, be an endogenous variable. The fact that the PSF was consistently

[3]Since municipality GDP is not available before 1999, we do not include this variable in our regressions. The exchange rate R$/US$ varied between 1.84 and 2.72 in the period under analysis, so the GDP per capita numbers shown in the table vary between US$ 2899 and U$ 4274.

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expanded as part of an explicit effort of the central government, until it included almost all municipalities in Brazil, suggests that eventual adoption did not suffer so much from this endogeneity problem. Still, endogeneity may be a serious concern in relation to the specific timing of adoption in a given municipality. As long as adoption is correlated with some pre-existing condition, the municipality fixed-effects present in a difference-in-difference approach take care of the problem. More worrisome are the following possibilities: the timing of adoption is related to some dynamic characteristic of the dependent variable, such as when municipalities subject to particularly negative health shocks are more likely to receive the program; or initial conditions are associated with a specific dynamic evolution of the dependent variable, such as when there is tendency toward convergence, so that initially worse-off municipalities naturally catch up to better-off ones.

Owing to a large number of municipalities (almost 5000 in most specifications), computational limitations and reduced degrees of freedom prevent us from using municipality-specific linear trends. Therefore, our specification includes state-specific time dummies to deal to some degree with this issue.[4] To the extent that differential dynamic behavior in mortality reflects differences across various areas of the country, this will be captured by different state-specific non-linear trends (time dummies). Still, these possibilities constitute our main concern in the empirical analysis, and we develop various procedures to check the robustness of our results to them. As an initial assessment of how serious these problems may be, at the end of this section we follow Galiani *et al.* (2005) and conduct a hazard estimation of the determinants of the probability that a given municipality joins the program.

Our second concern is related to omitted variables. It is possible that good governments make use of the PSF and also implement various other social policies, in which case we may end up attributing to the PSF an effect that indeed comes from other actions taken by local governments. In order to account for this possibility, we try to control for a wide range of municipality variables, encompassing different dimensions of local policy that may be correlated with the implementation of the PSF and may also lead to improvements in health and reductions in mortality. With this goal in mind, our vector of municipality controls includes the following dimensions: immunization coverage (BCG, measles, yellow fever, poliomyelitis and DTP, without the last two and with DT for adults),[5] health infrastructure (number of beds and hospitals per capita), and education infrastructure (number of schools and teachers per capita).

Given the considerations above, our benchmark specification in this case is a difference-in-difference allowing for heterogeneity in the effect of treatment according to time of exposure to the program, and also allowing for state-specific year dummies. The main sources of variation used to identify the effects of the program are: different timing of adoption across municipalities and different time of exposure. So our basic empirical specification is the following:

$$\mathrm{Mort}_{mt} = \alpha^h + \sum_{j=1}^{J} \beta_j^h . PSF_{mt}^j + \gamma^h . X_{mt} + \vartheta_m^h + \mu_{st}^h + \varepsilon_{mt}, \tag{1}$$

where Mort_{mt} denotes some age-specific mortality rate for municipality m in year t, PSF_{mt}^j indicates a dummy variable assuming value 1 if municipality m in year t has been in the program for j years, X_{mt} denotes a set of municipality level controls, ϑ_m^h is a municipality fixed-effect, μ_{st}^h is a state-specific year

[4]Note that this strategy also deals, to a great extent, with the measurement problem alluded to in the previous section. Any systematic variation in mortality recording across states at a point in time, or across time within a state, is controlled for by the state-year dummies. The only remaining potential bias due to measurement is related to a situation where recording is systematically improved by the presence by the PSF. But notice that in this case the bias would be in the direction of finding a positive effect of the program on mortality.

[5]It is possible that the PSF improves the delivery of immunization. Still, since widespread immunization in Brazil predates the PSF, we want to be able to estimate the effect of the program independently from its effects on immunization. Our qualitative results remain very similar when we exclude the immunization variables from the estimation.

dummy (26 non-linear state-specific trends), ε_{mt} is a random error term, and α^h, β_j^h's, and γ^h are parameters.

Finally, in order to account for the fact that the variance of mortality is strongly related to population size, we weight the regressions by municipality population. Also, to account for the possibility of serially correlated and heteroskedastic errors, and to avoid overestimation of the significance of estimated coefficients, we cluster standard errors at the municipality level (as suggested by Bertrand *et al.*, 2004).

4.2. Behavioral impacts

In the analysis of the impacts of the program on individual behavior, our unit of observation is an individual within a municipality at a point in time. We restrict the analysis to regions where the health impacts of the program seem to have been strongest. For obvious reasons, these are also the places where we would hope to find the clearest changes in behavior. In this case, our sample, extracted from the Brazilian National Household Survey, covers 361 municipalities (in the north and northeast regions). Given the reduced number of municipalities, we also allow for municipality-specific linear trends. This has at least one great advantage in relation to the approach suggested for the case of the health impacts of the program: differential trends across municipalities are immediately controlled for, taking care of one of the main concerns in our previous discussion.

Since the outcomes of interest now are represented by dichotomous categorical variables (labor supply, employment, school enrollment, and occurrence of a birth), we estimate probit models (all results are reported as marginal effects calculated at the mean of independent variables). Here again, the main sources of variation used to identify the effects of the program are: different timing of adoption across municipalities and different time of exposure. So our basic specification is the following:

$$P(\text{Behavior}_{imt} = 1) = \Phi\left(\alpha^b + \sum_{j=1}^{J} \beta_j^b \cdot \text{PSF}_{mt}^j + \varphi^b \cdot Z_{imt} + \gamma^b \cdot X_{mt} + \vartheta_m^b + \mu_t^b + \rho_m^b \cdot t\right), \quad (2)$$

where Behavior_{imt} denotes some dichotomous discrete indicator for the behavior of individual i in municipality m and year t, PSF_{mt}^j indicates a dummy variable assuming value 1 if municipality m in year t has been in the program for j years, Z_{imt} represents a set of individual level controls, X_{mt} denotes a set of municipality level controls, ϑ_m^b is a municipality fixed-effect, μ_t^b is a year dummy, t represents a linear time trend, $\Phi(\cdot)$ is the normal distribution function, and α^b, β_j^b's, φ^b, γ^b, and ρ_m^b's are parameters.[6]

This specification greatly reduces concerns related to differential dynamic behavior of the dependent variable across municipalities, as those expressed in the last subsection. Still, there remains the possibility of omitted variables associated with other relevant dimensions of policy. In this respect, we follow the same strategy outlined for the case of the municipality level analysis. We also cluster standard errors at the municipality level, to account for the possibility of correlation of residuals within municipalities (across individuals and time) and to avoid overestimation of the significance of estimated coefficients (as suggested by Bertrand *et al.*, 2004 in an OLS context).

4.3. Determinants of adoption of the Family Health Program

As an initial assessment of the determinants of adoption of the PSF and of how serious the issue of dynamic endogeneity may be, we follow Galiani *et al.* (2005). We conduct a hazard estimation of the

[6]It is known that fixed-effects estimates are not consistent in probit models, and that this may bias estimates of other parameters. But Fernández-Val (2007) has recently shown that, in this setting, estimates of average marginal effects have negligible bias relative to their true values (for a wide variety of distributions of regressors and individual effects). Since we concentrate our discussion on marginal effects, we proceed with the fixed-effects probit estimation and trust on these results.

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probability that a given municipality joins the program. Specifically, our dependent variable is a dummy indicating the presence of the program in a municipality. As soon as municipalities join the program, they leave the sample. So we estimate the effect of municipalities' characteristics on the probability of joining the program. Our main interest is on how this probability is related to fixed municipality characteristics and to changes in endogenous variables or other policy dimensions. Therefore, our hazard estimation evaluates the probability that a municipality joins the PSF as a function of shocks to health variables (changes in mortality in previous years), changes in other dimensions of public policy, a set of political variables indicating the party of the mayor,[7] and a set of socioeconomic variables[8] indicating the initial conditions of the municipality.

Results of this estimation are presented in the Appendix Table AII. The first three columns consider, respectively, the 1st, 2nd, and 3rd lags of mortality before age 1, each at time. The remaining three columns include mortality between ages 1 and 4 and between ages 15 and 59 in the analysis, again considering the 1st, 2nd, and 3rd lags separately.[9]

The results indicate that adoption of the program seems to be correlated with past health shocks, but that the quantitative impacts are extremely small when compared to other variables. The estimated coefficients imply that even substantial mortality shocks lead only to modest increases in the probability of program adoption: a one standard deviation increase in lagged mortality before age 1 increases the probability of program adoption by 3.5 percentage points (results are similar in the case of mortality in different age groups). In contrast, political considerations as well as initial municipality characteristics are quantitatively very important. Municipalities governed by the main left wing parties – Workers Party (PT), Popular Socialist Party (PPS), and Socialist Party (PSB) – and by the Social Democrat Party were more likely to adopt the program in any given year. The estimated coefficients imply that, if the mayor belonged to one of the parties mentioned before, the probability that a municipality would join the program in a given year would be increased by between 20 and 60 percentage points. Political considerations seem to be key in determining program implementation.

Also, several initial characteristics are correlated with early adoption. Overall, municipalities with initially worse-off conditions were more likely to adopt the PSF. In terms of initial variables, higher mortality before age 1, lower number of schools per capita, higher number of members per household, and lower income per capita were historically associated with early entry in the Family Health Program. Doubling household income per capita, for example, is associated with a 22 percentage point reduction in the probability that a municipality joins the program in a given year.[10]

In any case, adoption of the program is not greatly affected by shocks to health. So the dynamic issue of decision of adoption being driven by changes in dependent variables (health outcomes) does not seem to be serious enough to impair the use of the empirical strategy outlined above. In addition, the fact that program implementation is greatly affected by political considerations seems to guarantee some degree of exogeneity.

[7]During almost the entire period covered by the sample, the Social Democratic Party holds the Brazilian presidential office. Therefore, we do not include dummies indicating whether the mayor belongs to the party of the president, and choose to control only for the identity of the party.

[8]The initial conditions include initial values of: health variables (mortality before 1, between 1 and 4, between 15 and 59, and above 60), public policy variables (hospitals, hospital beds, schools, and teachers), average schooling, average age of the head of the household, average number of members in a household, percentage of households in vulnerable socioeconomic conditions (four or more members per working member and head of the household with less than 4 years of schooling), average household income per capita (ln), and unemployment rate.

[9]We do not include mortality above age 59 in this analysis because, as will be seen later on, it is not significantly affected by the program. In addition, the cross-municipality variance in old age mortality is relatively small when compared to its mean.

[10]An interesting aspect suggested by the table is that there seems to be some substitutability across different policy alternatives: municipalities more likely to adopt the PSF are those that have not increased the number of hospitals or the number of schools in recent years.

5. IMPACT ON MORTALITY

5.1. Main results

Table II presents some preliminary results from a simpler specification, where we still do not allow for heterogeneity in response according to time of exposure to the program. The table presents results from three regressions for each of the four different age groups – before age 1, from age 1 to 4, from age 15 to 59, and above age 59. In the first regression, the treatment is defined as a municipality being covered by the program, while in the second and third regressions, treatment is defined, respectively, as a municipality having been covered for at least one or two years (first and second lags of program implementation). The results show that program implementation takes some time to manifest itself on mortality and, in addition, its impact seems to change considerably through time. This evidence justifies the use of our benchmark specification, where we allow for heterogeneity according to time of exposure.

Table II presents the results from our baseline specification. The four columns display the estimated coefficients of the effects of the PSF on mortality for the four different age groups. The table suggests a strong negative correlation between program exposure and mortality for all age groups below 59, and some mild negative correlation for the age group above 59. Quantitative impacts are particularly strong for mortality before age 1, but in relative terms the impacts are also substantial for other age groups. For example, the estimated coefficients imply that municipalities that have been in the program for three years reduce infant mortality by 1.8 per 1000 more than otherwise identical municipalities not in the program. Taking the 1993 average infant mortality for Brazil (27 per 1000), this corresponds to a 6.7% reduction in the mortality rate. For a municipality 8 years into the program, there is a reduction of 5.4 per 1000, corresponding to 20% of the 1993 average.

For mortality rate between ages 1 and 4, the coefficients correspond to reductions of 6.4% (0.07 in absolute terms) for municipalities 3 years into the program, and 24% (0.26 in absolute terms) for municipalities 8 years into the program. Analogous numbers for mortality between ages 15 and 59 are 3.2% (0.11 in absolute terms) for 3 years into the program and 11.2% (0.38 in absolute terms) for 8 years into the program.

The effect of the PSF on mortality above age 59 is much less robust in terms of significance and less important in terms of magnitude. The impacts implied by the point estimates are quite small as compared to the average mortality observed in the age group. So municipalities 3 years into the program are estimated to experience additional reductions in mortality of 0.56 per 1000. Taking the 1993 mortality rate as a reference point, this represents a reduction of only 1.4% in mortality. The analogous number for 8 years into the program is 1.21 per 1000, corresponding to only 2.9% of the 1993 national average.

The time span covered by our sample allows us to look only at municipalities that have been in the program for 8 years or less. Within this time frame, mortality reductions seem to generally increase with each additional year of program exposure. So, for mortality before age 1, there is an average reduction in mortality of 0.69 per additional year in the PSF, while the analogous number for mortality between ages 1 and 4 and 15 and 59 is roughly 0.035.[11]

5.2. Heterogeneity in response

In order to better understand how the Family Health Program actually worked, its strengths and weaknesses, we explore some dimensions of potential heterogeneity in response. Heterogeneity in

[11]This result is not due to municipality heterogeneity correlated with time of exposure to the program. In the Appendix Table A.III, we interact the treatment dummies of *Program Year 3*, *Program Year 4*, and *Program Year 5* with dummies indicating 'early movers' (municipalities that joined the PSF during the first 3 years). The results remain unchanged, and the interactions of treatment dummies with 'early movers' are not statistically significant. So the larger effect for municipalities that have been in the program for a long time is not related to some unobserved characteristic of these 'early movers.'

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Table II. Mortality regressions by (a) age group and (b) age group and sex, Brazilian municipalities, 1993–2004

	Mortality rate <1			Mortality rate between 1 and 4			Mortality rate between 15 and 59			Mortality rate >59		
(a)[a]												
PSF	−0.1115			−0.0164			−0.0256			0.0364		
	(0.2691)			(0.0132)			(0.0165)			(0.1704)		
PSF_{t-1}		−0.5908**			−0.0284**			−0.0483***			−0.2967**	
		(0.2752)			(0.0134)			(0.0143)			(0.1437)	
PSF_{t-2}			−1.3149***			−0.0434**			−0.0462***			−0.4306***
			(0.3909)			(0.0178)			(0.0172)			(0.1560)
Municipality f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-specific year f.e.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N Obs	38 762	38 762	38 762	38 769	38 769	38 769	38 769	38 769	38 769	38 769	38 769	38 769
R^2	0.62	0.62	0.62	0.36	0.36	0.36	0.81	0.81	0.81	0.75	0.75	0.75

(b)[b]	Dependent variable: mortality by age group			
	Before 1	*Between 1 and 4*	*Between 15 and 59*	*Above 59*
(b)				
Program year 1	−0.5690**	−0.0322**	−0.0397**	−0.0713
	(0.2701)	(0.0156)	(0.0165)	(0.1832)
Program year 2	−0.7614**	−0.0494***	−0.0790***	−0.2396
	(0.3386)	(0.0172)	(0.0200)	(0.2234)
Program year 3	−1.8144***	−0.0707***	−0.1142***	−0.5590**
	(0.4706)	(0.0231)	(0.0252)	(0.2544)
Program year 4	−2.6899***	−0.1159***	−0.1595***	−0.8310**
	(0.6706)	(0.0279)	(0.0323)	(0.3802)
Program year 5	−3.6592***	−0.1626***	−0.1989***	−0.9035**
	(0.8202)	(0.0373)	(0.0407)	(0.3917)
Program year 6	−4.5655***	−0.2158***	−0.2642***	−1.0685**
	(1.1021)	(0.0432)	(0.0470)	(0.4926)
Program year 7	−4.0427***	−0.2160***	−0.2882***	−1.2634**
	(1.2616)	(0.0515)	(0.0631)	(0.5871)
Program year 8	−5.4048***	−0.2560***	−0.3834***	−1.2114*
	(1.5642)	(0.0562)	(0.0702)	(0.7170)
Municipality f.e.	Yes	Yes	Yes	Yes
State-specific year f.e.	Yes	Yes	Yes	Yes
No. Obs	46 771	46 778	46 778	46 778
R^2	0.61	0.34	0.81	0.75

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%.

[a]Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. Dependent variable: Mortality rate per 1000 in age group. Independent variables: dummies indicating if the municipality is in the program simultaneously, in t-1, and in t-2, municipality fixed-effects and state-specific non-linear trends. All regressions also included as additional controls (not shown in the table): health infrastructure (hospital beds and hospitals per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP, without the last two and with DT for adults), and public education infrastructure (number of schools and teachers – primary and secondary – per capita).

[b]Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. Dependent variable: Mortality rate per 1000 in age group and sex. Independent variables: dummies indicating number of years into the program, municipality fixed-effects and state-specific non-linear trends. All regressions also included as additional controls (not shown in the table): health infrastructure (hospital beds and hospitals per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP, without the last two and with DT for adults), and public education infrastructure (number of schools and teachers – primary and secondary – per capita).

response may be related to, among other things, initial conditions, geographic characteristics, or specific causes of death. In this subsection, we explore the differential impact of the program along some of these dimensions.

5.2.1. Regions. Table III presents results from regressions identical to those from Table II, but ran separately for each of the five geographic regions of Brazil: south, southeast, center-west, northeast, and north. The results reveal a clear pattern: the two poorest regions, which are also those with lower provision of several public goods – the north and the northeast – are by far the ones enjoying the greatest benefits from the program.[12] In the north, a municipality 8 years into the program is estimated to experience a reduction of 15.0 per 1000 in infant mortality rate, while the analogous reduction for the Northeast is 13.8 per 1000. The impact of the program for these two regions appears as significant and large in magnitude for all age groups analyzed, including mortality above 59.

In other regions, there is some evidence on the significant impacts of the PSF on mortality between 1 and 4 and 15 and 59 in the southeast, between 15 and 59 and above 59 in the center-west, and between 1 and 4 in the south, but results are never as robust as for the north and northeast.

The regional heterogeneity in response to the program is also consistent with results (not shown here) indicating that municipalities with lower levels of urbanization, less access to treated water, and less coverage from the public sewerage system benefited particularly from program implementation (see the working paper version of this paper – Rocha and Soares, 2009 – for these results). Overall, municipalities with initially worse socioeconomic conditions seem to have been the greatest beneficiaries of the PSF.

5.2.2. Cause of death. In order to shed further light on the driving forces behind the impacts of the Family Health Program, Table IV decompose the effect of the PSF on mortality by cause of death. Each table presents the same specification from Table II for a particular age group, for mortality decomposed by the main causes of death within that age group. The causes of death considered for each age group are enumerated in the table itself (see Appendix Table AIV for a detailed description of the specific causes of death included in each group).[13]

For mortality before 1, Table IV shows significant impacts of the program mainly on perinatal period conditions, infectious diseases, endocrine diseases, and respiratory diseases. Most of these estimated effects are in line with what should be expected from the type of intervention implied by the program. The estimated effect on ill-defined conditions during the first years of implementation, which may seem strange at first sight, is probably due to the fact that presence of the PSF is associated with a reduction in the number of deaths without proper diagnosis (reduction in the measurement error in cause of death).[14] Quantitatively, the largest impacts of the program on this age group are associated with mortality due to perinatal period conditions, infectious diseases, and respiratory diseases. These three causes of death include, for example, problems associated with complications during pregnancy, diarrhea and other intestinal diseases, influenza, asthma, and bronchitis. These are precisely conditions against which the kind of support and information provided by the presence of the Family Health

[12]For example, in the beginning of the period under analysis (1993), income per capita was R$2810 in the northeast and R$4630 in the north, against a national average for Brazil of R$6280 (values in R$ of 2000, from www.ipeadata.gov.br).

[13]We also experimented with morbidity data based on hospital admissions by place of residence, but found no significant impact of the program on any age group or disease. It is not clear whether this is due to reporting error in the data, or to the fact that the PSF may facilitate hospital access for certain fractions of the population. Given that most of health problems do not culminate in death, one should expect the impact of the Family Health Program on general health to be stronger than the impact on mortality estimated here.

[14]Notice that this interpretation is consistent with the fact that the effect on ill-defined conditions is reduced in magnitude and ceases to be significant after year 6. Also, this interpretation means that a fraction of the deaths that before were registered as due to ill-defined conditions are now properly classified into some other cause of death. This would imply an artificial increase in the number of deaths attributable to the causes, which in turn would tend to minimize the estimated impact of the program on these other causes of death. So, if anything, our estimates on other causes of death are likely to be slightly biased toward zero.

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Table III. Mortality effect of PSF by age group and geographic region, Brazilian municipalities, 1995–2003

	Mortality before 1					Mortality between 1 and 4				
	North	Northeast	Southeast	South	Center-West	North	Northeast	Southeast	South	Center-West
Program year 1	0.6614	−2.0970***	0.1669	0.4802	−0.0461	−0.0010	−0.0567*	−0.0218	−0.0280	0.0128
	(0.8555)	(0.6069)	(0.3159)	(0.4210)	(0.5543)	(0.0618)	(0.0328)	(0.0179)	(0.0368)	(0.0645)
Program year 2	0.3423	−3.0674***	0.5253	0.7267	−1.1315	0.0636	−0.1225***	−0.0155	−0.0668*	0.0606
	(1.0352)	(0.8445)	(0.3205)	(0.5386)	(1.1217)	(0.0764)	(0.0370)	(0.0211)	(0.0387)	(0.0847)
Program year 3	−2.7711**	−5.1062***	0.1644	0.4099	−1.9049	−0.1151	−0.1620***	−0.0190	−0.0590	0.0341
	(1.3771)	(1.1782)	(0.4619)	(0.5876)	(1.7159)	(0.0971)	(0.0496)	(0.0288)	(0.0405)	(0.1207)
Program year 4	−5.3465***	−7.1291***	0.2656	0.2739	−1.8297	−0.2012*	−0.2484***	−0.0534*	−0.0175	−0.0044
	(1.7341)	(1.8925)	(0.5897)	(0.7630)	(2.3510)	(0.1123)	(0.0727)	(0.0280)	(0.0504)	(0.1418)
Program year 5	−8.7942***	−8.3549***	−0.0207	−0.1699	−4.8848	−0.4263***	−0.3378***	−0.0307	−0.0802	−0.0341
	(2.6323)	(2.3365)	(0.7784)	(0.7137)	(3.2330)	(0.1591)	(0.0970)	(0.0370)	(0.0500)	(0.1920)
Program year 6	−12.6763***	−10.9172***	0.0482	−0.2554	−5.7943*	−0.6450***	−0.4393***	−0.0641*	−0.0947	−0.1750
	(3.7045)	(3.1196)	(0.9172)	(0.8955)	(3.1028)	(0.1811)	(0.1048)	(0.0387)	(0.0627)	(0.2244)
Program year 7	−12.7825**	−10.9113***	0.5394	−0.3188	−10.2979**	−0.2939	−0.4862***	−0.0331	−0.1026	−0.2881
	(5.4328)	(3.7662)	(1.1476)	(1.1068)	(4.2799)	(0.2903)	(0.1334)	(0.0527)	(0.0733)	(0.2820)
Program year 8	−14.9974***	−13.8228***	−0.7853	0.7429		−0.3850	−0.5465***	−0.0720	−0.2562**	
	(4.9848)	(4.5430)	(1.3497)	(1.6491)		(0.4827)	(0.1333)	(0.0737)	(0.1219)	
No. Obs	3436	14 021	12 272	9439	3756	3436	14 021	12 279	9439	3756
R^2	0.71	0.63	0.61	0.45	0.49	0.41	0.40	0.27	0.20	0.32

	Mortality between 15 and 59					Mortality above 59				
	North	Northeast	Southeast	South	Center-West	North	Northeast	Southeast	South	Center-West
Program year 1	0.0601	−0.0911**	−0.0138	0.0209	0.0287	1.2565*	−0.5510	0.0991	0.2266	−0.3658
	(0.0615)	(0.0386)	(0.0306)	(0.0290)	(0.0615)	(0.6695)	(0.4133)	(0.2096)	(0.3004)	(0.7128)
Program year 2	−0.0528	−0.1557***	−0.0434	0.0157	0.0026	−0.2253	−1.2913***	0.1821	0.4922	−0.7290
	(0.0937)	(0.0452)	(0.0265)	(0.0307)	(0.0785)	(0.8936)	(0.4653)	(0.2729)	(0.3469)	(0.8341)
Program year 3	−0.1464	−0.1866***	−0.0843**	0.0210	−0.1846*	−1.5530	−1.6477***	0.0646	0.6008	−2.3149
	(0.1155)	(0.0599)	(0.0343)	(0.0355)	(0.1009)	(1.1085)	(0.5563)	(0.2618)	(0.3802)	(1.4058)
Program year 4	−0.3032**	−0.2920***	−0.0854**	−0.0152	−0.2421	−2.4192**	−2.9310***	0.2569	0.9042**	−3.5137***
	(0.1328)	(0.0944)	(0.0390)	(0.0473)	(0.1616)	(1.1451)	(0.9767)	(0.2866)	(0.4317)	(1.2847)
Program year 5	−0.4467***	−0.3385***	−0.0947*	0.0086	−0.3748*	−4.3822***	−3.1603***	0.4530	0.3205	−3.6781**
	(0.1588)	(0.1088)	(0.0565)	(0.0571)	(0.2132)	(1.3944)	(1.0131)	(0.3642)	(0.5019)	(1.5535)
Program year 6	−0.6123***	−0.4003***	−0.1453**	−0.0206	−0.5198**	−4.7981**	−3.2521**	0.5509	0.6669	−6.7375***
	(0.1738)	(0.1445)	(0.0662)	(0.0645)	(0.2102)	(1.9348)	(1.3140)	(0.4109)	(0.7781)	(1.7915)
Program year 7	−0.9682***	−0.5037***	−0.0577	0.0816	−0.6049**	−4.8187	−4.5100***	1.2906*	0.4730	−4.7583*
	(0.3246)	(0.1784)	(0.0822)	(0.0630)	(0.2720)	(3.9731)	(1.6616)	(0.6685)	(0.9301)	(2.5538)
Program year 8	−0.9655***	−0.5898***	−0.1188	−0.0188		−5.3666	−4.9774***	1.2654	0.8350	
	(0.3114)	(0.2044)	(0.0925)	(0.0786)		(4.1192)	(1.9199)	(0.9774)	(1.0922)	
No. Obs	3436	14 021	12 279	9439	3756	3436	14 021	12 279	9439	3756
R^2	0.75	0.77	0.80	0.61	0.52	0.79	0.71	0.67	0.50	0.64

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. Dependent variable: Mortality rate per 1000 in age group. Independent variables: dummies indicating number of years into the program, municipality fixed-effects and state-specific non-linear trends. All regressions also included as additional controls (not shown in the table): health infrastructure (hospital beds and hospitals per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP, without the last two and with DT for adults), and public education infrastructure (number of schools and teachers – primary and secondary – per capita).

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Table IV. Mortality effect of PSF by age group and cause of death, Brazilian municipalities (a) 1995–2003 and (b) 1993–2004

	Mortality before age 1							
	Perinatal period	Infectious	External causes	Endocrine	Respiratory	Congenital anomalies	Nervous system and senses organs	Ill-defined
(a)[a]								
Program year 1	0.0879	−0.0784	0.0033	−0.0292	−0.0448	0.0280	−0.0267*	−0.1661*
	(0.1590)	(0.0589)	(0.0190)	(0.0224)	(0.0479)	(0.0502)	(0.0152)	(0.1002)
Program year 2	0.1859	−0.1752***	−0.0123	−0.0292	−0.0470	0.0098	−0.0058	−0.3006***
	(0.1868)	(0.0638)	(0.0210)	(0.0275)	(0.0512)	(0.0581)	(0.0186)	(0.1006)
Program year 3	−0.2225	−0.3464***	−0.0071	−0.0607*	−0.2050***	−0.0629	−0.0050	−0.5357***
	(0.2520)	(0.0917)	(0.0265)	(0.0333)	(0.0628)	(0.0727)	(0.0202)	(0.1526)
Program year 4	−0.6870*	−0.4511***	0.0156	−0.1216***	−0.2601***	−0.1625*	−0.0152	−0.5055***
	(0.3818)	(0.1222)	(0.0331)	(0.0371)	(0.0841)	(0.0838)	(0.0259)	(0.1798)
Program year 5	−1.2964***	−0.4589***	−0.0021	−0.1159**	−0.4238***	−0.1580*	−0.0074	−0.5556**
	(0.4909)	(0.1556)	(0.0398)	(0.0468)	(0.1139)	(0.0899)	(0.0293)	(0.2428)
Program year 6	−1.8221***	−0.6734***	−0.0127	−0.1757***	−0.5320***	−0.1934*	−0.0539*	−0.5871*
	(0.6603)	(0.2000)	(0.0412)	(0.0536)	(0.1522)	(0.1066)	(0.0324)	(0.3285)
Program year 7	−1.9880**	−0.5590**	−0.0053	−0.1853***	−0.4504**	−0.3309**	−0.0573	0.0467
	(0.8464)	(0.2762)	(0.0571)	(0.0718)	(0.1777)	(0.1578)	(0.0406)	(0.4937)
Program year 8	−3.3990***	−0.9300***	−0.0160	−0.3091***	−0.7318***	−0.2039	−0.0674	0.5490
	(1.2161)	(0.3370)	(0.0650)	(0.0960)	(0.1996)	(0.1889)	(0.0545)	(0.7473)
No. Obs	42 924	42 924	42 924	42 924	42 924	42 924	42 924	42 924
R^2	0.58	0.46	0.25	0.28	0.36	0.37	0.18	0.61

	Mortality between ages 1 and 4							
	Neoplasms	Infectious	External causes	Endocrine	Respiratory	Congenital anomalies	Nervous system and senses organs	Ill-defined
Program year 1	−0.0022	0.0001	−0.0088	−0.0021	−0.0178***	−0.0012	0.0004	0.0035
	(0.0030)	(0.0063)	(0.0059)	(0.0031)	(0.0064)	(0.0032)	(0.0032)	(0.0069)
Program year 2	0.0021	−0.0089	−0.0067	−0.0055	−0.0165**	−0.0024	0.0029	−0.0082
	(0.0035)	(0.0062)	(0.0065)	(0.0036)	(0.0068)	(0.0040)	(0.0034)	(0.0077)
Program year 3	0.0005	−0.0213***	−0.0059	−0.0048	−0.0146*	−0.0014	0.0017	−0.0132
	(0.0036)	(0.0076)	(0.0075)	(0.0043)	(0.0087)	(0.0046)	(0.0043)	(0.0104)
Program year 4	−0.0001	−0.0282***	−0.0212**	−0.0088*	−0.0215*	−0.0047	−0.0003	−0.0203*
	(0.0040)	(0.0088)	(0.0088)	(0.0048)	(0.0113)	(0.0053)	(0.0045)	(0.0123)
Program year 5	−0.0029	−0.0455***	−0.0253**	−0.0094	−0.0295**	−0.0032	−0.0080	−0.0242
	(0.0050)	(0.0113)	(0.0103)	(0.0058)	(0.0142)	(0.0056)	(0.0053)	(0.0161)
Program year 6	0.0009	−0.0402***	−0.0375***	−0.0201***	−0.0391**	−0.0111*	−0.0033	−0.0419**
	(0.0055)	(0.0126)	(0.0116)	(0.0067)	(0.0160)	(0.0063)	(0.0061)	(0.0198)
Program year 7	−0.0055	−0.0505***	−0.0304**	−0.0235***	−0.0550***	−0.0083	−0.0124*	−0.0168
	(0.0069)	(0.0161)	(0.0140)	(0.0080)	(0.0186)	(0.0082)	(0.0070)	(0.0256)
Program year 8	−0.0016	−0.0692***	−0.0396**	−0.0219**	−0.0684***	−0.0117	−0.0143*	−0.0126
	(0.0076)	(0.0188)	(0.0170)	(0.0094)	(0.0225)	(0.0103)	(0.0087)	(0.0312)
No. Obs	48 636	48 636	48 636	48 636	48 636	48 636	48 636	48 636
R^2	0.13	0.21	0.18	0.19	0.21	0.15	0.15	0.37

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Table IV. *Continued*

	Mortality between ages 15 and 59						
	Neoplasms	External causes	Endocrine	Respiratory	Circulatory	Digestive	Ill-defined
(b)[b]							
Program year 1	0.0042	−0.0007	−0.0124***	−0.0001	−0.0140***	0.0006	−0.0015
	(0.0031)	(0.0075)	(0.0037)	(0.0028)	(0.0047)	(0.0028)	(0.0056)
Program year 2	0.0029	−0.0088	−0.0161***	−0.0051*	−0.0156***	−0.0038	−0.0095
	(0.0038)	(0.0102)	(0.0045)	(0.0027)	(0.0057)	(0.0031)	(0.0074)
Program year 3	0.0078*	−0.0241**	−0.0224***	−0.0070**	−0.0216***	−0.0058	−0.0175**
	(0.0045)	(0.0120)	(0.0059)	(0.0033)	(0.0066)	(0.0036)	(0.0086)
Program year 4	0.0075	−0.0383***	−0.0276***	−0.0093**	−0.0200**	−0.0082*	−0.0316***
	(0.0054)	(0.0149)	(0.0072)	(0.0040)	(0.0085)	(0.0043)	(0.0111)
Program year 5	0.0073	−0.0474**	−0.0352***	−0.0089*	−0.0196*	−0.0092*	−0.0314**
	(0.0065)	(0.0210)	(0.0089)	(0.0051)	(0.0100)	(0.0056)	(0.0145)
Program year 6	0.0048	−0.0637**	−0.0437***	−0.0139**	−0.0275**	−0.0111*	−0.0413**
	(0.0081)	(0.0271)	(0.0103)	(0.0066)	(0.0132)	(0.0064)	(0.0207)
Program year 7	0.0216*	−0.0669**	−0.0511***	−0.0137*	−0.0196	−0.0237**	−0.0493**
	(0.0122)	(0.0335)	(0.0128)	(0.0077)	(0.0203)	(0.0093)	(0.0244)
Program year 8	0.0049	−0.1129***	−0.0492***	−0.0312***	−0.0059	−0.0254**	−0.0311
	(0.0141)	(0.0402)	(0.0135)	(0.0100)	(0.0233)	(0.0121)	(0.0311)
No. Obs	42 931	42 931	42 931	42 931	42 931	42 931	42 931
R^2	0.67	0.77	0.58	0.54	0.70	0.48	0.68

	Mortality above age 59					
	Neoplasms	External causes	Endocrine	Respiratory	Circulatory	Ill-defined
Program year 1	−0.0013	0.0095	−0.0102	0.0476	−0.0776	0.0952
	(0.0337)	(0.0150)	(0.0249)	(0.0465)	(0.0837)	(0.0854)
Program year 2	0.0756*	−0.0130	0.0186	0.0311	−0.0925	−0.0876
	(0.0446)	(0.0178)	(0.0318)	(0.0511)	(0.1019)	(0.1088)
Program year 3	0.0820*	−0.0024	−0.0088	−0.0271	−0.1237	−0.2815*
	(0.0465)	(0.0184)	(0.0400)	(0.0549)	(0.1335)	(0.1441)
Program year 4	0.0878	−0.0128	−0.0494	0.0166	−0.2309	−0.4816**
	(0.0575)	(0.0214)	(0.0511)	(0.0647)	(0.1781)	(0.1906)
Program year 5	0.0659	−0.0188	−0.0801	−0.0397	−0.2766	−0.3693*
	(0.0698)	(0.0278)	(0.0582)	(0.0838)	(0.2014)	(0.2234)
Program year 6	0.1590*	−0.0381	−0.0417	0.0493	−0.3051	−0.5848*
	(0.0910)	(0.0299)	(0.0720)	(0.1132)	(0.2987)	(0.2991)
Program year 7	0.1077	−0.0193	−0.0438	0.0124	−0.4783	−0.4993
	(0.1223)	(0.0404)	(0.0893)	(0.1514)	(0.4795)	(0.3977)
Program year 8	0.1550	−0.0581	−0.1799	−0.0929	−0.7436	−0.1479
	(0.1643)	(0.0464)	(0.1105)	(0.1800)	(0.6622)	(0.5698)
No. Obs	42 931	42 931	42 931	42 931	42 931	42 931
R^2	0.82	0.35	0.64	0.76	0.82	0.79

Notes: *significant at 10%; **significant at 5%; ***significant at 1%.

[a]Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. Dependent variable: Mortality rate per 1000 in age group. Independent variables: dummies indicating number of years into the program, municipality fixed-effects and state-specific non-linear trends. All regressions also included as additional controls (not shown in the table): health infrastructure (hospital beds and hospitals per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP, without the last two and with DT for adults), and public education infrastructure (number of schools and teachers – primary and secondary – per capita).

[b]Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. Dependent variable: Mortality rate per 1000 in age group. Independent variables: dummies indicating number of years into the program, municipality fixed-effects and state-specific non-linear trends. All regressions also included as additional controls (not shown in the table): health infrastructure (hospital beds and hospitals per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP, without the last two and with DT for adults), and public education infrastructure (number of schools and teachers – primary and secondary – per capita).

Program should be most effective. It is very reassuring that our results related to infant mortality paint a picture entirely consistent with the technology that constitutes the main intervention of the PSF. As a final point attesting to the consistency of our results, when we sum over all the coefficients associated with *Program Year 8* in Table IV, we end up with an aggregate impact on mortality of -5.15 per 1000, which is very close to the aggregate effect on mortality presented in Table II (-5.4).

In the age group between 1 and 4, the significant effects of the PSF are associated with mortality due to infectious diseases, external causes, endocrine diseases, and respiratory diseases. The causes of death affected by the program are similar to those in the age group before 1, but for the absence of perinatal period conditions and the presence of external causes. Since accidents are more common in this age group, and the PSF also provides first aid support in some of these cases, this result is not surprising.[15] Quantitatively, the largest impacts of the program in this age group are associated with mortality due to infectious and respiratory diseases.

Table IV shows that, in the age group between 15 and 59, the Family Health Program appears as having significant impacts on mortality due to external causes, endocrine, respiratory, circulatory, and digestive diseases. These are some of the causes of death that appeared as important in the age group between 1 and 4, plus circulatory and digestive diseases, which are typically adult conditions (including heart and cerebrovascular diseases, gastric ulcer, liver cirrhosis, and other liver diseases). Again, some of these conditions can be affected – through changes in diet or behavior, for example – by the information, monitoring, and guidance provided by the Family Health Program. Quantitatively, the largest impacts on this age group are observed for external causes, endocrine and respiratory diseases. For the population above 59, the evidence on the impacts of the program is rather weak. There are only some significant impacts on mortality by ill-defined causes and, surprisingly, some positive impacts on mortality due to neoplasms. Since these are relatively small in magnitude and seem to appear precisely when there are significant reductions in mortality due to ill-defined conditions, we do not attach much weight to these results. It seems fair to say that there is no consistent evidence on the effects of the program on mortality above 59.

5.3. Robustness of the impact on mortality

The main remaining concern in our specification is related to unobserved features of the dynamic behavior of mortality, coupled with the possibility of endogeneity in the adoption of the program. This may be the case, for example, if the program dummies are just capturing pre-existing trends in mortality, rather than the impact of the intervention. It may also be the case if municipalities that start off with high mortality tend to converge to lower mortality levels, as seems to be the case in recent decades in Brazil (see Soares, 2007a). In this situation, if high mortality municipalities are also more likely to adopt the program, one might attribute to the program an effect that is simply due to mortality convergence across municipalities.

Our analysis of the adoption of the program in Section 4.3 suggests that these concerns do not seem particularly relevant. Table AII showed that adoption of the program was related to political considerations and initial characteristics of municipalities, but did not seem to be greatly affected by shocks to mortality. Still, we take these possibilities seriously and adopt two strategies to deal with them. First, we introduce dummies indicating number of years before the program. If the effect of the PSF estimated before is due to pre-existing trends in mortality, these pre-program dummies should be significant. Second, we introduce an interaction of a linear time trend with initial mortality. This allows each municipality to converge to its state specific non-linear trend, at a rate that may vary with its initial conditions, so that municipalities with different mortality levels in 1993 may display different dynamics

[15] The Family Health Program is one of the ingredients of the National Policy of Urgency Attention ('Política Nacional de Atenção às Urgências'), being an integral part of a system of response to emergencies that includes a centralized system of rescue through the use of ambulances ('Serviço de Atendimento Móvel de Urgência') and public and private hospitals.

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in the behavior of mortality. We apply these procedures to the same specification used in Table II, and present the results in Tables V and VI.

Table V presents the results for the pre-existing trends exercise. For none of the age groups analyzed pre-existing trends seem to be an issue. Estimated coefficients for the pre-program dummies are quantitatively small and, in the vast majority of cases, far from significant (from the 32 pre-treatment coefficients displayed, only two turn out to be positive and statistically significant at the 10% level). Results for the coefficients on the program dummies remain very similar to those estimated on Table II.

Table VI presents the results when we control for an additional interaction between initial mortality and a time trend. Qualitative results remain similar to those from Table II: there are significant effects of the program on mortality before age 1, between ages 1 and 4, and between ages 15 and 59. Quantitatively, coefficients are smaller than those estimated before, indicating that there seems to be some convergence in mortality correlated with adoption of the PSF. Still, the pattern of convergence is

Table V. Robustness of mortality effect of PSF by age group, pre-existing trends, Brazilian municipalities, 1995–2003

	Mortality by age group			
	Before 1	Between 1 and 4	Between 15 and 59	Above 59
Program year 1	−0.0967	−0.0211	0.0031	0.2092
	(0.2876)	(0.0153)	(0.0159)	(0.1651)
Program year 2	−0.3233	−0.0398**	−0.0353*	0.0317
	(0.3251)	(0.0173)	(0.0183)	(0.2102)
Program year 3	−1.4609***	−0.0741***	−0.0788***	−0.2326
	(0.3986)	(0.0226)	(0.0229)	(0.2189)
Program year 4	−2.2840***	−0.1214***	−0.1286***	−0.5620*
	(0.5853)	(0.0276)	(0.0300)	(0.3130)
Program year 5	−3.1959***	−0.1757***	−0.1539***	−0.6548**
	(0.7598)	(0.0378)	(0.0359)	(0.3308)
Program year 6	−4.3431***	−0.2495***	−0.2156***	−0.6851
	(1.0070)	(0.0432)	(0.0432)	(0.4275)
Program year 7	−3.9732***	−0.2389***	−0.2057***	−0.8335
	(1.2522)	(0.0569)	(0.0650)	(0.6292)
Program year 8	−5.7332***	−0.3113***	−0.2896***	−1.1425
	(1.6801)	(0.0653)	(0.0757)	(0.7928)
Before program year 1	0.2705	0.0027	0.0155	0.2311
	(0.2925)	(0.0171)	(0.0216)	(0.1991)
Before program year 2	0.6702	0.0300	0.0481	0.5266**
	(0.4194)	(0.0201)	(0.0304)	(0.2573)
Before program year 3	0.6198	0.0449	0.0647*	0.2459
	(0.5260)	(0.0277)	(0.0378)	(0.3039)
Before program year 4	0.2431	0.0405	0.0345	−0.0236
	(0.6089)	(0.0291)	(0.0424)	(0.3414)
Before program year 5	0.2022	0.0226	0.0014	−0.1839
	(0.7056)	(0.0377)	(0.0517)	(0.4058)
Before program year 6	0.5319	0.0248	−0.0185	0.3797
	(0.8067)	(0.0450)	(0.0603)	(0.4780)
Before program year 7	0.8679	0.0799	−0.1091	0.4229
	(0.9876)	(0.0550)	(0.0714)	(0.5853)
Before program year 8	0.3918	−0.0222	−0.0344	0.1780
	(1.2222)	(0.0598)	(0.0906)	(0.8496)
No. Obs	42 924	42 931	42 931	42 931
R^2	0.62	0.35	0.81	0.75

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. Dependent variable: Mortality rate per 1000 in age group. Independent variables: dummies indicating number of years into the program, dummies for number of years before the program, municipality fixed-effects and state-specific non-linear trends. All regressions also included as additional controls (not shown in the table): health infrastructure (hospital beds and hospitals per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP, without the last two and with DT for adults), and public education infrastructure (number of schools and teachers – primary and secondary - per capita).

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Table VI. Robustness of mortality effect of PSF by age group, pre-existing trends, Brazilian municipalities, 1995–2003

	Mortality by age group			
	Before 1	Between 1 and 4	Between 15 and 59	Above 59
Program year 1	0.1849	−0.0155	0.0012	0.2167
	(0.2207)	(0.0146)	(0.0161)	(0.1460)
Program year 2	0.3659	−0.0210	−0.0187	0.1638
	(0.2522)	(0.0160)	(0.0171)	(0.1857)
Program year 3	−0.2976	−0.0408**	−0.0430**	0.0151
	(0.3206)	(0.0201)	(0.0215)	(0.1923)
Program year 4	−0.7335	−0.0775***	−0.0708**	−0.1881
	(0.4511)	(0.0237)	(0.0276)	(0.2632)
Program year 5	−1.1558**	−0.1141***	−0.0744**	−0.1395
	(0.5494)	(0.0315)	(0.0339)	(0.2684)
Program year 6	−1.8858***	−0.1709***	−0.1172***	−0.0915
	(0.6863)	(0.0334)	(0.0405)	(0.3221)
Program year 7	−1.4707*	−0.1515***	−0.0916	−0.1903
	(0.8494)	(0.0451)	(0.0571)	(0.4814)
Program year 8	−2.4724**	−0.1972***	−0.1384**	−0.2598
	(1.1643)	(0.0513)	(0.0625)	(0.5793)
Interaction of initial mortality with trend	yes	yes	yes	yes
No. Obs	42 764	42 771	42 771	42 771
R^2	0.67	0.36	0.82	0.76

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. Dependent variable: Mortality rate per 1000 in age group. Independent variables: dummies indicating number of years into the program, interaction of initial mortality with linear trend, municipality fixed-effects and state-specific non-linear trends. All regressions also included as additional controls (not shown in the table): health infrastructure (hospital beds and hospitals per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP, without the last two and with DT for adults), and public education infrastructure (number of schools and teachers – primary and secondary – per capita).

not enough to explain the significant effects of the Family Health Program estimated before. In reality, given the evidence above, it is even likely that part of the recent convergence in mortality is driven by the expansion of the PSF through different areas of the country, so that this may constitute indeed a very extreme test of the effectiveness of the program.

Overall, the robustness exercises suggest that there is a causal negative effect of the Family Health Program on mortality. It is very likely that these mortality reductions are also associated with improvements in health along various other dimensions. If that is the case, it is possible that program implementation also generates changes in household behavior. We tackle this issue in the next section.

6. IMPACT ON INDIVIDUAL BEHAVIOR

6.1. Main results

As the previous section highlighted, the impacts of the family health program were particularly strong in the north and northeast regions of Brazil. Therefore, in order to try to uncover the effects of the program on household behavior, we focus on these two regions.

During our sample period, the Brazilian Household Survey (PNAD) covers 316 municipalities in these areas. We construct a repeated cross-section with 10 rounds of the PNAD, restricting the sample of children to individuals aged between 10 and 17 and the sample of adults to individuals aged between 18 and 55. This leaves us with data sets of 118 269 children and 279 943 adults. We focus on variables that can be either affected by the change in incentives brought about by changes in health or directly affected by the presence of the Family Health Program. Therefore, our variables of interest are child labor (work during the previous week), school enrollment of

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Table VII. Descriptive statistics, individual level data, Brazilian north and northeast regions, 1993–2004

	Number of municipalities in the sample		Children (between 10 and 17)		Adults (between 18 and 55)		
Year	With PSF	Without PSF	Child labor (%)	School enrollment (%)	Labor supply (%)	Employment (%)	Fertility - birth last 21 months (% of women)
1993	0	316	31.69	77.65	73.64	70.55	18.79
1995	0	316	31.26	79.56	73.95	71.14	17.33
1996	28	288	25.65	81.17	71.87	68.86	16.68
1997	46	270	26.77	83.97	73.41	70.01	15.22
1998	109	207	27.33	86.77	73.93	70.35	15.06
1999	166	150	26.94	89.09	75.69	71.36	8.44
2001	243	73	22.51	90.21	74.34	69.51	13.87
2002	264	52	23.12	91.07	75.20	70.61	12.83
2003	273	43	21.92	90.99	76.29	71.14	12.18
2004	291	25	20.43	90.67	77.04	72.14	11.76

Note: Data for children between 10 and 17 or adults between 18 and 55; 316 municipalities in the north and northeast regions; calculated from 10 rounds of the PNAD (1993–2004, excluding 2000). Child labor and adult employment is defined as work during the last week. School enrollment indicates whether the child is enrolled in regular school. Fertility indicates whether the woman experienced a birth over the last 21 months.

children,[16] labor supply and employment of adults (work during the previous week), and fertility of women (a birth during the year of the interview or the previous calendar year, corresponding to the last 21 months).

Descriptive statistics for these variables are presented in Table VII. Program coverage among the 316 municipalities considered grew from 0 in 1993 to 291 (92%) in 2004. As the table shows, even these poor areas of Brazil experienced substantial improvement between 1993 and 2004. The incidence of child labor between ages 10 and 17 was reduced from 32 to 20%, while school enrollment in the same age group increased from 78 to 91%. Labor supply of adults between 18 and 55 increased from 74 to 77%, while employment remained roughly constant, around 71%. At the same time, fertility – as measured by the probability that a woman experiences a birth over a 21 month interval – was reduced from 19 to 12%.

6.1.1. Child labor and schooling. Table VIII presents the results related to the impacts of the PSF on child labor and school enrollment. Overall, there is almost no noticeable effect of the program on child labor, while there seems to be a positive effect on school enrollment. Eight years of exposure to the program are associated with an increase of 4.5% in school enrollment.

To explore the possibility of heterogeneous responses across genders and age groups, the table also breaks down the sample between boys and girls, and between ages 10 to 14 and 15 to 17. There is some evidence that the program may have increased the labor supply of boys between the ages of 10 and 14, but overall the child labor results remain non-significant. The estimates for school enrollment indicate stronger effects for boys and girls between ages 15 and 17 (point estimates are slightly higher for boys than girls), consistent with the idea that school enrollment below 14 was already very high by the end of the 1990s and that boys drop out of school before girls.[17]

[16]Ideally, we would measure the impact of the program on school attendance. The PNAD does not provide this type of information, so we focus on school enrollment.

[17]Though not reported here, we also investigated the impact of the PSF on teenage pregnancies and found no significant effects. These results are available from the authors upon request. We cannot rule out the possibility that the positive effects on schooling are spillovers from the interaction of health agents with families, possibly through counseling and advising regarding multiple aspects of family life.

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Table VIII. Impact on children between ages 10 and 17, individual level data, Brazilian north and northeast regions, 1995–2003

	Child labor between ages 10 and 17				
	All	Boys 10–14	Girls 10–14	Boys 15–17	Girls 15–17
Program year 1	0.0065	0.0074	0.0040	−0.0173	0.0178
	(0.0110)	(0.0162)	(0.0065)	(0.0253)	(0.0192)
Program year 2	0.0152	0.0425	0.0037	−0.0264	0.0093
	(0.0176)	(0.0268)	(0.0092)	(0.0380)	(0.0300)
Program year 3	0.0414	0.0894*	0.0124	−0.0102	0.0288
	(0.0293)	(0.0480)	(0.0171)	(0.0561)	(0.0473)
Program year 4	0.0566	0.1179*	0.0149	0.0003	0.0557
	(0.0422)	(0.0707)	(0.0242)	(0.0771)	(0.0713)
Program year 5	0.1048*	0.1855*	0.0401	0.0071	0.1131
	(0.0636)	(0.1090)	(0.0463)	(0.1048)	(0.1047)
Program year 6	0.1173	0.2278	0.0723	−0.0431	0.1208
	(0.0850)	(0.1502)	(0.0801)	(0.1320)	(0.1390)
Program year 7	0.1346	0.2313	0.1230	−0.0716	0.1322
	(0.1138)	(0.1962)	(0.1383)	(0.1662)	(0.1828)
Program year 8	0.1984	0.3244	0.1557	−0.0106	0.2008
	(0.1543)	(0.2641)	(0.1979)	(0.2130)	(0.2422)
No. Obs	118 262	36 987	37 142	22 063	21 700
	School enrollment between ages 10 and 17				
	All	Boys 10–14	Girls 10–14	Boys 15–17	Girls 15–17
Program year 1	0.0069*	−0.0005	0.0001	0.0103	0.0277**
	(0.0041)	(0.0017)	(0.0002)	(0.0135)	(0.0109)
Program year 2	0.0055	−0.0031	0.0002	0.0231	0.0249
	(0.0058)	(0.0031)	(0.0003)	(0.0193)	(0.0169)
Program year 3	0.0162**	−0.0048	0.0005**	0.0442*	0.0404*
	(0.0075)	(0.0057)	(0.0002)	(0.0239)	(0.0231)
Program year 4	0.0218**	−0.0081	0.0004	0.0580*	0.0581**
	(0.0097)	(0.0098)	(0.0004)	(0.0305)	(0.0267)
Program year 5	0.0239**	−0.0205	0.0005	0.0746**	0.0645**
	(0.0121)	(0.0233)	(0.0004)	(0.0339)	(0.0311)
Program year 6	0.0280*	−0.0320	0.0006	0.0915***	0.0642
	(0.0146)	(0.0422)	(0.0005)	(0.0345)	(0.0405)
Program year 7	0.0361***	−0.0669	0.0008***	0.1048***	0.0752**
	(0.0138)	(0.0937)	(0.0001)	(0.0286)	(0.0376)
Program year 8	0.0454***	−0.0755	0.0008***	0.1127***	0.0947***
	(0.0100)	(0.1297)	(0.0001)	(0.0237)	(0.0165)
No. Obs	118 221	36 114	35 543	22 057	21 018

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. Probit marginal effects are presented in the table. Robust standard errors allowing for clustering at the municipality level in parentheses. Dependent variables: dummies indicating whether the child worked in the previous week and whether the child is enrolled in school. Treatment variables are dummies indicating number of years into the program. All regressions include municipality and year fixed-effects, municipality-specific linear trends, as well as individual level controls – age, race, gender, presence of mother in the household, urban residence, education, age, gender and race of the head of the household, household income per capita, number of siblings, presence of elderly in the household, and household infrastructure (number of rooms per capita, access to treated water, and toilet connected to the public system) – and municipality level controls – health infrastructure (hospitals and beds per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP), and educational infrastructure (number of schools and teachers per capita). Data for children between 10 and 17 from 316 municipalities in the north and northeast regions; obtained from eight rounds of the PNAD (1995–2003, excluding 2000).

6.1.2. Labor supply and employment. Table IX presents the results on the response of adult labor supply and employment. The top panel presents results for labor supply, while the bottom panel presents the

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results for employment. Results are shown for both genders (ages between 18 and 55), and for men and women separately.[18]

The table suggests a consistent effect of the PSF on adult labor supply and employment. Municipalities 8 years into the program have adult labor supply 6.8 percentage points higher and employment 11 percentage points higher than otherwise equivalent municipalities not covered by the program. Quantitative results for both labor supply and employment are stronger for women than for men; though significance is reduced as the sample is broken down by gender. Point estimate seems to be somewhat too large quantitatively, but the overall pattern does seem to suggest a positive correlation between program implementation and adult employment.

6.1.3. Fertility. Table X presents the results related to fertility (probability of a birth over the 21 months preceding the interview). Implementation of the PSF seems to be systematically associated with reduced probability of women experiencing births. The average effect for women between ages 18 and 55 registered in the first column is due mostly to women between 31 and 40, though there are also negative but mostly non-significant impacts for women between 18 and 30. Given that Table X showed evidence of positive impacts of the program on labor supply and employment of women, the impact on fertility may be either due to better access to – or information about – contraceptive techniques, or due to improved health of adults and existing children (change in long-term lifetime decision on labor supply affecting fertility choice). Also, the age profile of the estimated response is consistent with what should be expected: we find no significant effect of the PSF on fertility between 41 and 55, an age group where fertility is typically much lower and undesired pregnancies much rarer.

Quantitatively, the estimated coefficients for the age group between 31 and 40 imply that, for municipalities 5 years into the program, women are 4.6 percentage points less likely to have experienced a birth in the previous 21 months than otherwise identical women in municipalities not covered by the PSF. The analogous number for municipalities 8 years into the program is 6.5 percentage points.

Overall, the evidence suggests that the Family Health Program reduced fertility, increased female labor supply, and improved school enrollment of children. These effects are consistent with what should be expected from improvements in access to health and their effects on decisions related to human capital, number of children, and labor supply.

6.2. Heterogeneity in response

In order to better understand the impact of the Family Health Program on household decisions, we explore some dimensions of potential heterogeneity in response. In this section, we look at the significant results from the previous tables and investigate heterogeneity in response in relation to the location where the family lives (rural vs. urban) and to conditions of the household (no access to treated water and no access to the public sewage system). Table XI presents a synthesis of the main results.

The table shows that the effect on school enrollment is stronger for households in rural areas and for those without access to treated water. The coefficients for municipalities 8 years into the program for these two regressions are, respectively, 0.058 and 0.064, as compared to 0.045 in the main specification presented before.

For adult labor supply and employment, effects are also much stronger in rural areas. The results appear as significant and of magnitude similar to that observed on Table IX for households without toilet connected to the public sewage system. In the cases of both child schooling and adult labor, the impact of the program seems to be associated with poor households in rural areas, possibly with less access to the public health system.

[18]We also tried regressions disaggregated by age group in this case, but results were rarely significant and did not shed much light.

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Table IX. Impact on adult labor, individual level data, Brazilian north and northeast regions, 1995–2003

	Labor supply		
	All	Men	Women
Program year 1	0.0103*	0.0040	0.0110
	(0.0056)	(0.0026)	(0.0100)
Program year 2	0.0170*	0.0057	0.0207
	(0.0087)	(0.0039)	(0.0150)
Program year 3	0.0248**	0.0066	0.0331
	(0.0122)	(0.0056)	(0.0222)
Program year 4	0.0317*	0.0070	0.0434
	(0.0164)	(0.0080)	(0.0291)
Program year 5	0.0518**	0.0109	0.0759**
	(0.0211)	(0.0095)	(0.0386)
Program year 6	0.0568**	0.0092	0.0844*
	(0.0272)	(0.0133)	(0.0494)
Program year 7	0.0746**	0.0140	0.1052*
	(0.0327)	(0.0136)	(0.0616)
Program year 8	0.0680*	0.0040	0.1092
	(0.0412)	(0.0246)	(0.0758)
No. Obs	279 943	127 331	152 511
	Employment		
	All	Men	Women
Program year 1	0.0090	0.0087*	0.0042
	(0.0066)	(0.0045)	(0.0104)
Program year 2	0.0168	0.0134*	0.0136
	(0.0107)	(0.0071)	(0.0163)
Program year 3	0.0332**	0.0217**	0.0341
	(0.0129)	(0.0086)	(0.0220)
Program year 4	0.0399**	0.0258**	0.0410
	(0.0175)	(0.0119)	(0.0292)
Program year 5	0.0668***	0.0367***	0.0770**
	(0.0224)	(0.0129)	(0.0390)
Program year 6	0.0802***	0.0436***	0.0889*
	(0.0285)	(0.0147)	(0.0505)
Program year 7	0.1093***	0.0530***	0.1211*
	(0.0333)	(0.0123)	(0.0631)
Program year 8	0.1136***	0.0501***	0.1424*
	(0.0410)	(0.0168)	(0.0765)
No. Obs	279 943	127 385	152 511

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. Probit marginal effects are presented in the table. Robust std errors allowing for clustering at the municipality level in parentheses. Dependent variable: dummies indicating whether individual is economically active and whether individual worked in the previous week. Treat. vars are dummies indicating number of years into the program. All regs include municipality and year fixed-effects, municipality-specific linear trends, as well as individual level controls – age, race, gender, education, presence of spouse in the household, urban residence, metropolitan region, presence of elderly and children in the household, and household infrastructure (number of rooms pc, treated water, and toilet connected to the public system) – and municipality level controls – health infrastructure (hospitals and beds per capita), immunization rates (BCG, measles, yellow fever, and DT), and educational infrastructure (number of schools and teachers per capita). Data for adults between 18 and 55 from 316 municipalities in the north and northeast regions; obtained from eight rounds of the PNAD (1995–2003, excluding 2000).

In the case of fertility, on the other hand, the effect comes from households in urban areas. It is still true that poorer households, with less access to the public sewage system and less access to treated water, seem to experience higher reductions in fertility after implementation of the program, but this effect is entirely associated with urban areas. This may indicate that reductions in fertility are driven by improved access to contraceptive techniques by households that already had some demand for birth control methods.

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Table X. Impact on fertility (birth over the last 21 months), individual level data, Brazilian north and northeast regions, 1995–2003

	Fertility			
	All	Between 18 and 30	Between 31 and 40	Between 41 and 55
Program year 1	−0.0128***	−0.0246**	−0.0162***	−0.0000
	(0.0031)	(0.0112)	(0.0052)	(0.0000)
Program year 2	−0.0125***	−0.0127	−0.0205***	0.0000
	(0.0042)	(0.0151)	(0.0078)	(0.0000)
Program year 3	−0.0180***	−0.0149	−0.0303***	0.0000
	(0.0058)	(0.0202)	(0.0097)	(0.0000)
Program year 4	−0.0245***	−0.0218	−0.0425***	0.0001
	(0.0071)	(0.0274)	(0.0109)	(0.0002)
Program year 5	−0.0276***	−0.0215	−0.0464***	0.0002
	(0.0088)	(0.0371)	(0.0119)	(0.0004)
Program year 6	−0.0353***	−0.0267	−0.0585***	0.0012
	(0.0098)	(0.0481)	(0.0101)	(0.0033)
Program year 7	−0.0373***	−0.0044	−0.0615***	0.0053
	(0.0115)	(0.0656)	(0.0074)	(0.0165)
Program year 8	−0.0456***	−0.0111	−0.0646***	0.0037
	(0.0105)	(0.0793)	(0.0048)	(0.0151)
No. Obs	152 511	48 105	53 616	40 519

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. Probit marginal effects are presented in the table. Robust standard errors allowing for clustering at the municipality level in parentheses. Dependent variable: dummy indicating whether woman gave birth during the last 21 months. Treat. vars are dummies indicating number of years into the program. All regressions include municipality and year fixed-effects, municipality-specific linear trends, as well as individual level controls – age, race, gender, education, presence of spouse in the household, urban residence, metropolitan region, presence of elderly and children in the household, and household infrastructure (number of rooms per capita, access to treated water, and toilet connected to the public system) – and municipality level controls – health infrastructure (hospitals and beds per capita), immunization rates (BCG, measles, yellow fever, and DT), and educational infrastructure (number of schools and teachers per capita). Data for adults between 18 and 55 from 316 municipalities in the north and northeast regions; obtained from eight rounds of the PNAD (1995–2003, excluding 2000).

7. CONCLUDING REMARKS

This paper shows that implementation of the Brazilian Family Health Program was associated with reductions in mortality throughout the age distribution, but particularly at very early ages (infant mortality). The response to the program seems to be particularly strong in municipalities with worse initial conditions and in the poorest regions of Brazil (north and northeast). The reductions in mortality determined by the program are mostly associated with perinatal period conditions, infectious, endocrine, and respiratory diseases, and, for older age groups, external causes and digestive diseases. In the North and Northeast regions, we also find that program implementation was significantly associated with reduced fertility, increased labor supply of adults, and increased school enrollment.

Given the estimated impacts presented on Table II and the costs of implementation calculated elsewhere (Fundação Getulio Vargas and EPOS Health Consultants, 2001), we can conduct some preliminary cost–benefit analysis of program implementation, based on yearly costs and the number of lives saved. For example, a municipality with 100 000 inhabitants, subject to the average program coverage observed in the sample (40%), should be expected to spend between US$ 1 252 688 and US$ 1 981 714 yearly to run the program. Assuming that such municipality would have the same age distribution of the Brazilian population in 2000, and taking the point estimates from Table II as being accurate, this municipality would save a cumulative total of 57 lives after 5 years of PSF implementation, and 150 lives after 8 years. Given the range of estimates available in the literature for the value of a statistical life (see Viscusi and Aldy, 2003), irrespective of the interest rate, this back of the envelope calculation suggests that the Family Health Program is highly effective from a cost–benefit perspective as a tool to promote health improvements. If, on top of that, one considers the indirect effect on household behavior estimated here and the morbidity effects that are also likely to be present, the figure would become even more positive.

Table XI. Heterogeneity of impact on children and adults, by household characteristics, individual level data, Brazilian north and northeast regions, 1995–2003

	School enrollment				Fertility			
	Rural	Urban	Without treated water	Without toilet connected to the public system	Rural	Urban	Without treated water	Without toilet connected to the public system
Program year 1	0.0167**	0.0045	0.0043	0.0079	–0.0175**	–0.0119***	–0.0134*	–0.0157***
	(0.0083)	(0.0042)	(0.0094)	(0.0063)	(0.0085)	(0.0033)	(0.0078)	(0.0043)
Program year 2	0.0147	0.0042	0.0082	0.0094	0.0079	–0.0149***	–0.0131	–0.0144**
	(0.0120)	(0.0060)	(0.0118)	(0.0076)	(0.0156)	(0.0046)	(0.0112)	(0.0059)
Program year 3	0.0478***	0.0044	0.0321**	0.0181*	0.0136	–0.0211***	–0.0197	–0.0256***
	(0.0083)	(0.0090)	(0.0133)	(0.0106)	(0.0237)	(0.0061)	(0.0150)	(0.0077)
Program year 4	0.0529***	0.0112	0.0383**	0.0203	0.0254	–0.0280***	–0.0221	–0.0300***
	(0.0097)	(0.0116)	(0.0170)	(0.0145)	(0.0348)	(0.0074)	(0.0204)	(0.0098)
Program year 5	0.0550***	0.0110	0.0435**	0.0308*	0.0244	–0.0312***	–0.0283	–0.0328***
	(0.0085)	(0.0152)	(0.0202)	(0.0178)	(0.0458)	(0.0090)	(0.0251)	(0.0126)
Program year 6	0.0571***	0.0125	0.0438*	0.0343	0.0246	–0.0391***	–0.0438	–0.0430***
	(0.0089)	(0.0200)	(0.0260)	(0.0223)	(0.0612)	(0.0096)	(0.0267)	(0.0146)
Program year 7	0.0593***	0.0181	0.0591***	0.0464*	0.0647	–0.0422***	–0.0262	–0.0437**
	(0.0048)	(0.0217)	(0.0176)	(0.0242)	(0.1064)	(0.0101)	(0.0427)	(0.0180)
Program year 8	0.0583***	0.0279	0.0636***	0.0502*	0.0386	–0.0482***	–0.0618**	–0.0590***
	(0.0022)	(0.0192)	(0.0148)	(0.0276)	(0.1180)	(0.0089)	(0.0267)	(0.0161)
No. Obs	18 365	99 730	34 247	116 869	17 158	135 314	38 199	132 883

Table XI. *Continued*

	Adult labor supply				Adult employment			
	Rural	Urban	Without treated water	Without toilet connected to the public system	Rural	Urban	Without treated water	Without toilet connected to the public system
Program year 1	0.0127	0.0108*	0.0007	0.0130**	0.0122	0.0099	−0.0023	0.0099
	(0.0140)	(0.0057)	(0.0101)	(0.0066)	(0.0150)	(0.0069)	(0.0110)	(0.0074)
Program year 2	0.0199	0.0168*	0.0105	0.0215**	0.0169	0.0180	0.0123	0.0151
	(0.0222)	(0.0091)	(0.0151)	(0.0102)	(0.0239)	(0.0111)	(0.0166)	(0.0111)
Program year 3	0.0487	0.0205*	0.0194	0.0270*	0.0499	0.0314**	0.0296	0.0327**
	(0.0324)	(0.0125)	(0.0221)	(0.0143)	(0.0339)	(0.0132)	(0.0234)	(0.0147)
Program year 4	0.0592	0.0258	0.0242	0.0378**	0.0569	0.0377**	0.0301	0.0415**
	(0.0433)	(0.0166)	(0.0301)	(0.0189)	(0.0456)	(0.0179)	(0.0320)	(0.0200)
Program year 5	0.0815	0.0461**	0.0420	0.0608**	0.0754	0.0663***	0.0587	0.0683***
	(0.0541)	(0.0215)	(0.0396)	(0.0244)	(0.0574)	(0.0229)	(0.0413)	(0.0257)
Program year 6	0.1168*	0.0473*	0.0410	0.0686**	0.1159*	0.0773***	0.0651	0.0830**
	(0.0618)	(0.0279)	(0.0517)	(0.0310)	(0.0658)	(0.0293)	(0.0531)	(0.0325)
Program year 7	0.1494**	0.0630*	0.0470	0.0887**	0.1535**	0.1055***	0.0817	0.1119***
	(0.0635)	(0.0341)	(0.0658)	(0.0368)	(0.0680)	(0.0344)	(0.0655)	(0.0379)
Program year 8	0.1840***	0.0532	0.0329	0.0804*	0.1859***	0.1091**	0.0829	0.1198***
	(0.0583)	(0.0435)	(0.0858)	(0.0468)	(0.0663)	(0.0428)	(0.0814)	(0.0459)
No. Obs	32 555	247 384	71 770	190 351	32 555	247 384	71 769	190 351

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. Probit marginal effects are presented in the table. Robust standard errors allowing for clustering at the municipality level in parentheses. Dependent variables: dummies indicating whether child is enrolled in school, whether a woman experienced a birth over the previous 21 months, whether individual is economically active, or whether individual worked in the previous week. Treat. vars are dummies indicating number of years into the program. All regressions include municipality and year fixed-effects, municipality-specific linear trends, as well as individual level controls – age, race, gender, presence of mother in the household, urban residence, education, age, gender and race of the head of the household, household income per capita, number of siblings, presence of elderly in the household, and household infrastructure (number of rooms pc, access to treated water, and toilet connected to the public system) – and municipality level controls – health infrastructure (hospitals and beds per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP), and educational infrastructure (number of schools and teachers per capita). Data from 316 municipalities in the north and northeast regions; from eight rounds of the PNAD (1995–2003, excluding 2000).

In short, our results confirm the importance and effectiveness of family and community-based health interventions as tools to improve health in economically disadvantaged areas. Nevertheless, replicability of this effort in other contexts requires a certain degree of institutional development to allow for the coordination of actions and monitoring of performance of heath teams. Similarly, labor costs, which constitute the highest fraction of costs of the Family Health Program, depend on specific labor market conditions and on the wage differentials required to convince medical doctors and health professionals to work in the relevant regions. These aspects should be explicitly taken into account when considering the implementation of this type of intervention in poor areas of other developing countries.

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CONFLICTS OF INTERESTS

No conflicts of interests disclosed.

APPENDIX A

Table AI in the Appendix contains a description of the variables included in our analysis, as well as their sources and availability in terms of years of coverage. Results of this estimation are presented in Table AII.

Table AI. Data

Variable	Source	Coverage
Mortality		
By age, gender, and cause of death	DATASUS/Brazilian Ministry of Health	1993–2004
Education infrastructure		
Number of teachers in public schools	School census/INPE	1993–2003
Number of public schools	School census/INPE	1993–2003
Immunization		
BCG, measles, yellow fever, poliomyelitis, DTP, DT	DATASUS/Brazilian Ministry of Health	1995–2004
Health Infrastructure:		
Number of hospitals	DATASUS/Brazilian Ministry of Health	1993–2003
Number of hospital beds	DATASUS/Brazilian Ministry of Health	1993–2003
Individual data		
Individual and household variables	Brazilian Household Survey (PNAD-IBGE)	1993–2004
GDP per capita	IBGE	1999–2004

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Table AII. Hazard estimation of the probability of joining the PSF, Brazilian Municipalities, 1993–2004

	Probability of joining the program					
Δ_{t-1} mortality before1	−0.0004			−0.0005		
	(0.0009)			(0.0009)		
Δ_{t-2} mortality before1		0.0020**			0.0020**	
		(0.0009)			(0.0009)	
Δ_{t-3} mortality before1			0.0021**			0.0022**
			(0.0009)			(0.0009)
Δ_{t-1} mortality between 1 and 4				0.0004		
				(0.0094)		
Δ_{t-2} mortality between 1 and 4					−0.0131	
					(0.0095)	
Δ_{t-3} mortality between 1 and 4						0.0201**
						(0.0095)
Δ_{t-1} mortality between 15 and 59				0.0261**		
				(0.0133)		
Δ_{t-2} mortality between 15 and 59					−0.0070	
					(0.0131)	
Δ_{t-3} mortality between 15 and 59						−0.0282**
						(0.0131)
Time-varying dimensions of public policy						
Δ_{t-1} hospitals per 1000	−0.0248***	−0.0252***	−0.0242***	−0.0250***	−0.0252***	−0.0244***
	(0.0072)	(0.0076)	(0.0074)	(0.0075)	(0.0076)	(0.0075)
Δ_{t-1} schools per capita	−113.4947***	−113.3292***	−113.5942***	−113.7860***	−113.4989***	−113.7806***
	(7.3298)	(7.4218)	(7.4668)	(8.1608)	(7.4315)	(7.4250)
Δ_{t-1} hospital beds per 1000	−0.0047	−0.0043	−0.0053	−0.0054	−0.0045	−0.0057
	(0.0180)	(0.0189)	(0.0185)	(0.0187)	(0.0189)	(0.0188)
Δ_{t-1} teachers per capita	14.6307***	14.5597***	14.6325***	14.6092***	14.6272***	14.6974***
	(2.6987)	(2.7246)	(2.7016)	(2.7192)	(2.7312)	(2.7228)
Party of the Mayor						
Workers Party (PT)	0.3090***	0.3097***	0.3094***	0.3110***	0.3119***	0.3105***
	(0.0973)	(0.0971)	(0.0970)	(0.0972)	(0.0972)	(0.0972)
Social Democrat Party (PSDB)	0.1684***	0.1690***	0.1670***	0.1672***	0.1672***	0.1665***
	(0.0464)	(0.0465)	(0.0466)	(0.0463)	(0.0465)	(0.0464)
Brazilian Labor Party (PTB)	−0.1262**	−0.1259**	−0.1263**	−0.1265**	−0.1256**	−0.1252**
	(0.0628)	(0.0628)	(0.0627)	(0.0631)	(0.0629)	(0.0628)
Progressist Party (PP)	0.0260	0.0263	0.0267	0.0272	0.0280	0.0273
	(0.0544)	(0.0534)	(0.0534)	(0.0535)	(0.0534)	(0.0534)
Liberal Front Party (PFL)	0.0106	0.0107	0.0108	0.0125	0.0125	0.0134
	(0.0458)	(0.0457)	(0.0454)	(0.0483)	(0.0458)	(0.0458)
Democratic Labor Party (PDT)	−0.0805	−0.0798	−0.0809	−0.0818	−0.0797	−0.0803
	(0.0661)	(0.0661)	(0.0661)	(0.0664)	(0.0661)	(0.0661)

Table AII. *Continued*

	Probability of joining the program					
Liberal Party (PL)	−0.1402*	−0.1398*	−0.1407*	−0.1391*	−0.1373*	−0.1383*
	(0.0769)	(0.0767)	(0.0758)	(0.0773)	(0.0769)	(0.0769)
Green Party (PV)	−0.2640	−0.2657	−0.2623	−0.2671	−0.2653	−0.2640
	(0.3184)	(0.3183)	(0.3185)	(0.3183)	(0.3183)	(0.3184)
Popular Socialist Party (PPS)	0.6607***	0.6628***	0.6599***	0.6604***	0.6617***	0.6617***
	(0.1291)	(0.1291)	(0.1291)	(0.1291)	(0.1291)	(0.1291)
Socialist Party (PSB)	0.3228***	0.3241***	0.3233***	0.3220***	0.3245***	0.3252***
	(0.0927)	(0.0924)	(0.0925)	(0.0925)	(0.0924)	(0.0924)
Variables measured in the beginning of the period						
Mortality before 1 (1993)	0.0029***	0.0030***	0.0033***	0.0028***	0.0029***	0.0032***
	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0008)
Mortality between 1 and 4 (1993)				−0.0024	−0.0026	0.0018
				(0.0121)	(0.0117)	(0.0118)
Mortality between 15 and 59 (1993)				0.0093	0.0083	0.0034
				(0.0134)	(0.0136)	(0.0139)
Hospitals per 100 000 (1993)	0.0013	0.0013	0.0013	0.0013	0.0013	0.0012
	(0.0019)	(0.0020)	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Schools per capita (1995)	−10.3398***	−10.3267***	−10.2255***	−10.0968**	−10.1056**	−10.1250***
	(3.8231)	(3.8417)	(3.8187)	(4.7633)	(3.9338)	(3.9297)
Hospital beds per 100 000 (1993)	−0.0070	−0.0070	−0.0069	−0.0071	−0.0071	−0.0069
	(0.0048)	(0.0050)	(0.0049)	(0.0049)	(0.0050)	(0.0050)
Teachers per capita (1995)	−0.9912	−1.0139	−0.9484	−0.9356	−1.0124	−0.9634
	(1.4774)	(1.5891)	(1.4151)	(1.5837)	(1.6320)	(1.6547)
Average schooling (1991)	0.0890***	0.0896***	0.0874***	0.0858***	0.0861***	0.0857***
	(0.0235)	(0.0286)	(0.0171)	(0.0307)	(0.0291)	(0.0287)
Average age of head of household (1991)	−0.0045*	−0.0045	−0.0046	−0.0043	−0.0044	−0.0045
	(0.0025)	(0.0041)	(0.0030)	(0.0030)	(0.0055)	(0.0047)
Average # of members oh household (1991)	0.0950***	0.0949**	0.0951***	0.0989**	0.0977**	0.0974**
	(0.0350)	(0.0383)	(0.0214)	(0.0406)	(0.0412)	(0.0425)
% vulnerable households (1991)	−0.0003	−0.0020	−0.0034	0.0039	0.0007	−0.0068
	(0.3018)	(0.2986)	(0.2485)	(0.2643)	(0.3007)	(0.3123)
ln household income per capita (1991)	−0.2205***	−0.2205***	−0.2187	−0.2179***	−0.2194***	−0.2173***
	(0.0126)	(0.0266)	(0.0000)	(0.0315)	(0.0322)	(0.0244)
Unemployment (1991)	−0.2694	−0.2686	−0.2646	−0.2657	−0.2688	−0.2626
	(0.4654)	(0.4720)	(0.4773)	(0.4653)	(0.4735)	(0.4740)
No. Obs	18 892	18 893	18 894	18 890	18 892	18 894

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. Hazard estimation where municipalities leave the sample when they enter the PSF. Independent variables arevariables are: change in age specific mortality rates lagged in one period, change in other dimensions of public policy lagged one period (hospitals, hospital beds per capita, number of schools, and teachers), political party of the Mayor, initial values of all lagged variables (mortality and public policy variables), average years of schooling, average age of the head of the household, average household size, % vulnerable households (households with four or more members per working member and with head of the household with less than 4 years of schooling), ln average household and income per capita, and unemployment rate. The excluded parties are the Brazilian Democratic Movement Party (PMDB) and other smaller parties. Municipality level observations. Data from DATASUS (Brazilian Ministry of Health), Brazilian School Census 1995, Brazilian National Census 1991.

Table AIII. Mortality effect of PSF by age group, and interactions with early movers, Brazilian Municipalities, 1995–2003

	Mortality by age group			
	Before 1	Between 1 and 4	Between 15 and 59	Above 59
Program year 1	−0.2776	−0.0265*	−0.0178	0.1039
	(0.2846)	(0.0151)	(0.0183)	(0.1644)
Program year 2	−0.4312	−0.0400**	−0.0546***	−0.0892
	(0.3290)	(0.0164)	(0.0186)	(0.2086)
Program year 3	−1.0200**	−0.0537**	−0.1163***	−0.4000
	(0.5072)	(0.0269)	(0.0284)	(0.2906)
Program year 4	−1.4336**	−0.0939***	−0.1550***	−0.7485*
	(0.7018)	(0.0326)	(0.0378)	(0.4264)
Program year 5	−2.1247**	−0.0912*	−0.1462***	−0.6268
	(1.0262)	(0.0477)	(0.0508)	(0.5267)
Program year 6	−4.0033***	−0.2208***	−0.2166***	−0.6573
	(1.0702)	(0.0407)	(0.0437)	(0.4362)
Program year 7	−3.5006**	−0.2054***	−0.2051***	−0.8238
	(1.3743)	(0.0555)	(0.0649)	(0.6544)
Program year 8	−5.0394***	−0.2599***	−0.2824***	−1.0332
	(1.8073)	(0.0627)	(0.0745)	(0.8211)
Early movers* program year 3	−0.9900	−0.0279	0.0437	0.1914
	(0.8639)	(0.0432)	(0.0463)	(0.4137)
Early movers* program year 4	−1.3401	−0.0201	0.0273	0.2037
	(1.0644)	(0.0473)	(0.0536)	(0.5225)
Early movers* program year 5	−1.1272	−0.0863	−0.0184	−0.1018
	(1.3748)	(0.0579)	(0.0623)	(0.6064)
Municipality f.e.	Yes	Yes	Yes	Yes
state-specific year f.e.	Yes	Yes	Yes	Yes
No. Obs	38 762	38 769	38 769	38 769
R^2	0.62	0.36	0.82	0.75

Notes: *significant at 10%; **significant at 5%; ***significant at 1%. Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. Dependent variable: mortality rate per 1000 in age group. Independent variables: Dummies indicating number of years into the program, interactions between early movers and some of these dummies, municipality fixed-effects and state-specific non-linear trends. All regressions also included as additional controls (not shown in the table): health infrastructure (hospital beds and hospitals per capita), immunization rates (BCG, measles, yellow fever, poliomyelitis and DTP, without the last two and with DT for adults), and public education infrastructure (number of schools and teachers – primary and secondary – per capita).

Table AIV. Classification of Diseases into Groups

Infectious and parasitic diseases	Neoplasms	Endocrine, nutritional and metabolic diseases	Nervous system diseases	Circulatory diseases	Respiratory diseases	Digestive diseases	Affections in the perinatal period	Congenite malformation, deformities and chromosomal anomalies	Symptoms, signs and abnormality finds ill-defined	External causes of mortality and morbidity
Infectious intestinal diseases	Neoplasms of lip, oral cavity, and pharynx	Diabetes mellitus	Meningitis	Acute rheumatic fever and rheumatic heart diseases	Influenza (grippe)	Duodenal, peptic and gastric ulcer	Fetus and newly born babies affected by complication in the pregnancy or in the childbirth	Congenite malformation of nervous system	Senility	Transport accidents
Cholera	Esophageal neoplasms	Malnutrition, underfeeding	Alzheimer's disease	Hypertensive diseases	Pneumonia	Peritonitis	Trouble related with duration of pregnancy and fetal growth	Circulatory congenite malformation	Death without medical care	Falls
Diarrhea and gastritis of infectious origin	Stomach neoplasms	Other endocrine, nutritional and metabolic diseases	Epilepsy	Ischemic heart disease	Other acute lower airways infections	Liver diseases	Childbirth traumatism	Other congenite malformation, deformities and chromosomal anomalies	Other Symptoms, signs and abnormality finds ill-defined	Drowning accidental submersion
Other infectious intestinal diseases	Neoplasms of the colon, rectum, and anus		Other nervous system diseases	Acute myocardial infarction	Bronchiolitis	Alcoholic liver diseases	Respiratory and cardiovascular troubles in the perinatal period			Smoke and fire exposition
Typhoid.	Liver neoplasms			Other heart diseases	Chronic diseases in the lower airways	Liver fibrosis and liver cirrhosis	Other affections in the perinatal period			Poisoning
Tuberculosis	Pancreatic neoplasms			Cerebrovascular diseases	Asthma	Other liver diseases				Suicide

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Table AIV. *Continued*

Infectious and parasitic diseases	Neoplasms	Endocrine, nutritional and metabolic diseases	Nervous system diseases	Circulatory diseases	Respiratory diseases	Digestive diseases	Affections in the perinatal period	Congenite malformation, deformities and chromosomal anomalies	Symptoms, signs and abnormality finds ill-defined	External causes of mortality and morbidity
Pulmonary tuberculosis	Laryngeal neoplasms			Atheroschlerosis	Other respiratory diseases	Cholecystitis				Aggression
Other tuberculosis	Neoplasms of the trachea, bronchi, and lung			Other circulatory diseases		Other digestive diseases				Events and facts without intention defined
Other bacterium diseases	Skin neoplasms									War operations and legal interventions
Pestilential disease	Mammary neoplasms									Other external causes
Leptospirosis	Cervical neoplasms									
Leprosy	Uterine neoplasms									
Tetanus	Ovarian neoplasms									
Neonatal tetanus	Prostate neoplasm									
Obstetric tetanus	Vesical neoplasms									
Accidental tetanus	Meningeal, encephalon and other nervous system neoplasms									

Diphtheria	Lymphoma not-Hodgkin
Whooping cough	Multiple myelome and plasma cell neoplasms
Infectious meningitis	Leukemia
Septicemia	Benign neoplasm
Sexual diseases	Other neoplasms
Viral diseases	
Acute poliomyelitis	
Rabies	
Dengue (breakbone fever)	
Yellow fever	
Other viral fevers	
Measles	
Viral hepatitis	
HIV diseases	
Protozoa diseases	
Malaria	
Leishmaniosis	
Chagas' disease	
Toxoplasmosis	
Helminthiasis	
Schistosomiasis	
Cysticercosis	
Other helminthiasis	
Other infectious and parasitic diseases	

The mortality effect of PSF by age group and interactions with early movers are given in Table AIII. A detailed description of the specific causes of death included in each group is given in Table AIV.

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