

# Growing Together: Assessing Equity and Efficiency in an Early-Life Health Program in Chile\*

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## Abstract

We estimate the impact of participation in *Chile Crece Contigo* (ChCC), Chile's flagship early-life health and social welfare program, on neonatal health outcomes. We use administrative birth data matched to social benefits usage, and the staggered program roll-out, to identify the impact of participation. We find that this targeted social program had significant effects on birth weight (approximately 10 grams) and other early life human capital measures. These benefits are largest among the most socially vulnerable groups, however shift outcomes toward the middle of the distribution of health at birth. We show that program is efficient when compared to other successful neonatal health programs around the world, and find some evidence to suggest that maternal nutrition and increased links to the social safety net are important mechanisms of action.

**JEL codes:** H23, O15, I14, H43, O38, H51.

**Keywords:** Public health; neonatal health; social security; efficiency; early life investments.

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# 1 Introduction

The importance of early life health over the entire life course of an individual has been extensively recognised in the economic (and non-economic) literature (Almond, Currie and Duque, 2017; Almond and Currie, 2011b; Barker, 1990). This justifies the central role that spending on infant and maternal health during the pre-natal period plays as a pillar of the social safety net in many countries (see for example discussion in Bitler and Karoly (2015) with respects to the US), as well as considerable public spending focused on technological innovation and remedial investments to improve neonatal health outcomes (Almond et al., 2010; Bharadwaj, Løken and Neilson, 2013). Influential work points to the importance of health as a determinant of equality within countries (Deaton, 2003), and document the long-shadow of early life insults to health in the developing world (Currie and Vogl, 2012). Recognition of the social determinants of health starting *in utero* has seen a burgeoning design and implementation of large, targeted early-life social safety-net programs throughout the developing world where previously these did not exist (Monteiro de Andrade et al., 2015).

An important motivation of these early-life health policies owes to the dynamic complementary between the efficiency of investments in health early in life and investments later in life. In an influential series of papers, Heckman and Cunha (2007); Cunha and Heckman (2009); Cunha, Heckman and Schennach (2010) argue that early-life remedial investments are not only efficient, but need not face equity–efficiency trade-offs implicit in later life remedial investments.

In this paper we study the equity and efficiency implications of a large targeted public health program. We examine the program *Chile Crece Contigo* (hereafter ChCC): a national-level multidimensional health program explicitly designed to target early-life health in vulnerable groups. ChCC was implemented in Chile in 2007, offering a basket of medical and social services, information and supplies to all expectant mothers enrolled in the public health system, as well as their children once they are born. As well as a transversal series of benefits available to all users of the public health service, an additional series of means-tested benefits were provided to families classified as part of the 60% most vulnerable in the country. ChCC also has a stated aim of addressing divergent health outcomes in socially excluded groups, releasing materials in both Spanish and native indigenous languages, given the well-documented health disparities among indigenous people across the world, and in Chile (Anderson, Robson and Coauthors, 2016).<sup>1</sup>

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<sup>1</sup>Chile’s population is 4.58% indigenous, the majority of whom are Mapuche, and this group has been documented as having poorer birth, neonatal and child health outcomes (Anderson, Robson and Coauthors, 2016).

ChCC is the flagship early life health program in the Chile, and one of the largest social safety net programs of any type in the country. It has been presented as a successful case of scaling-up development interventions in the recent Lancet Early Childhood Development Series ([Richter et al., 2017](#)), and has been replicated, largely unchanged, in other contexts.<sup>2</sup> Despite the size and scope of ChCC, as well as the attention paid to its roll-out and scale-up, few rigorous or well-identified studies have been conducted on the program’s effectiveness, and none have examined the policy’s effect on birth outcomes or survival during gestation. The headline results from our paper suggest that this program *has* been successful in improving neonatal health in Chile among program participants, suggesting that the attention paid to the program is warranted. We find that the effect of program participation on average birth weight is approximately a 10 gram increase, and observe some evidence to suggest that the program may also have reduced rates of fetal death and other health outcomes at birth.

**Assessing Program Equity** Beyond mean impacts of the program, we are interested in studying the program’s distributional impacts on the population of infants in Chile. ChCC is universally available in the public health system, however has means tested components designed to close health and developmental gaps which open early in life. In particular, in this paper we focus on two equity considerations relating to ChCC’s impacts. Firstly, we examine whether the program impacts the most vulnerable (poorest) population groups. And secondly we examine at what part of the health distribution policy impacts are observed. In terms of the first consideration, we do find that ChCC has largest effects among vulnerable (targeted) families, and virtually null results among non-targeted groups. However, turning to the impact of ChCC across the distribution of health at birth, we find that the largest impacts come towards the middle of the distribution, rather than among infants with the most fragile health stocks. While we do observe universally positive impacts of ChCC participation on both birth weight and weeks of gestation across their distribution, we estimate that these impacts do not become statistically significant until 2,000 grams and 36 weeks respectively, and are largest when considering babies weighing 3,500 grams, and born at full term. Together these results suggest that (at least ex-ante) targeting poor health may be significantly more challenging than targeting vulnerable families. Nonetheless, we do recognise that health improvements even above the median outcome have considerable long-term impacts ([Royer, 2009](#))

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<sup>2</sup>For example, [Marroig et al. \(2017\)](#) describe the program Uruguay Crece Contigo, which was designed following ChCC.

**Assessing Program Efficiency** In terms of total cost, ChCC is one of the largest health or welfare programs in Chile. Recent figures suggest that ChCC spending currently accounts for almost 1% of the national budget. And in terms of coverage, this program is substantial, reaching between 75 to 80% of all newborns in the country. To put the program’s estimated effects in context, we calculate the inferred cost of producing a gram of birth weight, and the implications of this to educational attainment later in life. When combined with the cost of running Chile Crece Contigo, our estimates suggest that the government spends around \$11 per gram of birth weight—a figure that is comparable to other large successful neonatal health programs, including those in developed countries, (such as the Special Supplemental Nutrition Program for Women, Infants, and Children, or WIC, in the US). Our estimates suggest that ChCC is efficient when compared to other programs which explicitly target health at birth, and that the cost per gram of birth weight is considerably lower than programs which do not explicitly target health at birth, but which have been documented to have unintended positive impacts on these outcomes (such non-targeted programs include a poverty alleviation program in Uruguay and the Food Stamp Program in the US). What’s more, given the well-known positive effects of birth weight on later life outcomes, we estimate that as an *upper bound* cost, each \$3700 spent on ChCC results in an additional 0.05 standard deviations of educational attainment on later life test scores. These results suggest a common metric for considering the impact of early-life health programs across contexts. When linked to the literature on the long-run impacts of birth weight in Chile, these results also suggest that targeted public health and social welfare programs can have large impacts in developing and emerging economies, and that these impacts may last much longer than the period in which an individual is enrolled in the program.

**Program Impacts and Mechanisms** In this study we take advantage of administrative data from vital statistics and enrollment in public programs to conduct the first study of ChCC’s impact *in utero*, drawing identification from two (different) sources. The first, and principal method, is based on time- and geographic variation in program roll-out and intensity in a difference-in-difference style setting. As a consistency check of these results, for a subset of women and children for whom linked administrative data is available, we observe the mother’s use of public programs, and so exploit within-mother variation in exposure produced across siblings around the date of the policy’s introduction.

Given that ChCC provides a basket of health and social support services to participants, after considering the net and distributional program impacts, we briefly examine the mechanisms of pro-

gram action. We find suggestive evidence that pre-natal nutritional supplements for mothers, and increasing linkages between families and the social safety net are important drivers of improvements of health at birth. All in all, the lessons from ChCC suggest that targeted health policies can have a substantial impact on birth outcomes of their intended recipients, but point to remaining challenges in shifting very poor outcomes even with quite intensive investments.

## 2 Background

### 2.1 Chile Crece Contigo

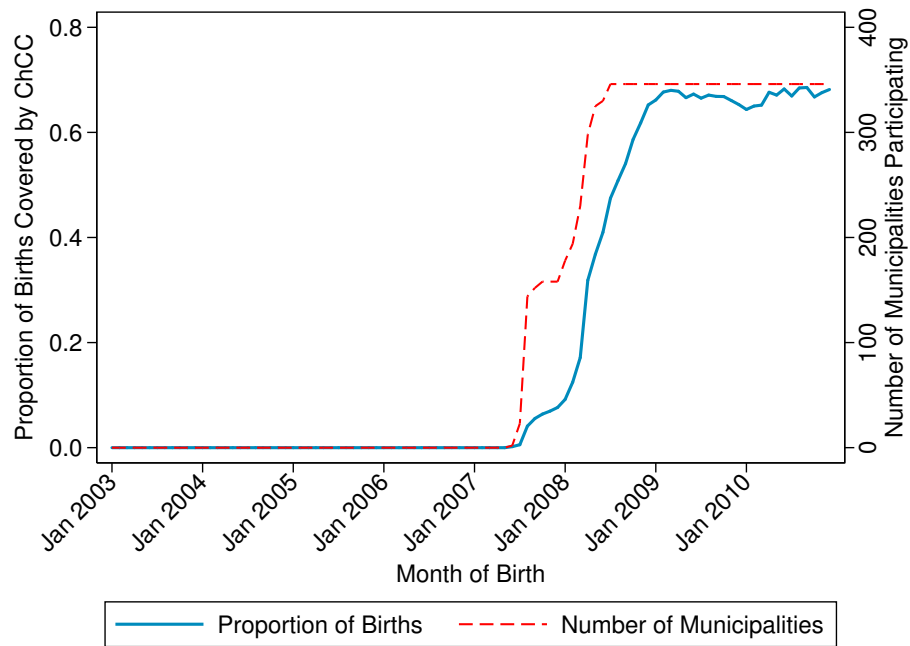
Chile Crece Contigo is a multidimensional early-life health program, targeting children from the first pre-natal check-up during gestation, and following them through the first four years of their life. From 2018 onwards, this will be extended to the first seven years of life with the implementation of a mental health component. It is the Government of Chile’s flagship social security program for children, reaching in some form approximately 75-80% of children in the country. The most comprehensive set of benefits are targeted to children from the 60% of most vulnerable families.<sup>3</sup> ChCC is jointly implemented by the Ministry of Social Development, the Ministry of Health, the Ministry of Education, and the Ministry of Labour, and is delivered by a local network of public providers in each municipality (known as the Chile Crece Contigo Municipal Network).

The program was implemented gradually throughout the country, starting in June of 2007. The yearly expansion in program size, both in terms of total municipalities covered and the proportion of all pregnancies nationwide, is displayed in Figure 1. In the first year the program covered 159 of Chile’s 346 municipalities, before being extended to all municipalities in early-2008. We provide a description of the geographic dispersion of roll-out in Appendix Figure A1. Early-implementing municipalities were not chosen at random, but rather were targeted given the availability of key infrastructure and the ability to manage the program in existing space in hospitals and health clinics (Arriet et al., 2013), explaining the earlier roll-out to less-densely populated regions in the north and south of the country. We return to discuss this in section 4 when outlining estimation strategies.

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<sup>3</sup>“Vulnerability” has historically been measured using a deterministic score assigned by government social workers, known as the *Ficha de Protección Social* (FPS), or Social Protection Score. Families with a FPS inferior to 13,484 points are classified as belonging to the 60% of most vulnerable households. Additional details of the FPS can be found in Herrera, Larrañaga and Telias (2010).

Figure 1: Usage of Gestational Component of ChCC by Month



NOTES TO FIGURE 1: Program usage by month and municipality, and proportion of all births covered nation-wide is calculated from administrative data provided by MDS. This captures the proportion of all mothers giving birth each month who participated in the pre-natal components of ChCC prior to giving birth. Additional details can be found in section 3 of this paper. Geographic distribution of municipal roll-out is provided in Appendix Figure A1.

Program participation among pregnant women also increased in line with geographic coverage. The proportion of all births in Chile receiving at least some ChCC benefits during gestation are displayed as the solid line in Figure 1. By the time ChCC was fully rolled-out, the program reached approximately 70% of all births nationwide, a figure which has remained quite steady over time. The deliver of ChCC means that there is no explicit demand-side, as all individuals enrolled in the public health service<sup>4</sup> automatically participate in ChCC from their first pre-natal check up, until the child ‘graduates out’ of the program when entering the primary schooling system. Thus, program participation is entirely determined by the supply-side, which depends on each municipality’s date of entry into ChCC. The program was institutionalised as a basic pillar of the Social Security system in 2009, with the approval of a law<sup>5</sup> guaranteeing its ongoing existence.

<sup>4</sup>The Chilean health system consists of a private and public stream and users nominally choose between public or private care. An associated monthly payment is automatically deducted from all formal salaries as a previsual payment. This payment is either made to the public health insurance (FONASA) or a private health insurer known as an ISAPRE. Any individual unable to pay contributions is covered by the public FONASA system. The private system is considerably more costly in terms of out of pocket costs. Recent administrative data suggests that 76% of the population is covered by public care. Nationally, 67% of beds are in the public system and the remaining 33% are in the private system (Departamento de Estadísticas E Información de Salud, Ministerio de Salud, 2016).

<sup>5</sup>The Law 20.379 was passed unanimously by parliament on April 2nd, 2009 to “institutionalise the subsystem of

The program consists of two main pillars. The first is the Program Supporting Bio/Psycho/Social Development (PADBP), and the second is the Program Supporting New-Borns (PARN). The PADBP pillar begins at the first pre-natal medical check-up, with the main goal of supporting fetal and child development by providing information and ongoing support in periodic check-ups, and in certain circumstances, home visits. We outline the principal components of the PADBP pillar in more detail below. The second program arm, the PARN, begins at the birth of the child. Among other things, this pillar provides a comprehensive kit of materials to all newborns born in the public health system including a crib, blankets, baby carrier, toys and didactic materials, clothing and sanitary products. In what remains of this section we provide a description of the components of the PADBP program, focusing only on the pre-natal components. We focus on this program arm in more depth given that we examine ChCC's impact on health at birth, which can only respond to prenatal investments, rather than health after birth. We provide additional discussion of the program, including both pre- and post-natal components, in [Appendix B](#).

**Pre-Natal Components of ChCC** The design of ChCC called for an increase in the amount of time spent on pre-natal controls (with midwives in public health clinics) from 20 minutes per appointment to 40 minutes per appointment. The increased time was used on newly incorporated components, such as the application of standardised tests for pre-partum depression, social support programs, and information to encourage the participation of fathers or partners in preparations for having a child. ChCC targets 7 pre-natal controls in public health centres. At the date of the first pre-natal control, families are supplied with an information kit (in Spanish or one of five indigenous languages or regional dialects), as well as a (music) CD for pre-natal stimulation. Any person meeting a set of pre-defined risk factors<sup>6</sup> also receives an additional psycho-social evaluation to determine whether they are referred for immediate additional support. The ChCC program also delivers nutritional components to expectant mothers. This principally consists of a fortified powdered milk disbursed by the kilogram at local health centres. The formula of this product was changed during the ChCC program to more accurately meet the nutritional needs of pregnant women. We return to discuss mechanisms of the program's action in more depth later in the paper.

Along with these universal benefits, families flagged as pertaining to the 60% most vulnerable

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integral protection of infancy, Chile Crece Contigo”.

<sup>6</sup>These factors are: a first pre-natal control at 20 weeks or later, the pregnant women being aged under 18 years, having 6 or fewer years of primary education, insufficient family support, “rejection of the pregnancy”, symptoms of depression, substance abuse, or suffering from intra-family violence.

of the population receive a series of preferential benefits. These benefits begin at the first pre-natal check-up with the definition of a personalised plan created between municipal health workers and families, as well as hour long home visits from social workers and paramedical technicians.<sup>7</sup> Finally, vulnerable families are referred to the ChCC Municipal Network, which includes meetings with municipal workers offering information related to education and labour market programs where relevant, information regarding other government programs and community services, and eventually access to free child care. *In situ* (anecdotal) interviews we conducted with midwives and social workers involved in the program highlighted that the implementation of ChCC resulted in a considerable increase in the quality of pre-natal care offered, and the ability to easily refer families between institutions. We provide additional information regarding the scope and design of the program in Appendix B, and a comprehensive list of program benefits is available in [Ministerio de Desarrollo Social \(2014\)](#), and summarised in Appendix Table B1.

## 2.2 Existing Evidence on The Impact of Early Life Programs on Infant Health

A well-established body of work—much in the economic literature—has documented the importance of public policies on indicators of health at birth and during gestation. These can be broadly split into two types of programs: those explicitly targeting infant health, and those with indirect impacts on infant health.

There is relatively less evidence on programs explicitly targeting infant health. Nevertheless, convincing evidence from the United States shows that publicly provided food and nutritional advice to pregnant mothers has considerable effects on birth outcomes. The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), has been shown to have appreciable impacts on health at birth (refer to [Bitler and Karoly \(2015\)](#) for a clear overview). A number of policies directly designed to targeted health at birth exist in Latin America, though often rigorous evaluations have not been implemented. These include programs such as Plan Nacer (Argentina) and Qali Warma (Peru). One notable exception is a CCT from Bolivia. [Celhay et al. \(2016\)](#) identify a significant reduction in rates of still birth following receipt of a relatively small CCT. In section 5.2 of this paper we benchmark the impacts of a range of early-life health programs such as WIC.

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<sup>7</sup>These home visits are not universally offered among the preferential group. Home visits are targeted to families with a greater number of risk factors as defined in ChCC materials handed out to local public health providers.

Evidence also exists on the impacts of non-targeted welfare policies on health at birth. Analysis from the United States suggests that the Supplementary Nutrition Assistance Program (Food Stamps) may increase birth weight by as much as 20 grams (Almond, Hoynes and Schanzenbach, 2011), and unintended impacts on child health have also been identified from the Earned Income Tax Credit (Hoynes, Miller and Simon, 2015). Another series of papers documents the impact of receipt of conditional cash transfers on infant health, even when these transfers were not directly targeting these outcomes. This includes the PROGRESA/Oportunidades program in Mexico (Barham, 2011), and the PANES program in Uruguay (Amarante et al., 2016), both of which identify considerable impacts on survival or (a reduction) in poor health at birth respectively.

### 2.3 Other Social Safety Net Programs in Chile

Chile Crece Contigo joined a number of other targeted social security programs in Chile. However, unlike other programs offered by the Ministry of Social Development, Chile Crece Contigo focuses exclusively on the early life stages, and covers a large proportion of the population of Chile.

The Chile Solidario program is focused on poverty reduction, and is targeted to the most vulnerable 10% of the population. This program includes a cash transfer (which fades out over time) and a series of home visits. This program has been demonstrated to increase the take up of employment programs, as well as participation in other public policies (Carneiro, Galasso and Ginja, 2014). Other programs targeted to families with children include the Subsidio Único Familiar, a subsidy for families with children, as well as a series of targeted scholarships and school meal programs. In each case, these policies are targeted to a more restricted group than ChCC recipients (Herrera, Larrañaga and Telias, 2010). One component of the (targeted) component of ChCC is ensuring that vulnerable families are adequately enrolled in additional social policies for which they are eligible. We examine the potential link between ChCC usage and connection to the social welfare network more generally in section 5.3 of this paper.

## 3 Data

**Birth Outcomes** Vital statistics covering all births occurring in Chile are publicly available from 1990 until 2015 from the Ministry of Health. Additionally, data on fetal deaths occurring after 22

weeks of gestation are available from 2002 onwards. These vital statistics data cover greater than 99% of all births, and coverage is stable over time. In this paper we use the full universe of births and fetal deaths occurring between 2003 and 2010 (four years pre- and post-ChCC), and match this with administrative data on ChCC usage in the gestational period provided by the Ministry of Social Development (MDS). This data allows us to calculate usage by month for each of the 346 municipalities of Chile.<sup>8</sup> The precise date of program roll-out by municipality is also provided by the MDS.

This birth data allows us to observe a range of human capital measures at birth. These are the weight of the baby, the baby's length in centimetres, and the gestational length as recorded at birth. These measures have been consistently shown to have large and long-lasting effects on health and well-being (Almond and Currie, 2011a). Although Apgar and head circumference are measured at birth in Chile, they are not currently available in administrative data. Along with measures of health immediately at birth, we are able to calculate rates of fetal death per live birth by combining fetal death registers with live birth registers. While fetal death data only records deaths occurring in hospitals, recording is consistent throughout the country (see for example Rau, Sarzosa and Urzúa (2017, p. 22) for additional details).

Administrative (micro-) data is collapsed at the municipal by month level, and matched with data on ChCC intensity by municipality and month. We match all births occurring between January of 2003 and December of 2010 (inclusive), surrounding the program's roll-out. ChCC data is available from mid-2007 (the first date of program roll-out) until 2010, and the pre-2007 period provides coverage of the pre-reform dates. This results in a sample of 1,917,085 births occurring to 1,241,514 mothers. When collapsed to the municipal level, this results in 31,842 municipal×month observations. The theoretical maximum number of observations is 346 municipalities × 8 years × 12 months (33,216 municipalities), but a number of smaller municipalities do not have births in each month.

In Table 1 we provide summary statistics of principal health indicators at birth, as well as rates of participation in Chile Crece Contigo by municipality and month. Municipal-level averages are largely in agreement with values observed in Vital Statistics data observed elsewhere (we also provide summary statistics at the level of births in Appendix Table C1). The average birth weight in municipal averages is approximately 3,350 grams, gestation is on average 38.7 weeks, and 5 and 6% of births are low birth weight or premature (respectively). In administrative data from 2003 to

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<sup>8</sup>Municipalities in Chile are the third level administrative district, and the lowest level of local governance, after provinces and regions. In Chile there are 346 municipalities, 54 provinces, and 15 regions.

2010, 25% of mothers are observed to participate in Chile Crece Contigo, though this value is considerably lower than actual participation rates once the program was implemented, as the program only began running from June of 2007 onwards. Rates of usage of the program (only the gestational component) by time are displayed in Figure 1. In Appendix Figure A2 we present the proportion of ChCC usage by municipalities once the program was implemented. We observe considerable variation in program intensity by municipality, reflecting different rates of usage of the public (rather than private) health system by municipality within the country. In examining the number of births occurring in each municipality in Table 1 (“Number of Births”) we observe a large range in municipal size. Depending on the municipality, the number of births per month ranges from as low as 1 birth (conditional on there not being 0 births) to as high as 787 births. As we discuss below, regression estimates are consistently weighted by the number of births per cell.

Table 1: Summary Statistics: Birth and Chile Crece Contigo Data

|                                  | N     | Mean    | Std. Dev. | Min     | Max     |
|----------------------------------|-------|---------|-----------|---------|---------|
| Proportion Enrolled in ChCC      | 31842 | 0.24    | 0.36      | 0.00    | 1.00    |
| Birth Weight (grams)             | 31805 | 3346.28 | 174.44    | 686.00  | 4868.00 |
| Low Birth Weight < 2500 grams    | 31805 | 0.05    | 0.07      | 0.00    | 1.00    |
| Gestation (weeks)                | 31806 | 38.66   | 0.60      | 24.00   | 42.00   |
| Premature < 37 weeks             | 31806 | 0.06    | 0.08      | 0.00    | 1.00    |
| Length (cm)                      | 31806 | 49.47   | 0.88      | 30.00   | 56.00   |
| Number of Births                 | 31842 | 60.21   | 93.69     | 1.00    | 787.00  |
| Rate of Fetal Deaths/1000 Births | 31842 | 9.56    | 38.45     | 0.00    | 2000.00 |
| Year of Birth                    | 31859 | 2006.51 | 2.29      | 2003.00 | 2010.00 |
| Mother’s Education               | 31808 | 10.74   | 1.50      | 0.00    | 19.00   |
| Mother’s Age                     | 31833 | 26.68   | 2.35      | 14.00   | 45.00   |
| Proportion Teen Births           | 31833 | 0.18    | 0.13      | 0.00    | 1.00    |
| Number of Children               | 31842 | 2.02    | 0.41      | 0.67    | 9.00    |

NOTES TO TABLE 1: Summary Statistics are displayed for municipality by month averages for each month from January 2003 to December 2010. Averages are displayed for each municipality in which there is at least one birth in the given month. The average number of births by comuna and month is displayed above. There are 346 municipalities in Chile, and hence a maximum number of observations of  $346 \text{ municipalities} \times 8 \text{ years} \times 12 \text{ months}$ , or 33,216 municipality  $\times$  month observations. The difference between this maximum and the observed number of observations are cases where no births occurred. Uncollapsed micro-data on births consists of 1,917,086 observations between 2003 and 2010. Additional details on this birth data is provided in Appendix D. Proportion enrolled in ChCC refers to the average proportion of births in each municipality which were covered by ChCC *in utero* during the entire period of 2003-2010, and so is always zero prior to the implementation of ChCC in 2007/2008.

For a sub-set of births, we are able to match all siblings with mothers, as well as with the mother’s participation in social programs. For these mothers we thus observe her full fertility history, as well as whether she participated in Chile Crece Contigo, and her social vulnerability score, defining the degree of usage of ChCC for which she will be eligible (ie for means tested and general items, or only for general items). Approximately 40% of births are correctly matched to their mother. We thus use this matched micro-data sample as an auxiliary test of the main result. While this does not include the full universe of births used in the municipal level analysis, the resulting data set is a unique source of information on births in Chile matched to the mother’s take-up of social safety net programs. In appendix C we discuss the match rates, as well as the characteristics of the matched and unmatched sample. The 60% of unmatched children were overwhelmingly matched with their father rather than their mother in the social registry, and so are excluded from micro-level analyses given the lack of information on the *mother’s* usage of public programs, including, fundamentally, ChCC.

**Chile Crece Contigo Data** Administrative data on ChCC usage as well as the exact date of roll-out is provided by the Ministry of Social Development of Chile. As discussed in section 2.1, program roll-out occurred gradually, based on infrastructure availability, and is documented geographically in Appendix Figure A1. Administrative figures for intensity of program use are also provided by the Ministry of Social Development which record the proportion of births in each month and municipality which used at least some ChCC components at some point of their gestation. The trend in this measure over time was plotted in Figure 1 of this paper. We also collect month-by-month figures describing the usage of a number of key program components from the Department of Health Information (DEIS) of the Ministry of Health. We return to discuss this data when examining the program’s mechanism of impact.

## 4 Methodology

**Estimating the Impact of ChCC** We leverage the time-varying roll-out and intensity of ChCC by municipality to estimate the following flexible difference-in-differences (DD) model:

$$InfantHealth_{ct} = \alpha_0 + \alpha_1 ChCC_{ct} + \mathbf{W}_{ct}\boldsymbol{\alpha}_w + \mu_t + \lambda_c + \eta_{ct} \quad (1)$$

where *InfantHealth* measures average birth outcomes for each municipality  $c$  in period  $t$ . In principal specifications, the unit of time is month by year. The variable  $ChCC_{ct}$  is a treatment measure indicating the proportion of all births in each municipality and month which received coverage from the *Chile Crece Contigo* program during gestation. This measure is always 0 prior to the program implementation, and increases to reach approximately 75% of the population following the program’s implementation. Given that the program was implemented in different municipalities at different times, we include full municipality and time (month $\times$ year) fixed effects as  $\lambda_c$  and  $\mu_t$  respectively. The measure of  $ChCC$  depends on program roll-out as well as the proportion of a municipality which is enrolled in the public health system. This share is largely fixed by municipality once a municipality reaches its steady state of program use, and is higher in municipalities with a larger proportion of low income households.<sup>9</sup> While we could use a simple binary measure for  $ChCC$  availability in specification 1, this is practically challenging, given that there is considerable variation in actual usage of ChCC for different time periods and municipalities, and replacing the continuous intensity variable with a binary availability variable results in much less identifying variation. Nonetheless, we present this specification as an Appendix model. Similarly, we present an appendix specification where we instrument  $ChCC_{ct}$  with lagged usage in the same municipality, to examine the possibility that our continuous ChCC measure captures program demand, rather than program availability.

If implementation of the policy were completely random,  $\alpha_1$  will give the unbiased effect of ChCC participation on infant health measures. However, as we may be concerned that early adopting municipalities with better infrastructure were following differential trends over time, we include a series of time-varying controls for health infrastructure and municipal development  $W_{ct}$ , and in supplementary regressions also examine the robustness of results to regional and municipal time trends, and separate regional and municipal fixed effects for each year. As is typical, we cluster standard errors by municipality (346 municipalities) to account for the well-known time-dependence in unobserved stochastic errors by geographic area (Bertrand, Duflo and Mullainathan, 2004; Cameron and Miller, 2015). We discuss a number of additional placebo checks below.

Our principal outcome measures of *InfantHealth* are based on the available measurements

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<sup>9</sup>All women enrolled in the public health system who become pregnant automatically participate in ChCC. In Appendix Figure A3 we document the proportion of the country enrolled in the public health system, and observe a declining trend prior to ChCC’s implementation. In Appendix Table A1, we test formally whether ChCC actually convinced people to participate in the public health system, which would complicate our empirical strategy, however find no evidence that this is the case. In Appendix Figure A4 we present scatter plots of the level of municipal enrollment, and various municipal characteristics, where, unsurprisingly, higher ChCC usage is associated with greater poverty shares and vulnerability.

recorded in vital statistics data, and consist of birth weight in grams, low birth weight ( $< 2,500$  grams), birth length in centimetres, gestational time in weeks, prematurity ( $< 37$  weeks gestation), and the frequency of fetal deaths. Given that we propose to use various outcome measures and a single independent treatment variable (*ChCC*), we correct for multiple hypothesis testing in a number of ways. Firstly, in order to ensure adequate size in hypothesis test, we apply Romano and Wolf (2005)’s stepdown hypothesis testing algorithm which fixes the Family Wise Error Rate at a set level  $\alpha$ . This hypothesis correction technique is considerably more powerful than older FWER techniques such as Bonferroni or Holm, and is increasingly used in the economic literature (see for example Gertler et al. (2014)). This is also a more demanding correction than corrections which fix the False Discovery Rate of findings. Secondly, we construct a single index based on the full set of outcome variables which gives more weight to variables which provide the most independent variation. To construct this index we follow the procedure described in Anderson (2008), allowing us to examine the estimated effect of ChCC on a single outcome variable, where variables which provide more independent information are given larger weights in the index.

**Alternative Identification Strategies** While our main identification strategy takes advantage of the time-varying roll-out of ChCC by municipality, we also estimate a child-level regression controlling for mother fixed effects leveraging within mother variation in policy exposure. For each mother in matched administrative data we observe all births occurring between 2003 and 2010, both before and after policy implementation. The inclusion of mother fixed effects thus allows us to capture all time-invariant unobservables of mothers correlated with program participation. We also include a number of time-varying controls, including maternal age and birth order fixed effects.

We estimate mother fixed effect models only as a robustness check rather than our main specification given that the match between children and mothers was not universal (while municipal-level regressions are based on complete vital statistics data). As discussed in section 3, approximately 50% of births were correctly merged with data on their mother’s use of public programs, while the remaining births were merged with the father’s social program participation. We provide additional details regarding the precise mother FE specification to be estimated, as well as match rates and characteristics of matched and unmatched children in Appendix C.

**Placebo Tests** We observe monthly usage rates of ChCC during gestation for each municipality following the reform’s implementation. This measure of usage by municipality and time is our

independent variable of interest in specification 1. In order to ensure that our estimates for  $\alpha_1$  are not simply capturing systematic differences between municipalities with varying implementation time and intensity of ChCC, we propose to conduct a series of placebo tests using lagged measures of the independent variable of interest.<sup>10</sup> Specifically, we estimate the following model:

$$InfantHealth_{ct} = \gamma_0 + \gamma_1^k ChCC_{c,t-k} + \mathbf{W}_{ct}\boldsymbol{\alpha}_w + \mu_t + \lambda_c + \eta_{ct} \quad \forall k \in 1, \dots, 40. \quad (2)$$

Here, rather than regressing birth outcomes on ChCC usage among births in the same month, we regress outcomes at time  $t$  on ChCC usage in month  $t - k$ . Provided that improvements in birth outcomes are truly flowing from the program, rather than systematic differences between municipalities, we should see that lags of  $ChCC_{ct}$  do not impact birth outcomes in future periods conditional upon municipal and time fixed effects.

**Distributional Effects of the Policy** Along with regressions examining birth weight, and gestational length, we are able to observe the effects of the policy over the entire range of these health distributions, to examine precisely where any average effects are observed. In our main specifications we examine the impact of ChCC on LBW and prematurity, but these cut-offs defined by medical standards are arbitrary. We can similarly consider outcomes across the entire support of the health measures at birth. We follow [Rossin-Slater \(2013\)](#), who undertakes a similar analysis of birth weight and the WIC program, in defining a range of binary variables which take the value of 1 if birth weight exceeds a certain weight, and zero otherwise, for points from 1000 to 5000 grams. Similarly, we create binary measures for gestational length greater than  $k$  weeks, where  $k$  is set at 30-41 weeks. This allows us to determine if mean impacts vary throughout the distribution of health at birth, where we simply replicate equation 1, however now with the range of distributional variables, in place of *InfantHealth*. Once again in these specifications we report results both uncorrected for multiple hypothesis testing, and results accounting for the fact that with multiple outcomes, we are likely to over-reject the null hypothesis of a zero-reform impact.

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<sup>10</sup>Frequently, identifying assumptions in DD-style models are tested by event study analysis, where treatment status is interacted with a full set of lags and leads. In the setting of this paper, where program usage is a continuous rather than binary measure, an event study is not suitable given the lack of binary treatment, and the fact that all municipalities are eventually treated. We thus proceed with the lagged placebo tests as described in this section.

## 5 Results

### 5.1 Program Impacts

#### 5.1.1 Headline Effects

Baseline estimates based on municipality and time-varying exposure to the Chile Crece Contigo program are presented in table 2. Estimates in this table are all produced by an archetypical DD model including ChCC coverage as the independent variable of interest, and municipality and month $\times$ year fixed effects. Standard errors are clustered by municipality.

Results from Table 2 suggest large and significant effects, particularly for birth weight and gestational length. As the independent variable is measured as the proportion of ChCC coverage in a municipality, an increase in 1 unit of this variable is equivalent to moving from 0 to universal ChCC coverage, or the mean impact of ChCC if the full population were treated. The mean impact of Chile Crece Contigo is estimated as a 10 gram increase in birth weight. When examining the proportion of low birth weight babies, results suggest that ChCC brought about a reduction in these births by 0.2 percentage points, however this is not distinguishable from 0 at the 10 percent level. When comparing the (statistically insignificant) point estimate to the absolute value of low birth weight births, this is approximately a 3.7% reduction. We find no impact of ChCC on size at birth, but do observe a small increase in gestational length of 0.24 weeks. No statistically significant effect is observed when considering the proportion of premature births, though once again impacts are weakly negative (ie a reduction in premature births). Finally, in turning to fetal deaths, we observe a significant reduction, of 1.6 fetal deaths per 1,000 live births following the program's implementation and expansion.

We examine alternative specifications and controls in Table 3. Here rather than simply estimating a baseline DD model with time and geographic fixed effects, we add additional time varying controls, region and municipal specific linear time trends, and region and municipality by year fixed effects. Even in the most demanding specification which includes both time-varying controls as well as separate fixed effect for each municipality in each year (346 $\times$ 8 fixed effects), estimates largely agree with those in the baseline DD model. The estimated effect of ChCC on birth weight falls slightly (from 10.092 to 9.78 grams), while the remaining effects are quite stable, with the exception of the estimated effect of ChCC on the rate of fetal deaths which no longer remain significant with

Table 2: Difference-in-Difference Estimates using Municipal Variation in Coverage

|                             | (1)<br>Weight          | (2)<br>LBW          | (3)<br>Size          | (4)<br>Gestation     | (5)<br>Premature    | (6)<br>Fetal Death  |
|-----------------------------|------------------------|---------------------|----------------------|----------------------|---------------------|---------------------|
| Proportion of ChCC coverage | 10.092***<br>[3.369]   | -0.002<br>[0.001]   | 0.004<br>[0.017]     | 0.024**<br>[0.012]   | -0.002<br>[0.002]   | -1.530**<br>[0.623] |
| Constant                    | 3351.522***<br>[3.868] | 0.054***<br>[0.002] | 49.479***<br>[0.019] | 38.705***<br>[0.013] | 0.065***<br>[0.002] | 4.892***<br>[0.716] |
| Observations                | 31805                  | 31805               | 31806                | 31806                | 31806               | 31842               |
| R-Squared                   | 0.261                  | 0.051               | 0.451                | 0.278                | 0.095               | 0.056               |

NOTES TO TABLE 2: Estimation sample consists of all municipal-level averages for each month between 2003 and 2010 for all women. Low birth weight refers to the proportion of births under 2,500 grams, and premature refers to the proportion of births occurring before 37 weeks of gestation. Birth weight is measured in grams, Size is measured in centimetres, and Gestation is measured in weeks. Fetal deaths are measured as the number of fetal deaths per 1,000 live births. Each cell is weighted using the number of births in the municipality and month, and all specifications include municipality and time (Year  $\times$  Month) fixed effects. \*  $p < 0.10$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

year by municipality fixed effects. In some models, significant positive impacts are observed on birth size and significant reductions are observed in the proportion of low birth weight babies, but these are not consistently observed. If we estimate using trimester  $\times$  municipality averages rather than month by municipality outcomes, estimates remain quite stable (Appendix Table A2-A3). While the precision of estimates falls slightly, rendering a number of coefficients no longer statistically significant at typical levels, the effect sizes agree very closely with those in Table 2. Finally, we correct for multiple hypothesis testing in Appendix Table A4. Panel A presents uncorrected and corrected  $p$ -values where we account for the fact that we are prone to over-reject the null when testing the impact of ChCC on multiple outcome variables. Original  $p$ -values come from estimates presented in Table 2, while corrected values follow Romano and Wolf (2005, 2016). This is a demanding correction, ensuring that no null hypotheses will be incorrectly rejected at a given size. In this case, we still observe a statistically significant effect on birth weight. When considering an index capturing infant health (where a positive value implies greater health), we observe that regression the single infant health index on rates of participation in ChCC results in statistically significant impacts.

We examine the plausibility of identifying assumptions using a series of placebo tests. These placebo tests use the ChCC participation rates for each municipality, however assigning the placebo reform treatment to a period entirely *before* the corresponding births had occurred. Thus, if there is no general prevailing difference in trends between municipalities with different roll-out timing or intensity of ChCC usage, we should observe that all placebo tests based on pre-reform dates lead to insignificant estimates of the effect of the placebo treatment on birth outcomes.

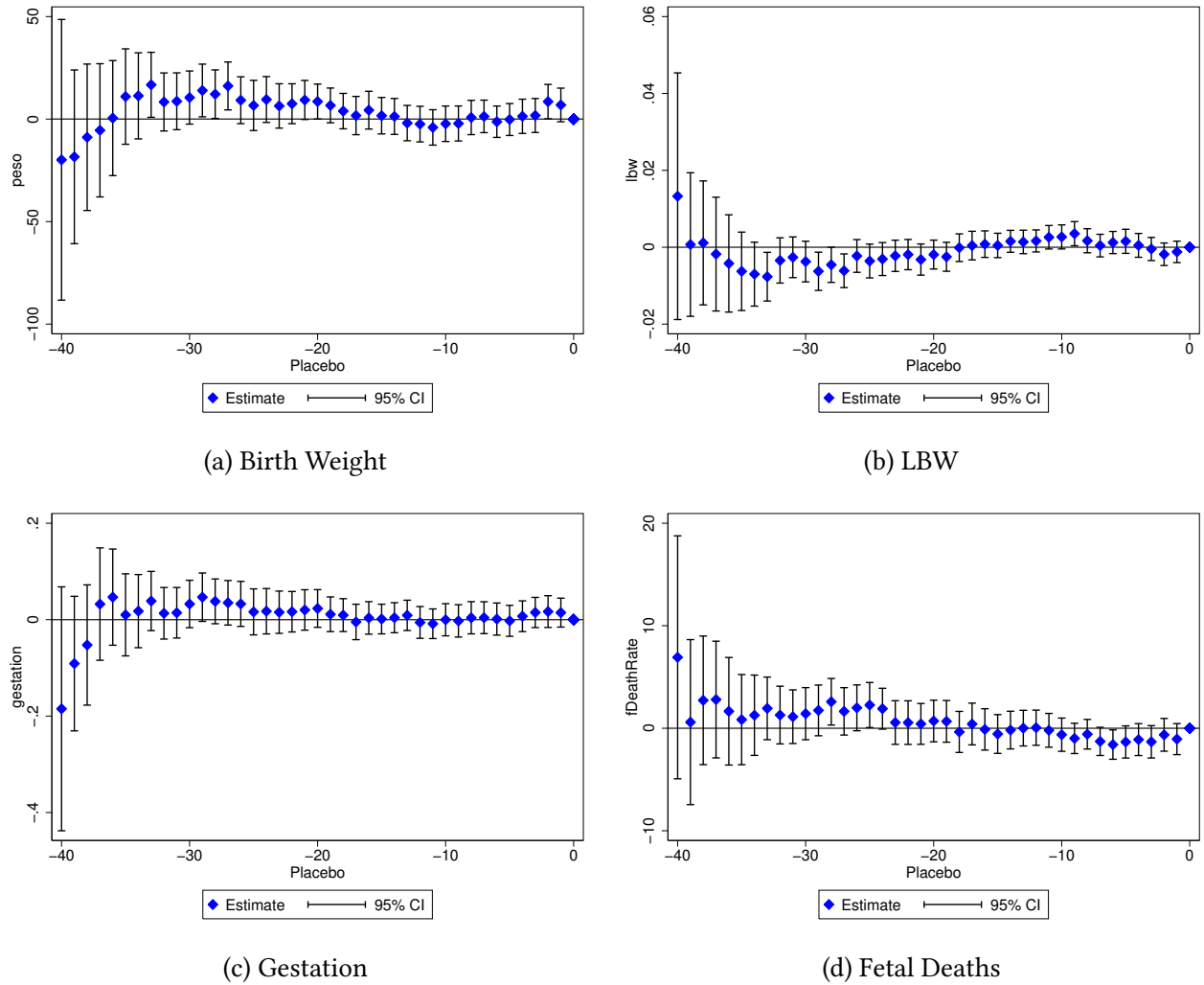
Table 3: Alternative Specifications: Diff-in-diff Estimates of Program Impacts

|                                  | (1)                  | (2)                 | (3)                 | (4)                 | (5)                 | (6)                  | (7)                | (8)                |
|----------------------------------|----------------------|---------------------|---------------------|---------------------|---------------------|----------------------|--------------------|--------------------|
| <b>Panel A: Birth Weight</b>     |                      |                     |                     |                     |                     |                      |                    |                    |
| Proportion of ChCC coverage      | 10.092***<br>[3.369] | 8.407**<br>[3.447]  | 8.284**<br>[3.450]  | 8.712**<br>[3.638]  | 7.761**<br>[3.693]  | 4.315<br>[3.727]     | 9.613*<br>[5.044]  | 9.782*<br>[5.051]  |
| <b>Panel B: LBW</b>              |                      |                     |                     |                     |                     |                      |                    |                    |
| Proportion of ChCC coverage      | -0.002<br>[0.001]    | -0.002<br>[0.001]   | -0.002<br>[0.001]   | -0.003**<br>[0.002] | -0.003**<br>[0.002] | -0.002<br>[0.002]    | -0.003<br>[0.002]  | -0.003<br>[0.002]  |
| <b>Panel C: Size</b>             |                      |                     |                     |                     |                     |                      |                    |                    |
| Proportion of ChCC coverage      | 0.004<br>[0.017]     | 0.017<br>[0.017]    | 0.007<br>[0.017]    | 0.030*<br>[0.018]   | 0.034*<br>[0.018]   | 0.004<br>[0.018]     | 0.048**<br>[0.024] | 0.049**<br>[0.024] |
| <b>Panel D: Gestation</b>        |                      |                     |                     |                     |                     |                      |                    |                    |
| Proportion of ChCC coverage      | 0.024**<br>[0.012]   | 0.021*<br>[0.012]   | 0.013<br>[0.012]    | 0.018<br>[0.013]    | 0.018<br>[0.013]    | 0.008<br>[0.013]     | 0.024<br>[0.017]   | 0.024<br>[0.017]   |
| <b>Panel E: Premature</b>        |                      |                     |                     |                     |                     |                      |                    |                    |
| Proportion of ChCC coverage      | -0.002<br>[0.002]    | -0.002<br>[0.002]   | -0.001<br>[0.002]   | -0.001<br>[0.002]   | -0.001<br>[0.002]   | -0.000<br>[0.002]    | -0.000<br>[0.002]  | -0.000<br>[0.002]  |
| <b>Panel F: Infant Mortality</b> |                      |                     |                     |                     |                     |                      |                    |                    |
| Proportion of ChCC coverage      | -1.530**<br>[0.623]  | -1.581**<br>[0.641] | -1.551**<br>[0.639] | -0.607<br>[0.674]   | -0.765<br>[0.688]   | -2.212***<br>[0.693] | -0.202<br>[0.929]  | -0.203<br>[0.934]  |
| Municipal and Year FEs           | Y                    | Y                   | Y                   | Y                   | Y                   | Y                    | Y                  | Y                  |
| Time-Varying Controls            |                      | Y                   |                     |                     | Y                   |                      |                    | Y                  |
| Region Time Trends               |                      |                     | Y                   |                     |                     |                      |                    |                    |
| Region $\times$ Year FEs         |                      |                     |                     | Y                   | Y                   |                      |                    |                    |
| Municipal Time Trends            |                      |                     |                     |                     |                     | Y                    |                    |                    |
| Municipal $\times$ Year FEs      |                      |                     |                     |                     |                     |                      | Y                  | Y                  |

NOTES TO TABLE 3: Each specification is estimated by differences-in-differences using municipal-level averages by month, and weights for the number of observations in each cell. Column 1 replicates results from Table 2, and then columns 2-8 include additional controls, linear trends, or fixed effects. Regions in Chile are the second-level administrative district, of which there are 15. Municipalities are within districts (analogous to states and counties in other countries), and there are 346 municipalities in Chile. The most demanding specification allows for a separate fixed effect for each municipality in each year under study, given that there are twelve observations for each municipality in each year. Time-varying controls are collected from the Government of Chile's National System for Municipal Information, and are available for each municipality in each year. These controls consist of total transfers for education and health, the proportion of each municipality enrolled in the public health system (FONASA), the proportion enrolled in school, a pre-determined poverty index calculated by the government, and the coverage of drinking water. Standard errors are clustered by Municipality. Refer to Table 2 for additional notes.

These results are displayed in Figure 2. Each point estimate and confidence interval corresponds to a placebo reform lagged by the number of periods indicated on the x-axis. In general, the large majority of placebo tests indicate results which are not statistically distinguishable from zero. At times certain lags result in estimates which are significant at 95%, however these generally occur with large time lags, when more observations are lost given lags in the placebo variable, and hence estimates are somewhat noisy. Across multiple placebo tests we reject 9 of 120 hypotheses at the 95% level, which is a rate of 0.075, reasonably close to the 0.05 expected rate of rejection.

Figure 2: Placebo Tests



NOTES TO FIGURE 2: Each point estimate and resulting confidence interval display the impact of a placebo test where the share of Chile Crece Contigo enrollees is lagged  $j \in \{1, \dots, 40\}$  months, where  $j$  is displayed on the horizontal axis. Each placebo test is estimated following the principal specification displayed in Table 2. Additional notes relating to each model can be found in Table 2.

As discussed in section 4, our measure of treatment intensity is usage of ChCC, which increases precipitously following the date of reform implementation. If we estimate using a binary measure of ChCC program availability, results are of the same direction, though frequently much less precisely implemented (Appendix Table A5). For example, in the case of birth weight, we observe that for those individuals born when the program was available in utero (but for less than the full 9 months) that ChCC availability increases birth weight by 1.4 grams, while for those individuals for whom ChCC was available during the entire pre-natal period, birth weight is 3.3 grams higher. These lower impacts are perhaps not surprising given that there is massive variation in usage of ChCC even when the program is available. This is observed in a temporal sense in Figure 1, where usage expands considerably during 2007 and 2008, and also in a spacial sense in Appendix Figure A2. While the rate of use of ChCC when the program was available was 56.5% (when weighted by municipal population, or 60.6% without weights), certain municipalities have rates of usage lower than 20%, while others have rates of usage of nearly 100%. Despite the lower precision of results when simply using a binary available/non-available distinction, if these results are scaled up based on usage rates of ChCC (following Almond, Hoynes and Schanzenbach (2011)), results are closer in magnitude to those reported in our main specification. For example, inflating the “ChCC Availability” estimate in Table A5 to account for the fact that usage rates of ChCC where ChCC was available for less than the full pregnancy were 35.7%, results in an inflated estimate of approximately 4 grams, while inflating the full availability estimate of 3.25 grams with usage rates of 56.6%, results in an estimate of approximately 6 grams.

To address concerns that our (continuous) estimates displayed in Table 2 may reflect the decision to use ChCC rather than participation itself, in Appendix Table A6 we present IV estimates, where participation in each municipality is instrumented by lagged participation rates. The logic behind these estimates is that while actual participation may reflect the decisions of the women who gave birth in a particular month, the participation rates of mothers in prior periods in the same municipality will be highly correlated with those of mothers in future periods, however will not reflect that actual characteristics of the precise group of mothers giving birth. In this case we observe that the first stage results presented in Appendix Table A6 are strong, suggesting reasonably stable rates of usage of public care within municipalities over time, and second-stage IV estimates agree in sign and magnitude with those reported in Table 2, however with slightly inflated standard errors.

An alternative consistency check comes from estimates based on mother fixed effects for the matched sample, which are presented in Appendix Table C2. We present fixed effects estimates in

each case also controlling for mother's age and birth parity fixed effects which may vary around the reform date. Identification is driven by changes in birth outcomes between siblings born before and after their mothers began participating in Chile Crece Contigo, compared with similar timed siblings occurring to never-participating mothers. Once again, we observe that the effect of Chile Crece Contigo participation is large and statistically significant. In this case we *do* observe an impact on the size of the baby at birth, and the impacts on all other variables remain largely consistent with those estimated from municipal-level DD models. One exception is an unexpected positive coefficient on the LBW indicator, however when controlling for municipal and time fixed effects in Appendix Table C3 this impact is not distinguishable from zero. The effect sizes observed for birth weight and gestational weeks are considerable. We estimate an effect of 19 grams in mother FE models, equivalent to approximately 0.5% of the mean birth weight in Chile over the time period examined, and similar to the reported effects of large successful programs world wide. For example, recent evidence suggests that participation in the Food Stamp Program in the United States, one of the largest and most costly social security programs, increases birth weight by approximately 20 grams (Almond, Hoynes and Schanzenbach, 2011). Similarly, participation in the supplementary nutrition program for Women, Infants and Children is estimated to increase birth weight by around 17-30 grams (Hoynes, Page and Stevens, 2011; Rossin-Slater, 2013). Full discussion related to the mother FE models and results, as well as data match rates is provided in Appendix C.

### 5.1.2 Program Targeting and Equity

While ChCC is universally accessible for any mother or family participating in the public health system, the degree of benefits of the program is means tested, and targeted more heavily to families identified as the most vulnerable. In Table 4 we estimate the impact of ChCC usage in each of three groups on average birth outcomes. In Panel A we examine the impact ChCC use among the 60% most vulnerable (the targeted group), in panel B we focus on the 40% most vulnerable (in early years, the targeted group was only the 40% most vulnerable), and in panel C we examine the impact of ChCC usage in the non-targeted group (those with a Social Protection Score in the top 40%, or those without a Social Protection Score).<sup>11</sup>

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<sup>11</sup>In practice, the means tested benefits also include a considerable discretionary component, beyond the simple cut-off score. For example, the home visit component of the program while only available for the 60% most vulnerable, was not available to the full vulnerable group given program demands, but rather was discretionarily offered by each local health centre based on perceived need and vulnerability (Ministerio de Desarrollo Social, 2014).

Table 4: Impacts by Vulnerability Quintile

|                                     | (1)<br>Weight      | (2)<br>LBW        | (3)<br>Size          | (4)<br>Gestation  | (5)<br>Premature  |
|-------------------------------------|--------------------|-------------------|----------------------|-------------------|-------------------|
| <b>Panel A: 60% Most Vulnerable</b> |                    |                   |                      |                   |                   |
| Proportion ChCC Coverage            | 9.090**<br>[4.265] | -0.002<br>[0.001] | 0.003<br>[0.028]     | 0.021<br>[0.015]  | -0.002<br>[0.002] |
| Observations                        | 31805              | 31805             | 31806                | 31806             | 31806             |
| R-Squared                           | 0.261              | 0.051             | 0.451                | 0.278             | 0.095             |
| <b>Panel B: 40% Most Vulnerable</b> |                    |                   |                      |                   |                   |
| Proportion ChCC Coverage            | 8.579**<br>[4.203] | -0.002<br>[0.001] | 0.006<br>[0.027]     | 0.019<br>[0.014]  | -0.002<br>[0.002] |
| Observations                        | 31805              | 31805             | 31806                | 31806             | 31806             |
| R-Squared                           | 0.261              | 0.051             | 0.451                | 0.278             | 0.095             |
| <b>Panel C: Non-Targeted Group</b>  |                    |                   |                      |                   |                   |
| Proportion ChCC Coverage            | -3.150<br>[2.350]  | 0.000<br>[0.001]  | -0.038***<br>[0.014] | -0.003<br>[0.009] | -0.000<br>[0.001] |
| Observations                        | 31805              | 31805             | 31806                | 31806             | 31806             |
| R-Squared                           | 0.261              | 0.051             | 0.451                | 0.278             | 0.095             |

NOTES TO TABLE 4: Identical specifications are estimated as in Table 2, however now each model is estimated using *only* observations which meet the criteria defined in panel headings. Classification of the 60% and 40% most vulnerable is based on the Government of Chile's official scoring based on the *Ficha de Protección Social* (FPS, or Social Protection Score in English), which is used to classify the degree of benefits received by families in ChCC. The official cut-off for the 40% most vulnerable is a score of 11,734 points or lower on the social protection score, and for the 60% most vulnerable is a score of 13,484 points or lower. Any mother with a score above 13,484 (or who has not applied for a score) is not in the targeted group. Additional discussion of the FPS is available in [Herrera, Larrañaga and Telias \(2010\)](#).

We observe that the impacts of the program are largest among those in the targeted group, and smallest among those in the non-targeted group. In general, these estimates become somewhat less precise, however, a clear gradient in estimated impacts is observed in moving from more to less vulnerable groups, particularly when considering the impact on average birth weight. The impact of ChCC for the most vulnerable 60% is estimated at 9.1 grams, while it is estimated as -3.1 grams among the non-targeted group.<sup>12</sup> Similar gradients in point estimates are observed in the probability

<sup>12</sup>These estimates *are* statistically distinguishable from each other at the 10% level. However it is worth noting that the estimated value of 9.09 among the 60% most vulnerable is not distinguishable from the estimated average value of 10.09 reported in Table 2.

of being low birth weight, size at birth, gestational length, and the likelihood of being premature, however none of these estimates are statistically distinguishable from zero.

These results are in line with ChCC’s stated aim of closing early-life health gaps. Equity-promoting early-life health policies are particularly important in the context of Latin America. Many Latin American countries are characterised by irregular, rather than universally poor, infant health outcomes (Belizán et al., 2007). Indicators are particularly sub-standard among socially isolated groups, including low-income households, rural communities, and indigenous people. These early-life health differentials are only magnified over the life course of individuals, partially explaining the emergence of significant gaps in adulthood in education, salary, and morbidity and mortality. In the Chilean context this has been documented, where divergence of outcomes at a very young age (birth weight) have important effects on academic achievement up to 18 years later (Bharadwaj, Eberhard and Neilson, forthcoming). We return to this point in the section which follows.

### 5.1.3 Distributional Effects

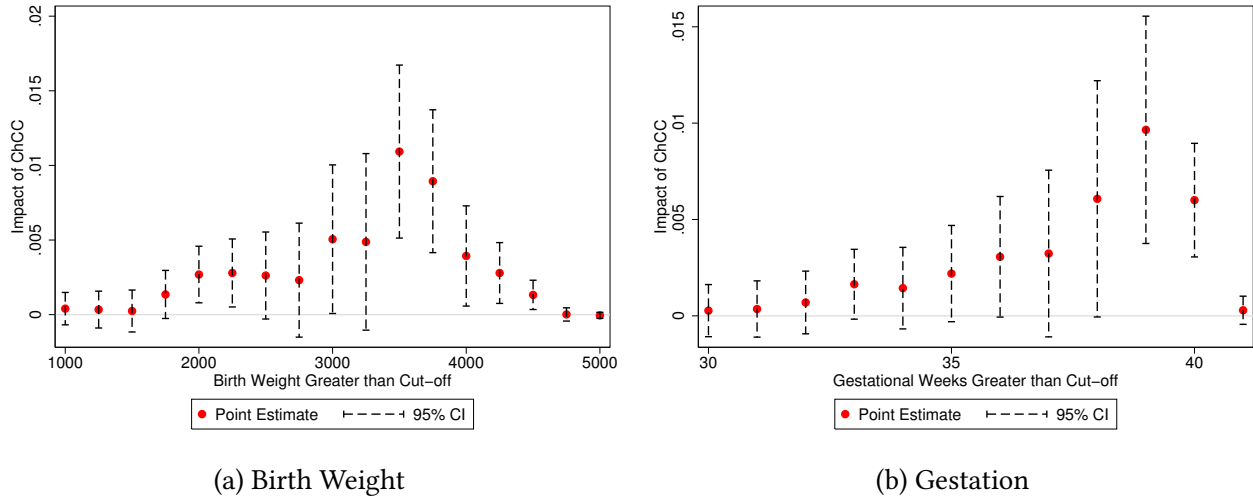
Mean impacts suggest that Chile Crece Contigo participation increases average birth weight by approximately 10 grams and increases average gestational length by 0.024 weeks. However, in Table 2, we found relatively little evidence to suggest that these impacts reduce the probability of being born with low birth weight ( $< 2,500$  grams) or premature ( $< 37$  weeks). To examine further *where* the mean impacts of the policy are produced, in Figure 3, we present estimates of the impact of ChCC at various points of the health distribution. In Figure 3a we examine ChCC’s impact on the likelihood that birth weight exceeds  $x$  grams, where  $x \in \{1000, 1500, \dots, 4750, 5000\}$ , and in Figure 3b we examine the likelihood that gestation exceeds  $x$  weeks, where  $x \in \{30, 31, \dots, 40, 41\}$ . In these figures we present a series of point estimates and confidence intervals which correspond to the estimates on  $ChCC_{ct}$  from equation 1 where the outcome variable is infant health exceeding the indicated cut-off.

In Figure 3a we observe that, although point estimates of the policy on birth weight are universally positive, estimated impacts are larger, and statistically less likely to be type I errors, at higher points in the birth weight distribution.<sup>13</sup> Estimates first become statistically significant at

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<sup>13</sup>Here once again we are testing many dependent variables on a single treatment variable, and so may expect that we will be prone to over-reject null hypotheses of a zero effect. When we correct each graph for multiple hypothesis testing using the Romano Wolf step-down procedure, inferential results are qualitatively similar (refer to Appendix Table A7).

Figure 3: Policy Impact Across the Health Distribution



NOTES TO FIGURE 3: Point estimates and 95% confidence intervals are presented of the impact of Chile Crece Contigo on birth weight and gestational length at different points of the distribution. Each specification follows equation 1, however instead of using mean birth weight or gestational length in each municipality, uses the proportion of births exceeding determined cut-points of the distribution (displayed on the horizontal axis) as the dependent variable of interest. Panel 3a displays the estimates when considering birth weight, while panel 3b presents estimate for gestational length. For additional details, refer to notes to Table 2.

2000 grams, suggesting that ChCC has a small impact on increasing weight of quite low birth weight babies, before once again becoming statistically significant from about 3000-3500 grams, which is quite close to the mean of the distribution (3346 grams). The impact peaks at 3500 grams, with the point estimate suggesting that participation in ChCC increases the likelihood of exceeding this barrier by as much as 1 percentage point. Quite a similar pattern is observed when considering the impact of gestational length in Figure 3b. While consistently positive impacts are observed across the gestational length distribution, these become largest at approximately the mean of the distribution (39 weeks) and remain considerable even at 40 weeks. It is worth noting that Chile Crece Contigo has targeted reductions in the rates of C-sections, which are extremely high in Chile, at approximately 50%, or 43% in the public health system, potentially partially explaining the increase in gestational length of full-term births.

Taken together with the findings from section 5.1.1, these impacts point to the difficulty in shift-

While this may seem surprising given that we test many outcome variables, this is a result of the more efficient Romano Wolf procedure, which controls for the very high correlation between outcome variables (which are based on the same underlying variable) in this case given that its bootstrap re-sampling procedure respects correlations between outcome variables across models.

ing outcomes towards the very bottom of the health distribution at birth.<sup>14</sup> While we do find a small impact on some low birth weight categories, we observe here that impacts are higher among larger babies. Work examining the impact of the WIC program from [Rossin-Slater \(2013\)](#) notes a similar pattern, with the largest impacts occurring at 3000-3500 grams.<sup>15</sup> While this points to the challenge of improving birth outcome at bottom of the health distribution, especially in large public programs such as ChCC, these improvements in birth weight even from the median of the birth weight distribution are certainly not trivial. Indeed, evidence from [Royer \(2009\)](#) suggests that returns to birth weight may actually be highest *above* the low birth weight cut-off. We turn to considerations relating to these returns, and returns of ChCC in particular, in the following sub-sections.

## 5.2 Program Efficiency

### 5.2.1 External Efficiency

Chile Crece Contigo is the flagship early life health program in the Chile, and one of the largest social safety net programs of any type in the country. It is also one of the most important early life health programs in a middle or lower-middle income country setting worldwide ([Richter et al., 2017](#)). As such, considerations of efficiency in public health care spending are of considerable importance. As we describe in Appendix Table [A8](#), spending on ChCC is approaching 1% of the fiscal budget per year, documenting the importance of this policy nation-wide. Using the current exchange rate, spending on ChCC in 2010 was approximately USD 422 million, or 600 million in PPP-adjusted terms.

To provide a broader consideration of the program's impacts and efficiency given public investment, we calculate the inferred cost of producing one gram of birth weight through this policy. In order to do so we compare the total cost of the pre-natal portion of Chile Crece Contigo with the total grams of birth weight produced by the policy. Information on the total costs of the program in each year included in this paper are compiled from government reports ([Arrieta et al., 2013](#)). This breaks costs down by component, and we display all costs in Chilean pesos and in US dollars (PPP

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<sup>14</sup>Investments in low birth weight babies, which are difficult to determine ex-ante, are also significant once the baby is born, and observed to be of low or very low birth weight. See [Bharadwaj, Løken and Neilson \(2013\)](#) for a discussion of public investments in very low birth weight babies in Chile.

<sup>15</sup>[Rossin-Slater \(2013\)](#) uses slightly broader distributional points, with estimates at each 500 grams, however the general pattern is very similar. It is important to note that such a finding is not universal in early life public programs. Notably, [Attanasio, Di Maro and Vera-Hernández \(2013\)](#) find that the impact of a community nursery program in Colombia impacted child height much more at quintiles 10, 25 and 50 of the height distribution than at quintiles 75 and 90.

Table 5: Costs and Estimated Impacts of Selected Early-Life Programs

| Reference                                                                       | Estimated Impact | Cost per Participant | Estimated Cost per gram |
|---------------------------------------------------------------------------------|------------------|----------------------|-------------------------|
| <b>Supplemental Nutrition Program for Women, Infants and Children (WIC, US)</b> |                  |                      |                         |
| <a href="#">Rossin-Slater (2013)</a>                                            | 27.30 (7.98)     | \$405 USD            | \$14.8                  |
| <a href="#">Hoynes, Page and Stevens (2011)</a>                                 | 28.75 (15.13)    | \$405 USD            | \$14.1                  |
| <b>PANES (Uruguay)</b>                                                          |                  |                      |                         |
| <a href="#">Amarante et al. (2016)</a>                                          | 30.83 (18.44)    | \$918 USD            | \$29.8                  |
| <b>Supplemental Nutrition Assistance Program (FSP, US)</b>                      |                  |                      |                         |
| <a href="#">Almond, Hoynes and Schanzenbach (2011)</a>                          | 8.96 (5.05)      | \$1125 USD           | \$125.6                 |
|                                                                                 | 20.27 (6.89)     | \$1125 USD           | \$55.5                  |
| <b>Earned Income Tax Credit (EITC, US)</b>                                      |                  |                      |                         |
| <a href="#">Strully, Rehkopf and Xuan (2010)</a>                                | 15.70 (1.211)    | \$1558 USD           | \$99.2                  |
| <a href="#">Hoynes, Miller and Simon (2015)</a>                                 | 9.95 (2.05)      | \$1558 USD           | \$156.6                 |
| <b>Chile Crece Contigo (Chile)</b>                                              |                  |                      |                         |
| Our estimates                                                                   | 10.09 (3.37)     | \$111 USD            | \$11.0                  |

NOTES: Estimates from [Hoynes, Miller and Simon \(2015\)](#) refer to single women with no more than a high-school education (the “high impact” group, with highest eligibility for policy use). Two estimates are presented for [Almond, Hoynes and Schanzenbach \(2011\)](#), given that their results are presented by race. The top line refers only to black mothers, while the bottom line refers only to white mothers. Estimates for black mothers are based on the most recent estimates presented by the authors’ in their Erratum. All US program costs are expressed in US dollars, and non-US program costs (Chile and Uruguay) are denoted in PPP adjusted US dollars. PPP adjusted costs are higher than non-PPP adjusted costs, so this results in a conservative estimates of costs per gram. Similar estimates and additional calculation details are presented in [Clarke, Orefice and Quintana-Domeque \(2017\)](#) for the WIC and FSP only.

adjusted and un-adjusted) in Appendix Table A8. Based on this, we estimate that it costs USD \$111 for a single participant in the pre-natal period of ChCC, based on the average PPP-adjusted cost in each of the four years laid out in Table A8.<sup>16</sup> This value can then be compared with the average birth weight gain per birth to program participant of approximately 10 grams (from Table 2). All told, this suggests an average cost of per gram of birth of \$11 in PPP-adjusted terms (in non-PPP adjusted terms this is even lower, at around \$7).

In order to put these estimates in context, we can compare them to a series of successful early-life programs in other countries. In Table 5 we collect all estimates of the impact of early-life public

<sup>16</sup> We note that this refers to the marginal costs of the program. This will thus not include the costs of historical infrastructure investment, costs of non-program medical care during pregnancy, and so forth. These marginal costs are compared with the benefits from project participation, which also are marginal benefits.

programs on outcomes at birth where birth weight is available as an outcome, and where administrative data on birth outcomes are available. This results in a series of comparison programs. These are largely from the US (WIC, the Food Stamp Program and the Early Income Tax Credit), however one estimate is also available for a CCT program from Uruguay ([Amarante et al., 2016](#)). It is important to note that not all of these programs actually target health at birth (in the same way that ChCC explicitly targets early-life health). Thus we can split the programs listed above into those which explicitly target health at birth (WIC and ChCC), and those which do not (PANES, FSP, EITC) but which have nonetheless been documented to have unintended impacts on early-life outcomes.

The estimated impact of each alternative program is drawn from the articles cited in the first column of Table 5. In most cases, these are presented as a single estimate, although in the case of [Almond, Hoynes and Schanzenbach \(2011\)](#) estimates are presented separately for black and white mothers, so we report each estimate. Details on the cost per user are also generally drawn from various sources. In the case of the PANES program in Uruguay, the cost per user is reported by [Amarante et al. \(2016\)](#) as \$102 per month in PPP adjusted terms. In each case we infer the cost of the program by assuming 9 months of coverage, as this allows for consistent comparisons across programs. In the case of the WIC program, recent figures suggest that the cost of the program is quite stable at around \$45 per month per participant ([USDA, 2017b](#)), suggesting a 9 month cost estimate of \$405 per participant. Similar estimates for the FSP suggest costs of approximately \$125 per month per participant, or \$1125 over the course of 9 months ([USDA, 2017a](#)). Finally, costs from the EITC program are reported in [Hoynes, Miller and Simon \(2015, their Appendix Table A1\)](#).

These comparisons lead to a number of conclusions regarding the cost of producing birth weight in public programs, and the relative efficiency of different programs. Firstly, perhaps unsurprisingly, programs which explicitly target health at birth produce birth weight much more cheaply than non-targeted programs. The targeted programs (WIC and ChCC) range from anywhere between 2–15 times cheaper per gram of birth weight produced than non-targeted programs such as SNAP/FSP, the EITC or PANES in Uruguay. In general, it is likely reasonable to demand more of a program which aims to increase child health, so the increased costs among non-targeted programs should not be seen as a program inefficiency. Secondly, we note that ChCC produces birth weight in a comparatively efficient way, even when compared to WIC in the US. Our back-of-the-envelope calculation of the cost of birth weight in Chile is \$11 USD per gram (PPP-adjusted), compared to estimates of around \$14 USD per gram from the WIC program. As discussed above, this is then additionally more efficient than comparison non-targeted programs both in the US, and in Latin America.

### 5.2.2 Internal Efficiency

Finally, while the value above benchmarks the efficiency of the ChCC program compared to other early-life health programs, it provides less context on the implications of these costs for social spending and development outcomes within the country. In order to put these estimates in context, we can ask how investments in birth weight can be expected to map to *returns* to birth weight in the country. In Chile there are a number of well-identified estimates of the value of birth weight to later-life education, with significant and long-standing observed impacts (Bharadwaj, Løken and Neilson, 2013; Bharadwaj, Eberhard and Neilson, forthcoming). Using a within family estimation strategy (similar to the strategy proposed as a specification check in 4), Bharadwaj, Eberhard and Neilson (forthcoming) estimate that a 10% increase in weight at birth increases child test scores by approximately 0.05 standard deviations (for language and math), and that these returns are quite stable between primary, secondary, and university entry exams. Using our estimates, as well as data on birth weights in Chile, we can thus back out the approximate amount required to be invested in ChCC to produce an additional 0.05 standard deviations of educational outcomes (performance, rather than attendance) for a single child.

From Table 1, a 10% increase in average birth weight is 334 grams. Our calculation above suggests that the cost per gram of birth weight produced by ChCC is \$11, implying that the cost of 334 grams is approximately \$3700. Thus, this rough calculation suggests that for every \$3700 invested in the pre-natal components of the ChCC program, performance on tests (compared to a static population) would increase by 5% of a standard deviation for the recipient child. Stated in another way, given that the cost per participant is estimated at \$111, the follow-on impact of this investment during the child's life is an increase in 0.15% of a standard deviation.<sup>17</sup> What's more, these costs are clearly an upper bound, as we ignore all other impacts of improvements in early-life health. While birth weight is a well known determinant of educational attainment, birth weight is also known to impact labour market outcomes (Johnson and Schoeni, 2011b; Cook and Fletcher, 2015; Behrman and Rosenzweig, 2004; Rosenzweig and Zhang, 2013; Case, Fertig and Paxson, 2005), the prevalence of chronic morbidities (Barker, 1995; Almond and Mazumder, 2005; Johnson and Schoeni, 2011a), mortality (van den Berg, Lindeboom and Portrait, 2006), and a range of psychological outcomes (Fletcher, 2011).

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<sup>17</sup>This is calculated as  $\$111/\$3700 \times 5\% = 0.15\%$ .

### 5.3 Mechanisms

Currently, our headline estimate of an average impact of 10 grams treats ChCC receipt as a black box. However, as discussed in section 2.1, ChCC includes a range of provisions and services, which have been shown to work in other contexts. For example, provision of food to mothers during pregnancy has been shown to have large short- and long-term effects in the US using data from the 1960s and 1970s (Almond, Hoynes and Schanzenbach, 2011; Hoynes, Schanzenbach and Almond, 2016). Doyle (2017) documents medium-term improvements in cognitive and socio-emotional development of children in response to home visits to families and group education classes. In this section we consider four potential mechanisms of action to explain the impacts of ChCC. These are (i) A maternal nutrition component, (ii) a prenatal care component, (iii) a home visit component, and (iv) a social connection component capturing links to the wider social-safety net. These potential mechanisms envelope the majority of ChCC components, with the exception of the pre-natal educational component for parents, which as we discuss below is not included given problems with data availability.

In order to assess the importance of different components we require data describing the usage of each component with variation ideally by month and municipality. Administrative data from The Ministry of Health of Chile describe usage of various health services by month and by Health Service for each month from 2001 onwards as part of their Summarised Monthly Statistics (REM). We thus collect in a consistent way all available indicators related to prenatal use of health services for the period under study. However, it is important to note that the data are not currently available at the municipal level, but rather by Health Service, which generally encompass various municipalities. In Appendix Figure A5 we show how municipalities are classified into Health Services, where each municipality is contained in only one Health Service. Using these data we are able to collect consistent reports of the number of prenatal controls, the number of home visits to pregnant mothers, the number of packages (kilograms) of fortified milk disbursed to expectant mothers, as well as the number of visits to Social Assistants at local health clinics. We thus cross our municipal level data with *health service* level controls, where each mechanism is consistently measured as the average use of each component per pregnancy in the 9 months prior to each birth. In Appendix Figure A6 we display the evolution of the usage of these components over time.

To examine the importance of different potential mechanisms, we augment equation 1, adding

the vector of program usage variables to the specification in the following way:

$$birthweight_{cst} = \alpha_0^m + \alpha_1^m ChCC_{cst} + \mathbf{Mech}_{st}\boldsymbol{\gamma} + \mathbf{W}_{ct}\boldsymbol{\alpha}_w + \mu_t + \lambda_c + \eta_{cst}. \quad (3)$$

Here we add a subscript  $s$  to indicate health service given that mechanism data is available at this level.<sup>18</sup> The vector of  $\mathbf{Mech}_{st}$  controls are clearly “bad controls” (Angrist and Pischke, 2009) given that they are themselves outcomes of the ChCC program. However, we include these controls as a mechanism test as it allows us to examine the impact of ChCC on birth weight, *conditional* on a particular program component. We include different mechanism variables in a step-wise manner, and examine, conditional on each mechanism, how  $\hat{\alpha}_1^m$  compares to the original  $\hat{\alpha}_1$  estimate, allowing us to infer the proportion of the ChCC effect explained by each particular mechanism. As the order in which we add the mechanisms in this process is arbitrary, we also calculate the Gelbach (2016) decomposition (for each outcome variable considered). This decomposition allows us to consistently apportion changes in the estimate of ChCC impact between  $\hat{\alpha}_1$  and  $\hat{\alpha}_1^m$  to each mechanism, by considering the impact of ChCC on each mechanism, and the impact of each mechanism on the outcome variable of interest.

Table 6 displays estimates of unconditional ChCC impacts, and the impact of ChCC conditional on the various proposed mechanisms. The baseline impact of 9.851 grams is marginally different (not statistically distinguishable) from the 10.092 grams reported in Table 2 given the small number of observations without mechanism controls. We consistently compare conditional impacts with the 9.851 unconditional estimate to maintain fixed the estimation sample. Subsequent columns introduce particular mechanisms one-by-one. In column 2 we observe that an additional pre-natal control is associated with a  $\sim 6$  gram increase in birth weight. Column 3 includes controls for the original and updated formulation of fortified milk distributed to mothers (we provide full details related to fortified milk, and full mechanism data, in Appendix B). In general we find quite inexact estimates of their impacts on birth weight, potentially also reflecting the lack of data availability at the finer municipal level. Additional columns of home visits and social safety net components are similarly imprecise, with the exception of enrollment of mothers in the Chile Solidario program, which is associated with a large positive impact on birth weight (comprehensive details and analysis of the

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<sup>18</sup>When a variable is collapsed at the level of municipality and health service, this results in identical levels and number of observations as when only collapsed at the level of municipality, given that each municipality is only found in one health service. In 2008, a single health service split into two, meaning that for a small number of observations, we are unable to calculate lags for the mechanism variables. The number of month $\times$ municipal observations in the original regression are 31,805, however when including municipal controls this health service split results in 31,760 observations.

Chile Solidario program is provided in [Carneiro, Galasso and Jinja \(2014\)](#)).

Table 6: Partial Test of ChCC Mechanisms

|                               | (1)<br>Base            | (2)<br>Prenatal Care    | (3)<br>Supplements      | (4)<br>Home Visits      | (5)<br>Social           |
|-------------------------------|------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Proportion of ChCC Coverage   | 9.851**<br>[4.450]     | 9.545**<br>[4.350]      | 7.743*<br>[4.387]       | 7.610*<br>[4.568]       | 6.881<br>[4.588]        |
| Prenatal Controls             |                        | 5.870***<br>[1.815]     | 5.915***<br>[2.147]     | 5.870***<br>[2.186]     | 5.696***<br>[2.154]     |
| Fortified Milk (New Formula)  |                        |                         | 1.207<br>[1.065]        | 1.175<br>[1.091]        | 1.160<br>[1.079]        |
| Fortified Milk (Original)     |                        |                         | -0.630<br>[1.500]       | -0.625<br>[1.505]       | -0.564<br>[1.485]       |
| Home Visits                   |                        |                         |                         | 2.056<br>[10.488]       | 2.771<br>[10.475]       |
| Social Assistance             |                        |                         |                         |                         | 0.222<br>[0.246]        |
| Chile Solidario Enrolment     |                        |                         |                         |                         | 13.897***<br>[4.765]    |
| Constant                      | 3352.795***<br>[4.115] | 3322.564***<br>[10.890] | 3324.236***<br>[11.111] | 3324.454***<br>[11.282] | 3320.908***<br>[11.323] |
| Explained Effect              |                        | 0.031                   | 0.189                   | 0.017                   | 0.096                   |
| Explained Effect (Cumulative) |                        | 0.031                   | 0.214                   | 0.227                   | 0.301                   |
| Observations                  | 31670                  | 31670                   | 31670                   | 31670                   | 31670                   |
| R-Squared                     | 0.262                  | 0.263                   | 0.263                   | 0.263                   | 0.263                   |

NOTES TO TABLE 6: Specifications replicate column 1 of Table 2, where birth weight is the dependent variable. All mechanism variables are available for each health service and month. One health service split into two in 2008, meaning that a small number of mechanism variables are not available where lagged measures are used. We consistently estimate without these observations so each column is comparable. Explained effect refers to the proportion of the baseline impact of ChCC which is explained away when conditioning on a particular mechanism, and the cumulative explained effect refers to the total explained effect summing all mechanisms. Additional details related to mechanisms and measurement are available in section 5.3. \*  $p < 0.10$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

Most interesting for the present analysis are the changes in the estimates of the impact of ChCC moving across columns. The estimated impact of 9.85 grams in column 1 is reduced to 6.88 grams in the final column, suggesting that the proposed mechanisms, even though measured noisily, can explain 30% of the full impact. At the foot of the table we provide two decompositions of this movements. The first row (“Explained Effect”) calculates the percent of the movement in the effect from one column to another attributable to the particular mechanism. Here we observe that the mechanism which explains the largest proportion of the impact in this setting is food supplementation (18.9%), followed by increased links to the social safety net (9.6%), and then prenatal care and home

visits. The second row, displaying the cumulative explained effect, provides a cumulative sum of the ability of proposed mechanisms to explain Chile Crece Contigo's impact on birthweight, which reaches 30.1% of the full effect in the final column.

It is important to note that this calculation is at best partial, as there are components which are hard to measure or not observed in publicly available data. Indeed, even when controlling for the full set of mechanisms, there is still 69.9% of the impact which we are unable to explain. For example, as discussed above, we do not observe group education usage over time, and measures like prenatal controls are potentially significantly under-reporting the true changes due to ChCC, given that prenatal controls approximately doubled in length and included a number of new and standardised components. Thus, measures of prenatal check-up coverage, while capturing ChCC's impact on extensive margin impacts, does not capture intensive margin impacts of additional time and additional components in a given check-up. In general, controlling for the absolute value of inputs over time will only allow us to capture impacts flowing from changes in component usage, and not capture any changes flowing from improved *quality* of inputs owing to ChCC. Finally, in Appendix Table A10 we present the alternative decomposition suggested by Gelbach (2016) which is based on the regression in column 5 of Table 6. Here we present the decomposition for each outcome measure in Table 2, and generally find that food supplements and increased linkages to the social safety net explain the largest proportion of (explainable) ChCC impacts on health outcomes at birth.

## 6 Conclusion

We estimate the impact of a large early-life health and social inclusion policy, *Chile Crece Contigo*. This policy, explicitly designed to target differences in psychological, behavioural, and cognitive development of children in vulnerable households which open early in life, is found to have significant impacts on health at birth over a range of dimensions. Using municipal roll-out and variation in intensity of use of ChCC in a difference-in-difference specification, we estimate that participation in ChCC increased weight at birth by 10 grams on average. We also find an increase in gestational length, and some evidence to suggest that the program increased the likelihood of fetal survival. These results are validated by a large (but not universal) sample of micro-data where within mother variation in program exposure is used to estimate the policy's impact on infants.

We find that this policy is both equity enhancing, as well as quite efficient when compared with

other policies world-wide, and as a manner to invest in human capital accumulation. The impacts are observed to be largest amongst the most vulnerable groups, which are specifically targeted to receive preferential transfers in the program. Combined with the cost of running ChCC, our estimates suggest that the government of Chile spends approximately \$11 per gram of birth weight—a figure that is comparable and slightly less than other large neonatal health programs, even when controlling for purchasing power. What’s more, given the well known positive effects of birth weight on later life outcomes, we are able to estimate that as an *upper bound* cost, each \$3700 spent on ChCC results in an additional 0.05 standard deviation of educational attainment on later life test scores.

However, our estimates suggest that the program impacts are highest for babies with health stocks at birth *above* the median outcome. We observe that the mean program effect of 10 grams largely come from shifting children who were born weighing between 3,500-4,000 grams, and for increasing gestational length at full term (weeks 39 and 40). All told this paper suggests that despite challenges of targeting and improving the health at birth of conceptions towards the bottom of the health distribution, public investments in early life health in developing and emerging economies can have considerable mean impacts when well targeted and well designed, and that these impacts may propagate through the economy long after birth and program implementation.

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# Appendices

## A Appendix Tables and Figures

Table A1: Test of FONASA Coverage and ChCC Roll-out

|              | (1)<br>Women               | (2)<br>Men                 | (3)<br>All                |
|--------------|----------------------------|----------------------------|---------------------------|
| (mean) chcc  | -1710.965<br>[2135.177]    | -2665.317<br>[3063.904]    | -4376.359<br>[5044.565]   |
| Constant     | 52395.850***<br>[2354.014] | 49867.394***<br>[3045.407] | 1.02e+05***<br>[5321.473] |
| Observations | 23502                      | 23502                      | 23502                     |
| R-Squared    | 0.971                      | 0.956                      | 0.965                     |

NOTES TO TABLE A1: DD specifications are reported where birth outcomes are replaced by FONASA enrollees as the dependent variable. All remaining details follow specification 1. FONASA enrollment data is available at the municipal-level from December of 2005 onwards, and so only the December 2005-December 2010 period is available for use in this regression. Values for total number of women, men and all people enrolled in FONASA in each municipality are available in December of each year, and are linearly interpolated for other months.

Table A2: Summary Statistics by Trimester: Birth and Chile Crece Contigo Data

|                                  | N     | Mean    | Std. Dev. | Min     | Max     |
|----------------------------------|-------|---------|-----------|---------|---------|
| Proportion Enrolled in ChCC      | 10826 | 0.26    | 0.36      | 0.00    | 1.00    |
| Birth Weight (grams)             | 10814 | 3345.85 | 128.57    | 686.00  | 4868.00 |
| Low Birth Weight < 2500 grams    | 10814 | 0.05    | 0.05      | 0.00    | 1.00    |
| Gestation (weeks)                | 10814 | 38.66   | 0.47      | 24.00   | 42.00   |
| Premature < 37 weeks             | 10814 | 0.06    | 0.05      | 0.00    | 1.00    |
| Length (cm)                      | 10814 | 49.47   | 0.69      | 30.00   | 55.00   |
| Number of Births                 | 10826 | 177.08  | 278.55    | 1.00    | 2217.00 |
| Rate of Fetal Deaths/1000 Births | 10826 | 9.20    | 27.09     | 0.00    | 1000.00 |
| Year of Birth                    | 10837 | 2006.51 | 2.29      | 2003.00 | 2010.00 |
| Mother's Age                     | 10824 | 26.69   | 1.72      | 15.00   | 44.00   |
| Proportion Teen Births           | 10824 | 0.18    | 0.09      | 0.00    | 1.00    |
| Number of Children               | 10826 | 2.02    | 0.32      | 1.00    | 8.00    |

NOTES TO TABLE A2: Summary Statistics are displayed for municipality by trimesterly averages for each trimester from January 2003 to December 2010. Trimesters refer to January-March, April-June, July-September, and October-December. For additional notes, refer to Table 1 which provides summary statistics at the municipality by month level.

Table A3: Difference-in-Difference Estimates with Data Collapsed by Trimester

|                             | (1)<br>Weight          | (2)<br>LBW          | (3)<br>Size          | (4)<br>Gestation     | (5)<br>Premature    | (6)<br>Fetal Death  |
|-----------------------------|------------------------|---------------------|----------------------|----------------------|---------------------|---------------------|
| Proportion of ChCC coverage | 10.774**<br>[5.343]    | -0.003<br>[0.002]   | -0.016<br>[0.038]    | 0.025<br>[0.020]     | -0.003<br>[0.002]   | -1.452<br>[0.931]   |
| Constant                    | 3351.932***<br>[3.093] | 0.054***<br>[0.001] | 49.481***<br>[0.021] | 38.712***<br>[0.014] | 0.063***<br>[0.001] | 4.801***<br>[0.342] |
| Observations                | 10814                  | 10814               | 10814                | 10814                | 10814               | 10826               |
| R-Squared                   | 0.492                  | 0.125               | 0.668                | 0.501                | 0.225               | 0.138               |

Estimation sample consists of all municipal-level averages for each quarter between 2003 and 2010 for all women. Refer to additional notes in table 2, and summary statistics for each variable at the trimester by municipal level in Table A2. \* p<0.10; \*\* p<0.05; \*\*\* p<0.01.

Table A4: Adjusting For Multiple Hypothesis Testing

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Index             |                 | Original Variables |               |                    |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------|--------------------|---------------|--------------------|-----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Anderson<br>Index | Birth<br>Weight | LBW                | Birth<br>Size | Weeks<br>Gestation | Premature |
| PANEL A: MUNICIPAL-LEVEL ANALYSIS                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                   |                 |                    |               |                    |           |
| <i>p</i> -value (Original)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   | 0.0226          | 0.1356             | 0.8940        | 0.1168             | 0.1499    |
| <i>p</i> -value (Corrected)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>0.0888</b>     | 0.0392          | 0.2941             | 0.9412        | 0.2941             | 0.2941    |
| PANEL B: INDIVIDUAL-LEVEL ANALYSIS                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |                 |                    |               |                    |           |
| <i>p</i> -value (Original)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   | 0.0000          | 0.0839             | 0.0257        | 0.0000             | 0.5553    |
| <i>p</i> -value (Corrected)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>0.0479</b>     | 0.0392          | 0.2549             | 0.0588        | 0.0196             | 0.7451    |
| NOTES: Corrected <i>p</i> -values based on original variables are calculated using the <a href="#">Romano and Wolf (2005)</a> technique to control the Family Wise Error Rate of hypothesis tests. The <a href="#">Anderson (2008)</a> index converts the multiple dependent variables into a single dependent variable (index) giving more weight to variables which provide more independent variation. The specification of each regression follows Table 2 (panel A), and Appendix Table C2 (panel B). |                   |                 |                    |               |                    |           |

Table A5: Difference-in-Difference Estimates using Municipal Program Availability

|                                      | (1)<br>Weight          | (2)<br>LBW          | (3)<br>Size          | (4)<br>Gestation     | (5)<br>Premature    | (6)<br>Fetal Death  |
|--------------------------------------|------------------------|---------------------|----------------------|----------------------|---------------------|---------------------|
| ChCC Availability                    | 1.443<br>[2.744]       | 0.000<br>[0.001]    | 0.005<br>[0.014]     | 0.000<br>[0.010]     | -0.000<br>[0.001]   | -1.098**<br>[0.508] |
| ChCC Availability ( $\geq 9$ months) | 3.250<br>[2.729]       | 0.001<br>[0.001]    | 0.017<br>[0.014]     | -0.003<br>[0.010]    | -0.000<br>[0.001]   | -1.009**<br>[0.505] |
| Constant                             | 3351.512***<br>[3.868] | 0.054***<br>[0.002] | 49.479***<br>[0.019] | 38.705***<br>[0.013] | 0.065***<br>[0.002] | 4.894***<br>[0.716] |
| Observations                         | 31805                  | 31805               | 31806                | 31806                | 31806               | 31842               |
| R-Squared                            | 0.261                  | 0.051               | 0.451                | 0.278                | 0.095               | 0.056               |

NOTES TO TABLE 2: Estimation sample consists of all municipal-level averages for each month between 2003 and 2010 for all women. Low birth weight refers to the proportion of births under 2,500 grams, and premature refers to the proportion of births occurring before 37 weeks of gestation. Birth weight is measured in grams, Size is measured in centimetres, and Gestation is measured in weeks. Fetal deaths are measured as the number of fetal deaths per 1,000 live births. Each cell is weighted using the number of births in the municipality and month, and all specifications include municipality and time (Year  $\times$  Month) fixed effects.

\*  $p < 0.10$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

Table A6: IV Estimates Using Lagged ChCC Enrollment

|                               | (1)<br>Weight       | (2)<br>LBW          | (3)<br>Size         | (4)<br>Gestation    | (5)<br>Premature    | (6)<br>Fetal Death  |
|-------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| <b>Second Stage Estimates</b> |                     |                     |                     |                     |                     |                     |
| Proportion of ChCC coverage   | 9.586**<br>[4.774]  | -0.002<br>[0.002]   | -0.027<br>[0.024]   | 0.014<br>[0.017]    | -0.004<br>[0.002]   | -1.438<br>[0.886]   |
| <b>First Stage Estimates</b>  |                     |                     |                     |                     |                     |                     |
| Lagged ChCC coverage          | 0.701***<br>[0.004] | 0.701***<br>[0.004] | 0.701***<br>[0.004] | 0.701***<br>[0.004] | 0.701***<br>[0.004] | 0.701***<br>[0.004] |
| Observations                  | 31454               | 31454               | 31455               | 31455               | 31455               | 31489               |
| AP First Stage (F)            | 30099.31            | 30099.31            | 30100.26            | 30100.26            | 30100.26            | 30105.51            |
| AP First Stage (p)            | 0.000               | 0.000               | 0.000               | 0.000               | 0.000               | 0.000               |

NOTES: Difference-in-difference estimates are presented following the results of Table 2. However, here the Proportion of ChCC Coverage among births in a given month and municipality is instrumented with lagged ChCC coverage from the same municipality. The 2SLS results along with standard errors clustered by municipality are displayed in the top panel of the Table. The second panel documents the first stage results of regression ChCC coverage on its lagged value. The associated first stage F-statistic and its p-value are documented at the foot of the table.

Table A7: Correction for Multiple Hypothesis Testing in Distributional Estimates

| Birth Weight |                             |                                | Gestation |                             |                                |
|--------------|-----------------------------|--------------------------------|-----------|-----------------------------|--------------------------------|
| Cut-off      | Original<br><i>p</i> -value | Romano Wolf<br><i>p</i> -value | Cut-off   | Original<br><i>p</i> -value | Romano Wolf<br><i>p</i> -value |
| 1000         | 0.4592                      | 0.6707                         | 30        | 0.6905                      | 0.6587                         |
| 1250         | 0.5786                      | 0.7206                         | 31        | 0.6245                      | 0.6587                         |
| 1500         | 0.7191                      | 0.8383                         | 32        | 0.3666                      | 0.4850                         |
| 1750         | 0.0632                      | 0.0619                         | 33        | 0.0464                      | 0.0439                         |
| 2000         | 0.0014                      | 0.0000                         | 34        | 0.1695                      | 0.2535                         |
| 2250         | 0.0135                      | 0.0020                         | 35        | 0.0804                      | 0.0818                         |
| 2500         | 0.0737                      | 0.0838                         | 36        | 0.0539                      | 0.0559                         |
| 2750         | 0.2736                      | 0.4371                         | 37        | 0.2337                      | 0.3413                         |
| 3000         | 0.1169                      | 0.1397                         | 38        | 0.2651                      | 0.3513                         |
| 3250         | 0.2212                      | 0.3373                         | 39        | 0.0477                      | 0.0439                         |
| 3500         | 0.0056                      | 0.0000                         | 40        | 0.0005                      | 0.0000                         |
| 3750         | 0.0030                      | 0.0000                         | 41        | 0.5312                      | 0.6587                         |
| 4000         | 0.0221                      | 0.0100                         |           |                             |                                |
| 4250         | 0.0167                      | 0.0040                         |           |                             |                                |
| 4500         | 0.0144                      | 0.0020                         |           |                             |                                |
| 4750         | 0.9501                      | 0.9421                         |           |                             |                                |
| 5000         | 0.4313.                     | 0.6707                         |           |                             |                                |

NOTES TO TABLE A7: Un-adjusted and multiple-hypothesis test adjusted *p*-values are displayed corresponding to the estimates and standard errors displayed in Figure 3. Unadjusted *p*-values refer to the *p*-value on ChCC in each regression where the outcome variable is birth weight or gestation exceeding the listed cut-off. Romano Wolf adjusted *p*-values are based on a null re-sampled distribution as described in Romano and Wolf (2005). We re-sample using 500 bootstrap samples.

Table A8: Costs of ChCC Per Participant in Gestational Program

|                                                  | 2007        | 2008        | 2009        | 2010        |
|--------------------------------------------------|-------------|-------------|-------------|-------------|
| PANEL A: ALL AMOUNTS IN 1000s OF CHILEAN PESOS   |             |             |             |             |
| Costs Associated with PADBP                      | 1,969,162   | 6,116,663   | 14,231,107  | 14,444,574  |
| Costs Ministry of Planning                       | 1,001,810   | 2,529,976   | 2,604,131   | 4,197,607   |
| Massive Education Program                        | 20,000      | 195,640     | 261,462     | 196,624     |
| <b>Total Prenatal Development Components</b>     | 2,990,972   | 8,842,279   | 17,096,700  | 18,838,805  |
| Total Budget (ChCC)                              | 67,903,331  | 126,446,362 | 159,660,473 | 214,505,550 |
| Total Budget/1000 (All Chile)                    | 17,883,154  | 20,650,579  | 23,406,879  | 25,651,970  |
| Total Women Participating during Gestation       | 47,683      | 166,900     | 171,811     | 171,799     |
| Proportion of all Participants in Pre-natal Care | 1           | 0.449       | 0.307       | 0.303       |
| Cost per Pre-Natal Participant                   | 62,726      | 24,714      | 30,549      | 33,116      |
| PANEL B: ALL AMOUNTS IN US DOLLARS               |             |             |             |             |
| Costs Associated with PADBP                      | 3,702,025   | 12,288,376  | 22,257,451  | 28,470,255  |
| Costs Ministry of Planning                       | 1,883,403   | 5,082,722   | 4,072,861   | 8,273,483   |
| Massive Education Program                        | 37,600      | 393,041     | 408,917     | 387,546     |
| <b>Total Prenatal Development Components</b>     | 5,623,027   | 17,764,139  | 26,739,239  | 37,131,285  |
| Total Budget (ChCC)                              | 127,658,262 | 254,030,741 | 249,708,980 | 422,790,439 |
| Total Budget/1000 (All Chile)                    | 33,620,330  | 41,487,013  | 36,608,359  | 50,560,033  |
| Total Women Participating during Gestation       | 47,683      | 166,900     | 171,811     | 171,799     |
| Proportion of all Participants in Pre-natal Care | 1           | 0.449       | 0.307       | 0.303       |
| Cost per Pre-Natal Participant                   | \$118       | \$50        | \$48        | \$65        |
| Cost per Pre-Natal Participant (PPP Adjusted)    | \$192       | \$72        | \$87        | \$93        |

NOTES TO TABLE A8: Costs per pre-natal participant are calculated by dividing the pro-rata total costs of prenatal development components by the total number of participants in the pre-natal period. Total prenatal development components are calculated as the sum of the costs of the PADBP program, fixed costs assigned to the Ministry of Planning, and the costs of the Massive Education program. Costs are assigned pro-rata to pre-natal versus non pre-natal components using the proportion of all participants which are in the pre-natal period, rather than during years 1-5. In the first year, the program only began in utero, so all costs are assigned to pre-natal development. Budget details are all compiled from the ChCC final reports ([Arriet et al., 2013](#)), and historic budget laws (for example [Ministry of Finance, Government of Chile \(2007\)](#)). Total participants during gestation as well as in the post-natal period are compiled from the Department of Health Statistics and Information from the Ministry of Health. PPP-adjusted costs are based on the World Bank's PPP conversion factor.

Table A9: Impact of Chile Crece Contigo on Pregnancy Inputs

|                             | (1)<br>Home Visits  | (2)<br>Food Supplement + | (3)<br>Food Supplement | (4)<br>Prenatal Visits | (5)<br>Social Support | (6)<br>Chile Solidario |
|-----------------------------|---------------------|--------------------------|------------------------|------------------------|-----------------------|------------------------|
| Proportion of ChCC Coverage | 0.052<br>[0.060]    | 2.171***<br>[0.398]      | 1.304***<br>[0.257]    | 0.096***<br>[0.019]    | -1.002*<br>[0.531]    | 0.061***<br>[0.006]    |
| Constant                    | 5.107***<br>[0.051] | -0.112**<br>[0.055]      | 2.826***<br>[0.118]    | -0.003<br>[0.004]      | 8.712***<br>[0.612]   | 0.168***<br>[0.004]    |
| Observations                | 31707               | 31707                    | 31707                  | 31707                  | 31707                 | 31842                  |
| R-Squared                   | 0.913               | 0.954                    | 0.894                  | 0.847                  | 0.637                 | 0.616                  |

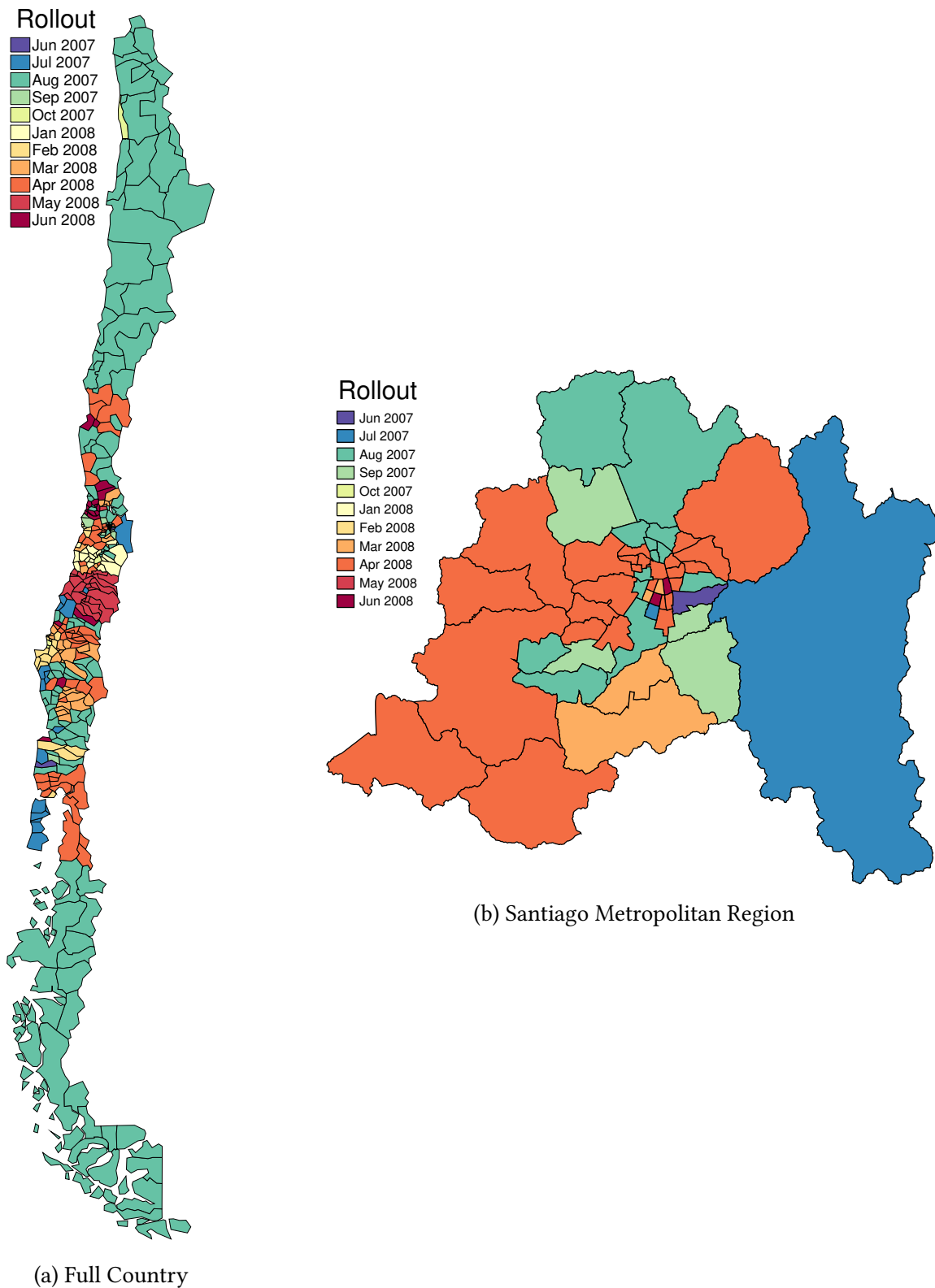
NOTES TO TABLE A9: Each regression shows the correlation between ChCC usage and different program components. Each variable with the exception of Chile Solidario refers to the average usage per birth in the 9 months prior to each birth, and is measured at the level of health service and month. One health service split in two in 2008, and hence lags are not available for a small number of areas in this period. Home visits refers to the number of 'integral home visits' to pregnant women by a nurse or midwife, Food Supplement and Food Supplement + refer to a fortified powdered milk drink given to pregnant women with an updated formula from 2008 onwards. Prenatal visits refer to check-ups with nurses, doctors or midwives at local health centres. Social support refers to all visits with Social Assistants, and Chile Solidario refers to the number of pregnant women giving birth each month who have at any point participated in Chile Solidario, a targeted social welfare program including a cash transfer. \* p<0.10; \*\* p<0.05; \*\*\* p<0.01.

Table A10: Gelbach (2016) Decomposition of ChCC Mechanism

|                                         | (1)<br>Weight     | (2)<br>LBW        | (3)<br>Size       | (4)<br>Gestation    | (5)<br>Premature     | (6)<br>Fetal Death |
|-----------------------------------------|-------------------|-------------------|-------------------|---------------------|----------------------|--------------------|
| Decomposition of $\Delta$ ChCC Coverage |                   |                   |                   |                     |                      |                    |
| Prenatal Controls                       | 0.296<br>[0.375]  | -0.000<br>[0.000] | 0.002<br>[0.003]  | 0.002<br>[0.002]    | -0.000<br>[0.000]    | 0.026<br>[0.030]   |
| Food Supplementation                    | 1.785<br>[1.169]  | -0.000<br>[0.000] | 0.005<br>[0.012]  | 0.009*<br>[0.005]   | -0.002***<br>[0.001] | 0.025<br>[0.264]   |
| Home Visits                             | 0.269<br>[1.007]  | 0.001*<br>[0.000] | 0.011<br>[0.007]  | -0.006<br>[0.005]   | 0.001<br>[0.000]     | 0.454**<br>[0.210] |
| Social Safety Net                       | 0.622*<br>[0.377] | 0.000<br>[0.000]  | 0.003<br>[0.003]  | 0.005***<br>[0.002] | -0.000<br>[0.000]    | 0.034<br>[0.070]   |
| <b>Total Explained Difference</b>       | 2.972*<br>[1.567] | 0.000<br>[0.001]  | 0.021*<br>[0.012] | 0.010<br>[0.006]    | -0.002**<br>[0.001]  | 0.538**<br>[0.243] |
| Observations                            | 31670             | 31670             | 31671             | 31671               | 31671                | 31707              |

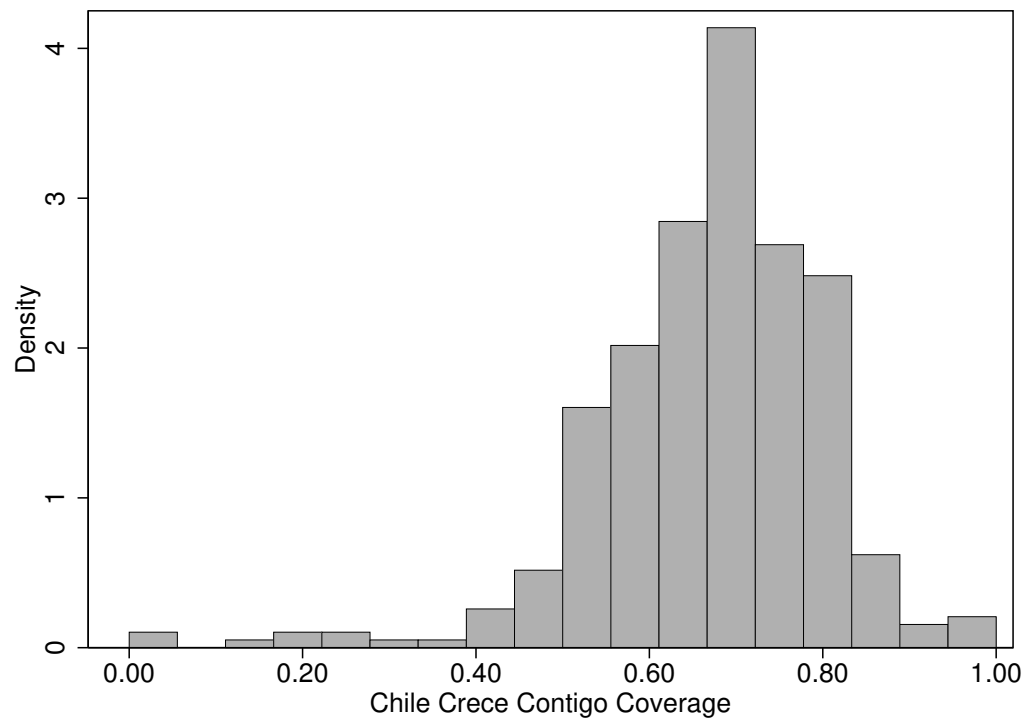
NOTES TO TABLE A10: Each column displays the coefficient change decomposition developed by Gelbach (2016) for a different outcome variable. This decomposition considers the change in the estimated effect of ChCC from the baseline diff-in-diff model compared with that estimated in the full model where all proposed mechanisms are accounted for. The full change is given by ‘Total Explained Difference’, and this is decomposed into the portion owing to each of the four mechanisms discussed in section 5.3. Full details of the decomposition and estimation of the variance-covariance matrix is provided by Gelbach (2016).

Figure A1: Program Roll-out by Date



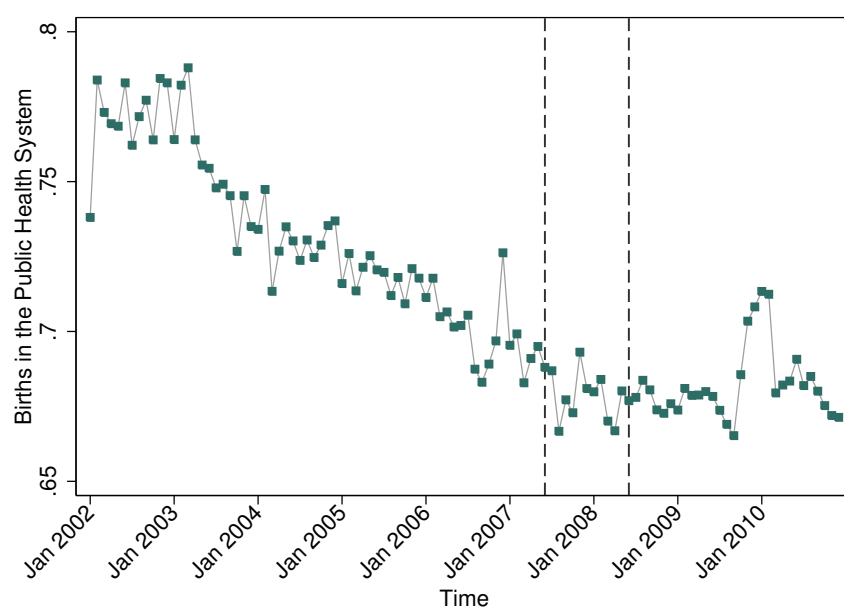
NOTES TO FIGURE A1: Chile consists of 346 municipalities (“*comunas*”) which are the lowest geographic administrative level with their own political administration. ChCC roll-out started in June 2007, and reached 159 of the 346 municipalities in 2007 (chosen due to the availability of infrastructure) and then was rolled out to the remaining municipalities during 2008. Precise roll-out dates are provided by the Ministry of Social Development of Chile. The full country is displayed in the left-hand panel, and only the Metropolitan Region of Santiago (from the centre of the country) is displayed in the right-hand panel.

Figure A2: ChCC Usage in Post-Implementation Period



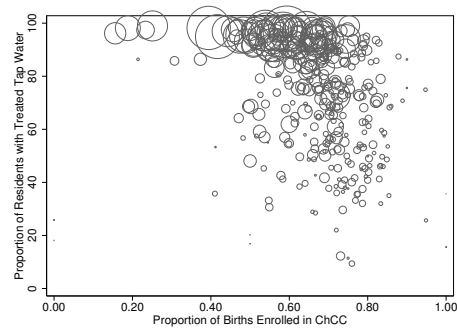
NOTES TO FIGURE A2: The density of ChCC usage by municipality over the entire post-treatment period is displayed. Usage refers to the average proportion of all births in each municipality for which ChCC components were accessed by the mother during the gestational period. Usage data comes from The Ministry of Social Development's administrative data on public program use, and is averaged at the level of each municipality. Refer to Figure A4 for additional details regarding municipal level usage of ChCC components and municipal characteristics.

Figure A3: Proportion of Births Attended in the Public Health System

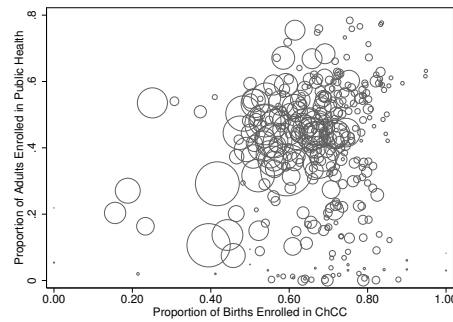


NOTES TO FIGURE A3: Figures on the proportion of births in the public health system and all births nation-wide are provided monthly by the Department of Statistics and Health Information (DEIS) of the Ministry of Health of Chile. Monthly proportions are displayed for each month from January 2002 until December 2010. The first vertical dotted line is the beginning of ChCC roll-out, while the second vertical dotted line is when ChCC reached the full country.

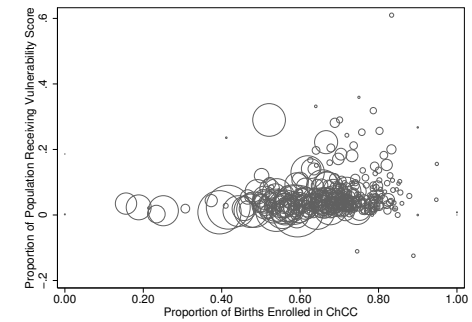
Figure A4: Municipal Characteristics and ChCC Enrollment



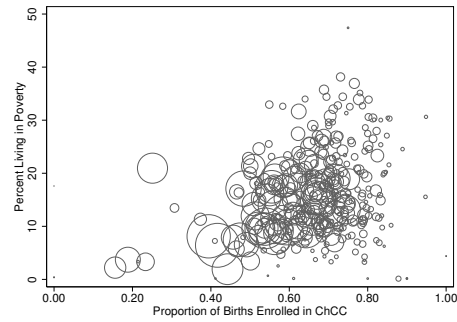
(a) Treated Piped Drinking Water



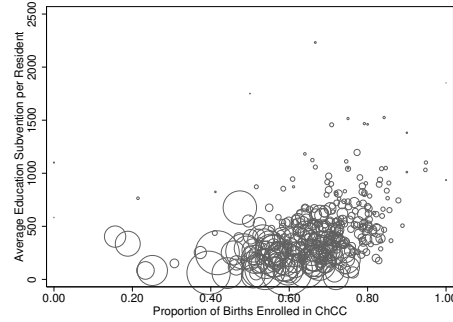
(b) FONASA enrolments



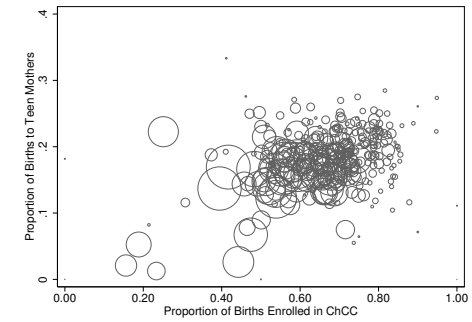
(c) Proportion of FPS per Year



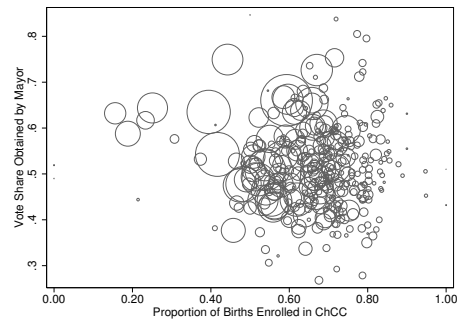
(d) Poverty



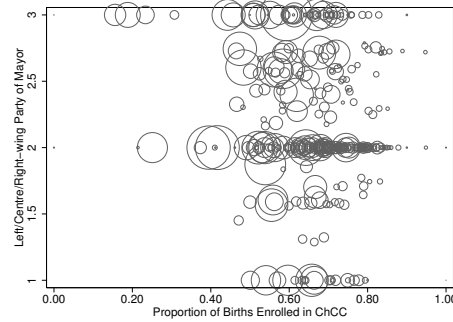
(e) Education Subvention



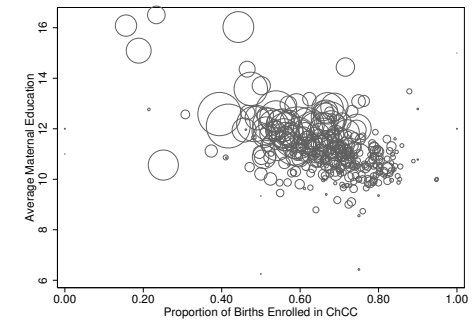
(f) Proportion of Teen Births



(g) Vote Share (Mayor)



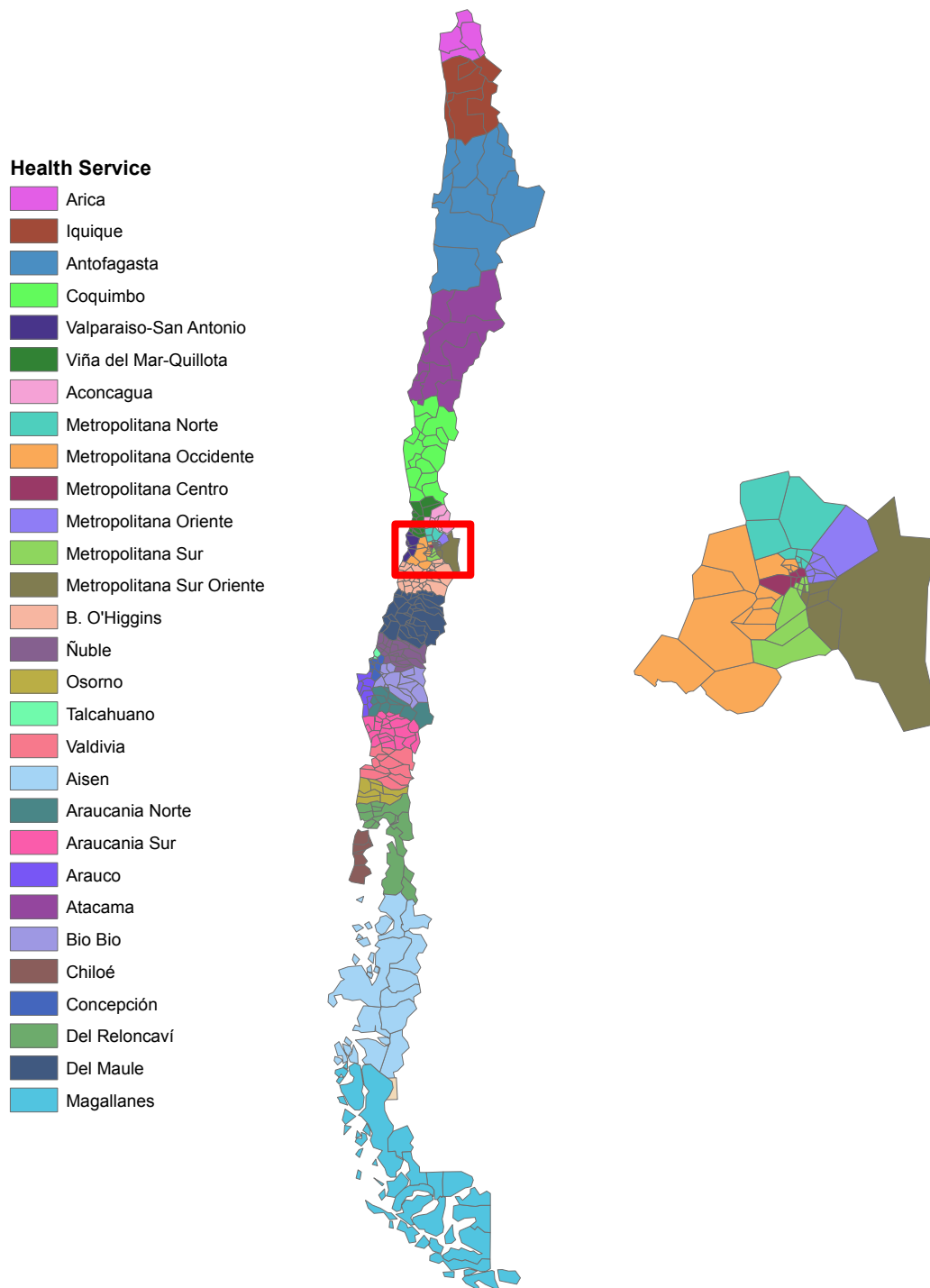
(h) Political Association



(i) Maternal Education

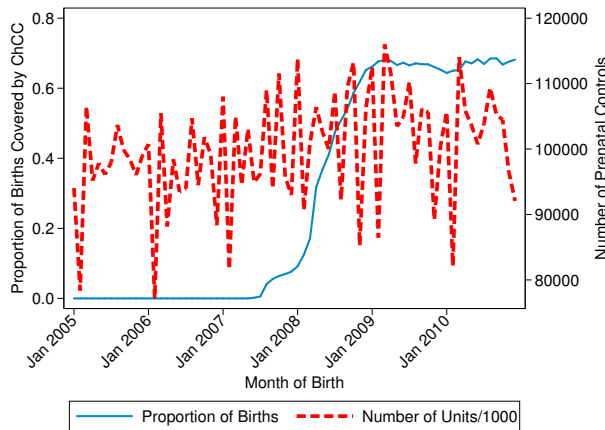
NOTES TO FIGURE A4: Each panel presents the proportion of Chile Crece Contigo enrollees in each municipality after the introduction of the program along with municipal level averages in a range of other social or political variables. In each case, ChCC enrollment is displayed on the horizontal axis, and alternative outcomes on the vertical axis.

Figure A5: Health Services and Municipalities

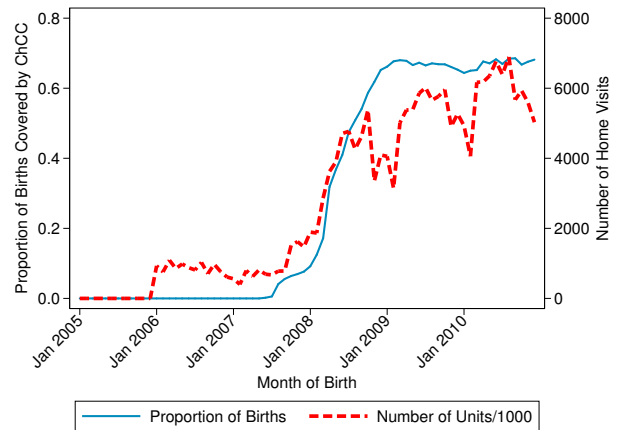


NOTES TO FIGURE A5: Municipalities are indicated by municipal boundaries, and health services are indicated by colours. Each of Chile's 346 municipalities belongs to one of 29 Health Services. The entire country is displayed at right, and the densely populated Metropolitan Region of Santiago is displayed at left.

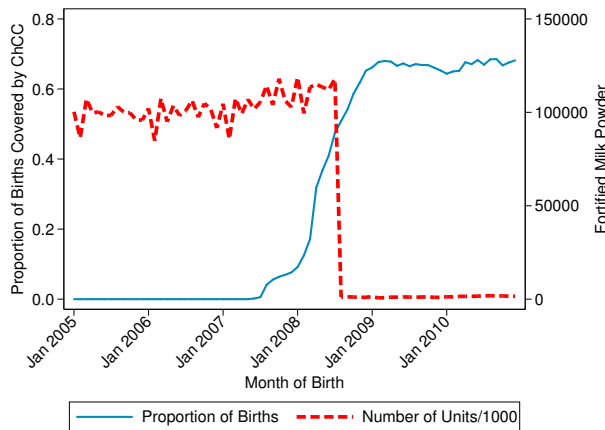
Figure A6: ChCC roll-out and Pregnancy Inputs Disbursed



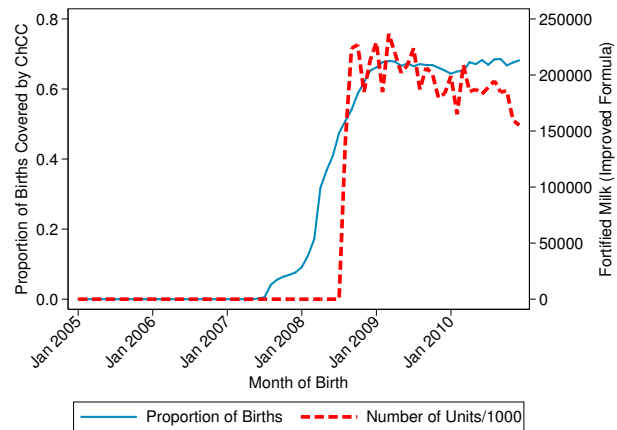
(a) Prenatal Controls



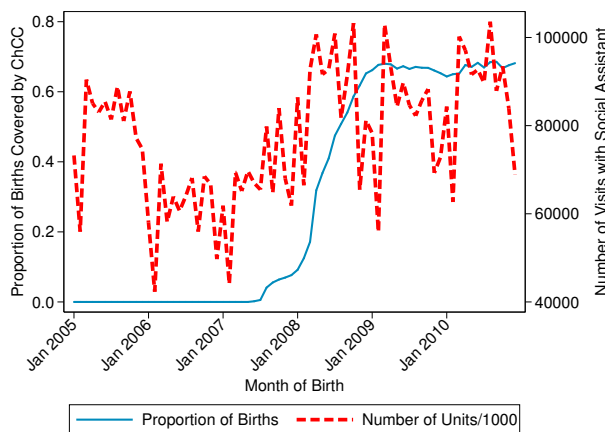
(b) Home Visits



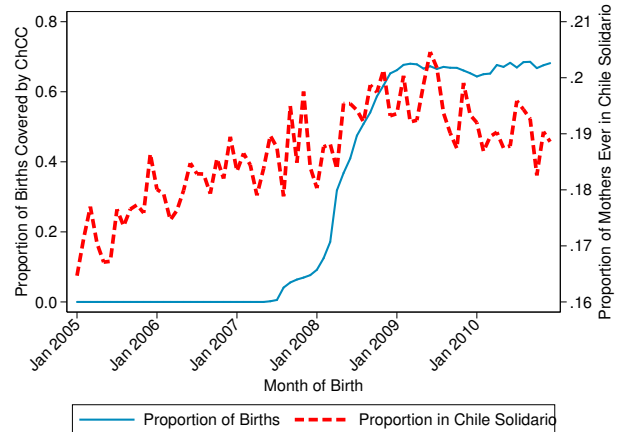
(c) Fortified Milk (Original Formula)



(d) Fortified Milk (Updated Formula)



(e) Social Assistance Appointments



(f) Chile Solidario

NOTES TO FIGURE A6: Solid blue line displays the roll-out of ChCC and proportion of coverage of births as in Figure 1. Dotted red lines display the total units of various components of the program disposed over time in whole of Chile. Each panel with the exception of Chile Solidario coverage in panel A6f presents the number of units divided by 1,000. Additional discussion of variables and their measurement is provided in section 5.3.

## B Additional Program Details and Component Data

**Additional Program Details** The full Chile Crece Contigo program covers children from before birth (officially from the first planned gestational control at week 14 of pregnancy) until early childhood. Initially, with the design and roll-out of the program in 2007, the program ended at age 4, once children enter the first transition level to primary school.<sup>19</sup> More recent extensions mean the program now follows children up until the age of 8, with mental health treatment for children with mental health disorders aged between 5 and 8.

The original program designed for children aged up to 4 years consisted of 5 components and various sub-components. We lay these out below in Table B1. Component 1, which is targeted to pregnant mothers, is the only component which can potentially impact birth outcomes, as the remainder of the components are entirely delivered in the birth to 4 year period of life. The components below are universal, with the exception of component 1B and component 5, which are preferential components received by families flagged as being among the 60% most vulnerable based on a social protection score.

Each particular program item described in table B1 consists of one or a series of check-ups, goods or other services. Each item also comes with a clear definition of how to deliver the item to the objective population, and key targets for public service workers. For example, Item 1A, Part i (prenatal check-ups) specifies that 7 prenatal check-ups should be targeted in low risk cases, and that the duration of these check-ups is 40 minutes. Particular check-ups also have their own requirements, such as specific diagnostic tests including the abbreviated psycho-social evaluation during the first and third trimester.

In this appendix we provide only a short summary of each component in Table B1. Full details regarding each component are available in the ChCC guide to services ([Ministerio de Desarrollo Social, 2014](#)). Specific components targeted to vulnerable families consist of the generation of a personalised plan identifying availability of differential services, home visits lasting 1 hour (which are targeted to families with specific risk-factors), information related to other subsidies and local programs, and contact with local healthcare and social professionals. Additionally, all children in vulnerable families are guaranteed access to extended nursery and pre-school programs at no cost.

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<sup>19</sup>In Chile pre-primary education ends with the first and second levels of transition (or pre-kinder and kindergarten), which begin at ages 4 and 5 respectively. At age 6, children begin grade 1 of primary school.

Table B1: List of ChCC Policy Components and Phases

| Component Name                                              | Subcomponent Name                                                | Program Item                                                                                                                                                                                                                                       | Time-Period           |
|-------------------------------------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 1. Strengthening of Prenatal Development                    | A. Strengthening of Prenatal Care                                | i) Prenatal check-ups, establishment of link and detection of psychosocial risk factors<br>ii) Receipt of gestational reading guides                                                                                                               | Weeks 14-40 Gestation |
|                                                             | *B. Integral Support for families in Psycho-Social Vulnerability | i) Design of individual health plan for pregnant mothers and families in psycho-social vulnerability<br>ii) Integral home visits for pregnant mothers in vulnerable situations<br>iii) Links with municipal ChCC Network in cases of vulnerability |                       |
|                                                             | C. Education for the Pregnant women and her partner or companion | i) Group or individual education for pregnant women and partner/companion. Cognitive and emotional support for birth and child-rearing                                                                                                             |                       |
|                                                             |                                                                  |                                                                                                                                                                                                                                                    |                       |
| 2. Personalised Care During the Birth Process               | A. Personalised care during                                      | i) Integral care prior and during childbirth                                                                                                                                                                                                       | At Birth              |
|                                                             | B. Integral Care during the Postpartum period                    | i) Personalised integral support for the postpartum mother and infant<br>ii) Personalised cross-check of families bio-psycho social development<br>iii) Timely coordination with the primary health team                                           |                       |
|                                                             | C. Newborn Support Program (PARN)                                | i) Education regarding the use of the PARN implements and early-life child-rearing<br>ii) Handout of basic implement set and educational material                                                                                                  |                       |
|                                                             |                                                                  |                                                                                                                                                                                                                                                    |                       |
| 3. Integral Developmental Support for hospitalized children | A. Integral support for newborns in neonatal care                | i) Integral evaluation; Developmental care plan; integration with families; hospitals open to families; prevention of neuro-developmental deficit; education and psycho-social interventions                                                       | 0-4 Years             |
|                                                             | B. Integral support for children in pediatric care               | ii) Integral evaluation; Developmental care plan; Provision of space for education and play; Use of stimulation protocol; Helpful relationships built between health team and father/mother/carers                                                 |                       |

Continued...

| Component Name                                                                                                                                                                                                                                                            | Subcomponent Name                                                                                   | Contents                                                                                                                                                                                                                                                                                                                                                                                | Time-Period |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| 4. Strengthening Integral Development of Children                                                                                                                                                                                                                         | A. Strengthening Child Health Checkups for Integral Development                                     | i) Prenatal controls, establishment of link and detection of psychosocial risk factors<br>ii) Participation in Child Health checkups (“Niño/a sano”)<br>iii) Check-ups with evaluation and follow-ups                                                                                                                                                                                   | 0-4 Years   |
|                                                                                                                                                                                                                                                                           | B. Educational Interventions to support child-rearing                                               | i) Group or individual education for development of parenting tools, “Nobody is Perfect” workshops                                                                                                                                                                                                                                                                                      |             |
| *5. Support for Children in Vulnerable Situations                                                                                                                                                                                                                         | A. Strengthening of interventions for children in vulnerable situations, or developmentally delayed | i) Health support for children who are vulnerable, or developmentally delayed in integral components<br>ii) Health support for children with developmental deficit in integral components<br>iii) Integral home visits for families of children under 4 in vulnerable situations for their bio-psycho-social development<br>iv) Support module for infant development in health centres | 0-4 Years   |
| Notes: Components and sub-components are based on official Chile Crece Contigo guide to services ( <a href="#">Ministerio de Desarrollo Social, 2014</a> ). Components or sub-components indicated with “*” are targeted components received only by means-tested groups. |                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                         |             |

**Data on Program Component Coverage** The examination of program mechanisms of action in section 5.3 relies on data recording program components, and their coverage over time. As laid out in the paper, we collect this data from public monthly administrative health statistics data. In each case we calculate the average level of component use for each birth in the 9 months prior to birth. Averages are always calculated at the health service and monthly level. In a number of cases, we linearly extrapolate coverage by month *prior to 2005* only, given that data is not always available in 2003 and 2004. This period is entirely in the pre-program period, and time fixed effects also capture periods in which linear extrapolation is performed.

Fortified milk disbursed to pregnant women as part of the program was originally called “Leche Purita Fortificada” (*Purita* Fortified Milk). In 2008 this underwent a modification to better meet the dietary requirements of pregnant women, and was renamed to “Purita Mamá”. *Purita Mamá* thus replaced *Leche Purita Fortificada*, although a very small number of batches of the original formula was still disbursed post 2008. In Table B2 we show the change in composition between the two types of dietary supplements. The guidelines issued by the Ministry of Health provide a clear description of how this milk should be disbursed to pregnant women. For those who begin pregnancy with normal weight, are overweight, or are obese, 1 kilogram of milk powder is given per month. For those women who begin pregnancy with an underweight diagnosis, 3kg of milk powder is delivered per month ([Gobierno de Chile, 2008](#)).

Measures of home visits refer to “Integral Home Visits” to pregnant women. Government reports highlight that Chile Crece Contigo has increased the frequency of home visits to pregnant mothers by around 500% . These home visits are targeted particularly to families identified as being in “psycho-social risk”, which implies meeting the vulnerability cut-off, and also presenting a number of additional risk factors. Given that the demand for home visits varies considerably by income level of municipalities, the precise decision of which families to visit is made by municipal health centres, where visits should be targeted to families with the largest number of risk factors. A complete discussion of the goals and recommendations for social workers completing home visits is provided in [Gobierno de Chile \(2009\)](#).

Remaining components such as prenatal check-ups and appointments with social assistants in local health centres are also reported in monthly health usage data. In this case the number of appointments completed are reported, and in Section 5.3 we calculate the average number of appointments per health service for a pregnancy in the 9 months prior to the birth.

Table B2: Changes in Composition of Complementary Nutrition Component

| Micronutrient           | Units/Portion | Purita Mamá | Purita Fortificada |
|-------------------------|---------------|-------------|--------------------|
| Vitamin A               | μg            | 120         | 50                 |
| Vitamin C               | mg            | 35          | 14                 |
| Vitamin D               | μg            | 1           | 0.6                |
| Vitamin E               | mg            | 7.5         | 0.1                |
| Vitamin B <sub>1</sub>  | mg            | 0.4         | 0.06               |
| Vitamin B <sub>2</sub>  | mg            | 0.4         | 0.24               |
| Niacin                  | mg            | 4           | 0.12               |
| Vitamin B <sub>6</sub>  | mg            | 0.5         | 0.06               |
| Folate                  | μg            | 130         | 7.34               |
| Vitamin B <sub>12</sub> | μg            | 1.3         | 0.64               |
| Vitamin B <sub>5</sub>  | mg            | –           | 0.46               |
| Calcium                 | mg            | 325         | 182.4              |
| Iron                    | mg            | –           | 2.0                |
| Phosphorous             | mg            | 291.5       | 155.2              |
| Magnesium               | mg            | 62.5        | 15.0               |
| Zinc                    | mg            | 1.9         | 1.0                |
| Copper                  | mg            | –           | 0.08               |

Notes: All values come from Technical Guidelines for Leche Purita Fortificada (old formula) and Leche Purita Mamá (new formula). Each are described in terms of quantity of nutrients per recommended portion. In the new formula, the recommended portion is 25 grams, versus a recommended portion of 20 grams in the old formula.

## C Maternal Fixed Effects

As a consistency check of the difference-in-difference results reported in the paper, we also undertake an analysis using the full matched micro-data observing each mother’s participation status in ChCC. Identification is driven by variation within mother’s exposure to the program over time. We estimate the following mother FE specification:

$$InfantHealth_{ijt} = \beta_0 + \beta_1 ChCC_{jt} + \mathbf{X}_{ijt} \boldsymbol{\beta}_x + \phi_t + \mu_j + \varepsilon_{ijt} \quad (4)$$

where *InfantHealth* refers to the same measures of health at birth as discussed in the body of the paper of child *i* born to mother *j* at time *t*.

The matched administrative data allows us to construct a panel of mothers and their children, and the independent variable of interest in 4 is *ChCC<sub>jt</sub>*. This measures for each mother at time *t* whether she participated in Chile Crece Contigo, and under typical (fixed effect) panel assumptions,  $\beta_1$  identifies the effect of participation on infant health. We include maternal fixed effects  $\mu_j$  and year fixed effects  $\phi_t$ , as well as a series of time-varying controls for mothers including birth order dummies, mother’s age at birth dummies, and child year of birth dummies.<sup>20</sup> Identification takes advantage of the fact that there are mothers who (a) participated in ChCC and had births both before and after the introduction of the policy, and (b) never participated in the policy and also had births both before and after the policy’s introduction.

The matched mother and child data does not include the entire universe of births (we do use the entire universe of births in municipal-level regressions presented in the paper). As such, any estimated program impacts in the micro-level mother FE specification are at best suggestive of the average effects in the population. When matching vital statistics data with parental social program use data, approximately 50% of births were matched with fathers, rather than mothers, and in these cases we do not observe the mother’s ChCC participation status. We thus restrict the analysis with mother FE only to the population of children matched with mothers, noting that it is not a representative sample, and as such not directly comparable to the municipal-level difference-in-difference regressions presented in the paper based on the entire universe of births. Nevertheless, it acts as a

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<sup>20</sup>We are also able to control for a number of other individual-level covariates including maternal education, however in our main specification do not propose include this control given that ChCC explicitly aims to ensure that young mothers who are still enrolled in education finish their studies, and hence education is likely a bad control. In supplementary analyses we augment the controls in 4 to examine the robustness of findings to alternative specifications.

useful robustness check of the impact of ChCC based on different identifying assumptions.<sup>21</sup>

Table C1: Summary Statistics: Matched Mother, Child and Social Security Data

|                                                | N       | Mean    | Std. Dev. | Min     | Max     |
|------------------------------------------------|---------|---------|-----------|---------|---------|
| <b>Panel A: All Mothers</b>                    |         |         |           |         |         |
| Birth Weight (grams)                           | 1912573 | 3327.45 | 539.30    | 500.00  | 5000.00 |
| Low Birth Weight < 2500 grams                  | 1912573 | 0.06    | 0.23      | 0.00    | 1.00    |
| Gestation (weeks)                              | 1910932 | 38.59   | 1.74      | 25.00   | 44.00   |
| Premature < 37 weeks                           | 1910932 | 0.07    | 0.25      | 0.00    | 1.00    |
| Length (cm)                                    | 1911391 | 49.47   | 2.49      | 30.00   | 60.00   |
| Year of Birth                                  | 1917085 | 2006.57 | 2.30      | 2003.00 | 2010.00 |
| Mother's Age                                   | 1915322 | 27.08   | 6.81      | 14.00   | 49.00   |
| Proportion Teen Births                         | 1917085 | 0.16    | 0.36      | 0.00    | 1.00    |
| Number of Children                             | 1916934 | 1.96    | 1.13      | 0.00    | 15.00   |
| <b>Panel B: Matched Mothers and Children</b>   |         |         |           |         |         |
| Proportion Ever Enrolled in ChCC               | 741963  | 0.38    | 0.48      | 0.00    | 1.00    |
| Birth Weight (grams)                           | 740393  | 3333.34 | 541.73    | 500.00  | 5000.00 |
| Low Birth Weight < 2500 grams                  | 740393  | 0.06    | 0.23      | 0.00    | 1.00    |
| Gestation (weeks)                              | 739707  | 38.64   | 1.76      | 25.00   | 44.00   |
| Premature < 37 weeks                           | 739707  | 0.07    | 0.25      | 0.00    | 1.00    |
| Length (cm)                                    | 739913  | 49.50   | 2.50      | 30.00   | 60.00   |
| Year of Birth                                  | 741963  | 2006.60 | 2.29      | 2003.00 | 2010.00 |
| Mother's Age                                   | 741413  | 26.91   | 6.75      | 14.00   | 49.00   |
| Proportion Teen Births                         | 741963  | 0.15    | 0.36      | 0.00    | 1.00    |
| Number of Children                             | 741918  | 1.96    | 1.14      | 0.00    | 15.00   |
| <b>Panel C: Unmatched Mothers and Children</b> |         |         |           |         |         |
| Birth Weight (grams)                           | 1172180 | 3323.73 | 537.72    | 500.00  | 5000.00 |
| Low Birth Weight < 2500 grams                  | 1172180 | 0.06    | 0.23      | 0.00    | 1.00    |
| Gestation (weeks)                              | 1171225 | 38.57   | 1.73      | 25.00   | 44.00   |
| Premature < 37 weeks                           | 1171225 | 0.07    | 0.26      | 0.00    | 1.00    |
| Length (cm)                                    | 1171478 | 49.46   | 2.48      | 30.00   | 60.00   |
| Year of Birth                                  | 1175122 | 2006.55 | 2.31      | 2003.00 | 2010.00 |
| Mother's Age                                   | 1173909 | 27.19   | 6.84      | 14.00   | 49.00   |
| Proportion Teen Births                         | 1175122 | 0.16    | 0.37      | 0.00    | 1.00    |
| Number of Children                             | 1175016 | 1.96    | 1.13      | 0.00    | 15.00   |

NOTES TO TABLE C1: Summary statistics are presented for all births matched with the mother's participation in social programs. Summary statistics are presented for all years from 2003-2010. *Chile Crece Contigo* began in June of 2007, and so any mothers having all births prior to this date never participated in ChCC. For additional notes on variable definitions and comparison with the full universe of births (collapsed by municipality) refer to Table 1.

<sup>21</sup>The two proposed strategies (the DD estimates in the body of the paper and the mother FE estimates in Appendices) rely on strict (conditional) exogeneity for the family panel specification in equation 4 and parallel trends for the DD specification in equation 1.

In Table C1 we present summary statistics of births to all mothers, births to mothers who were matched with their social program usage, and births to mothers who were not matched the mother's social program usage data. While their observable measures are largely similar, matched mothers appear to be slightly younger (26.91 versus 27.19 years), and have births with slightly better health indicators (3,333 grams of birthweight versus 3,324 on average).

We present regression results using maternal fixed effects in Table C2. In this case identification is driven by mothers who have had more than one birth, and hence variation in program coverage. Despite the alternative methodology (and estimation sample) we observe results that are qualitatively similar to those reported using the municipal roll-out to estimate program impacts. In this case we observe a larger impact on birth weight (19 grams, versus 10 grams), and significant impacts also when considering size at birth of each child. One result does not agree across specifications, and this is the estimate on the impact of ChCC on low birth weight children. In this specification we observe a weakly positive impact, while in the specification reported in Table 2 we observed a weakly negative impact. However, in Table C3 when we additionally include full time and municipal fixed effects, we observe that the result is no longer statistically distinguishable from zero, while remaining effects are largely unchanged. In panel B of Appendix Table A7 we present  $p$ -values on the impact of ChCC when correcting for multiple hypothesis testing. For birth weight, birth size, and gestational length we observe that results remain statistically distinguishable from zero when controlling for the family wise error rate using Romano and Wolf's step-down correction.

Table C2: Estimated Program Effects with Mother Fixed Effects

|                      | (1)<br>Weight           | (2)<br>LBW         | (3)<br>Size          | (4)<br>Gestation     | (5)<br>Premature    |
|----------------------|-------------------------|--------------------|----------------------|----------------------|---------------------|
| Participated in ChCC | 19.395***<br>[4.534]    | 0.004*<br>[0.002]  | 0.049**<br>[0.022]   | 0.090***<br>[0.016]  | -0.001<br>[0.002]   |
| Constant             | 3074.884***<br>[63.811] | 0.090**<br>[0.036] | 48.412***<br>[0.316] | 38.069***<br>[0.253] | 0.124***<br>[0.038] |
| Observations         | 739811                  | 739811             | 739332               | 739126               | 739126              |
| R-Squared            | 0.018                   | 0.002              | 0.022                | 0.012                | 0.002               |

Estimation sample consists of all births where the data link exists between the child and the mother's participation in social programs, including ChCC. Additional details regarding this procedure are provided in Appendix C. In each case mother's fixed effects are included, and full fixed effects for mother's age at birth, child birth order, and child's year of birth are included. Standard errors are clustered by mother. \*  $p < 0.10$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

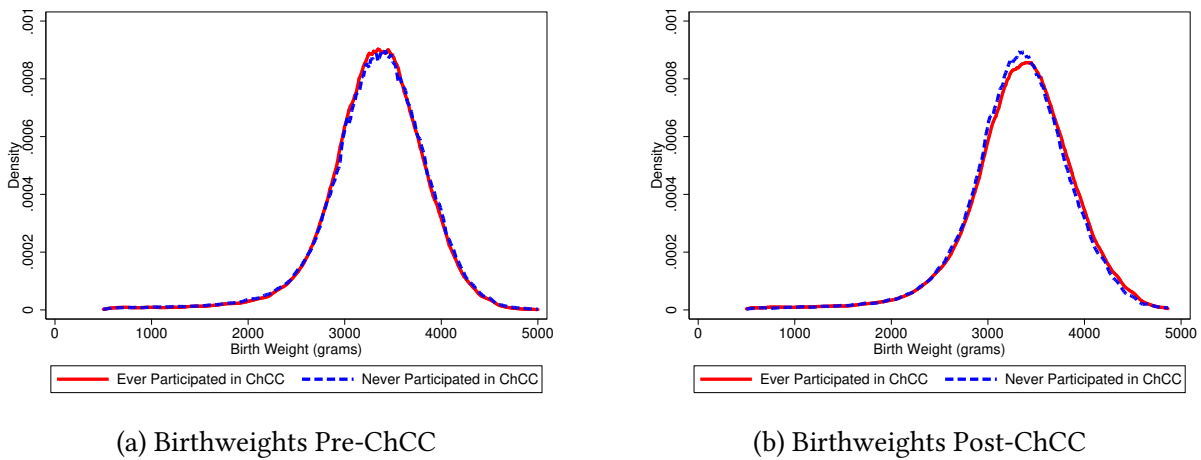
Table C3: Maternal FE Estimates with Additional Controls

|                      | (1)<br>Weight           | (2)<br>LBW          | (3)<br>Size          | (4)<br>Gestation     | (5)<br>Premature    |
|----------------------|-------------------------|---------------------|----------------------|----------------------|---------------------|
| Participated in ChCC | 19.878***<br>[4.599]    | 0.003<br>[0.002]    | 0.057**<br>[0.022]   | 0.094***<br>[0.016]  | -0.002<br>[0.002]   |
| Constant             | 3078.749***<br>[72.798] | 0.110***<br>[0.040] | 48.101***<br>[0.356] | 37.870***<br>[0.281] | 0.149***<br>[0.042] |
| Observations         | 739554                  | 739554              | 739075               | 738869               | 738869              |
| R-Squared            | 0.023                   | 0.006               | 0.027                | 0.017                | 0.006               |

Refer to notes in table C2. All details of estimated specifications are identical, however we now include year by month fixed effects, and fixed effects for municipality of birth.

Finally, we briefly examine distributional impacts of the program on health at birth, as examined in Figure 3. In this case we simply examine descriptive evidence, considering the distribution of birth weight between program recipients and non-program recipients prior and posterior to the program's implementation. These are presented in Figure C1, and we observe that in the pre-program period, the distribution of birth weight for recipient mothers is slightly below the corresponding distribution for non-recipient mothers, while post-program the reverse pattern is observed (both differences are observed in the rejection Kolmogorov-Smirnov of tests of the equality of distributions). Interestingly, the distribution appears to be most shifted from around 2500-4500 grams, providing some descriptive support of the distributional results documented in Figure 3.

Figure C1: Birthweight Distributions Pre- and Post-Program Implementation



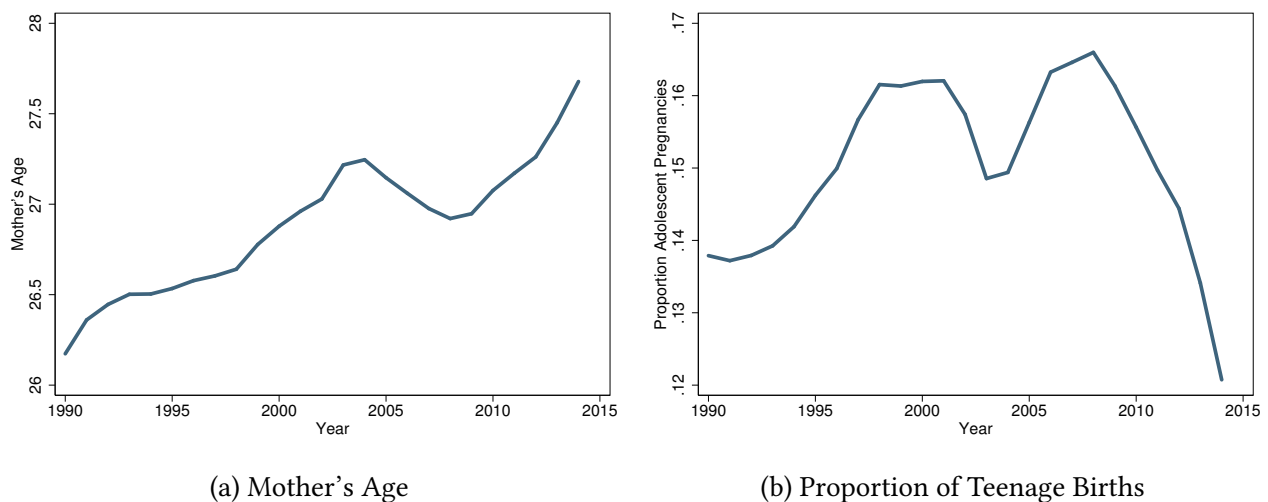
NOTES TO FIGURE C1: Densities are plotted using an Epanechnikov kernel with a bandwidth of 5 grams. Each panel separates distributions by whether the mother *ever* participates in Chile Crece Contigo. Panel (a) displays only pre-ChCC time periods, while panel (b) displays only post-ChCC time periods. In both cases, Kolmogorov-Smirnov tests reject equality of distributions (in different directions).

## D Broader Context on Birth Outcomes and Maternal Characteristics in Chile

Following the return to democratic rule in 1990, full microdata on all births in Chile has been available from the Ministry of Health's Department of Statistics and Health Information (DEIS). These vital statistics include each child's birth weight, weeks of gestation, and a number of characteristics of the mother and father (when the father is present). This data is recognised to be of high quality and very close to universal (see for example [Mikkelsen et al. \(2015\)](#)).

The average age of mothers in Chile has risen from slightly over 26 in 1990, to slightly under 28 in 2015 (Figure D1). The average age of mothers increased constantly from 1990 until approximately 2004, before falling slightly, and ascending once again from 2009 onwards. This reduction in maternal age occurred during a considerable slow-down in growth, and an uptick in the number of births each year (Figure D2), in line with results suggesting countercyclicality in fertility. Panel b of Figure D1 displays the proportion of teenage births (among all births), which rose until the early 2000s, began to fall until the growth slowdown in the mid-2000s, and has fallen sharply from 2007.

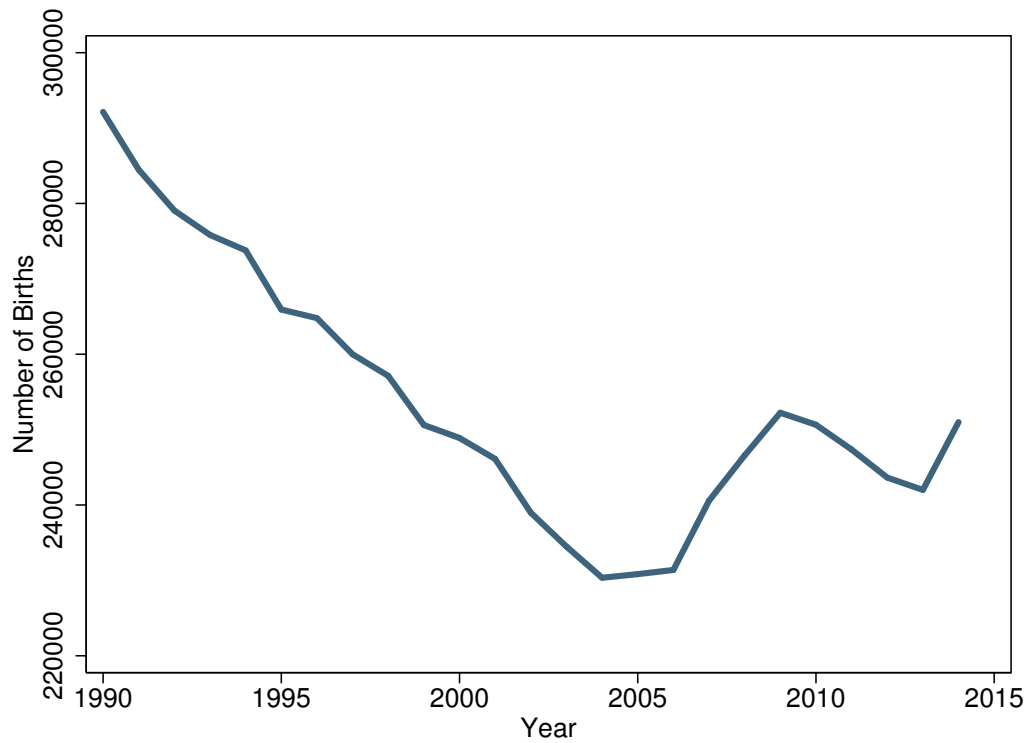
Figure D1: Trends in Maternal Characteristics in Chile



NOTES TO FIGURE D1: Yearly averages of age and the proportion of all mothers aged under 20 years of age based on Ministry of Health (DEIS) microdata covering all births in Chile between 1990 and 2015.

We display descriptive plots of average birth outcomes across time in figure D3. These indicators, particularly birth weight, improved sharply following the transition to democracy in the early 1990s,

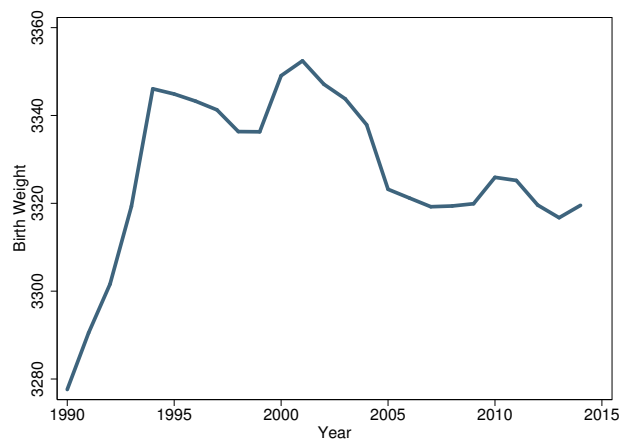
Figure D2: Number of Births per Year



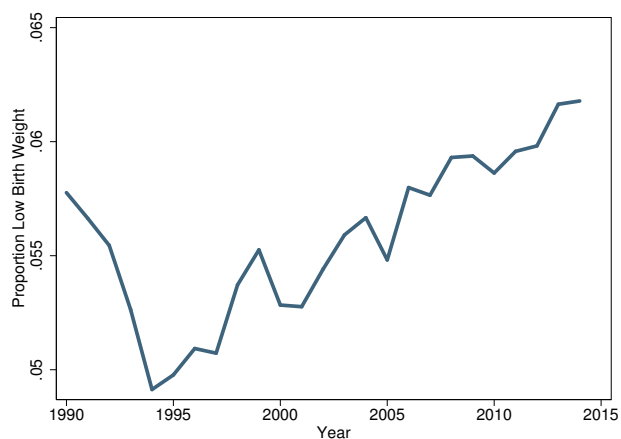
and the implementation of a considerable public health reform. Average birth weight increased by more than 60 grams, and the proportion of low birth weight babies fell by a full percentage point (refer to panels [D3a](#) and [D3b](#)). From the year 2000 onwards, average outcomes have gradually worsened, in line with increases in maternal age.

Primary care in the public health system in Chile is provided by municipal health centres which, among other things, provide pre-natal appointments for pregnant mothers and families. These municipal health centres exist in each municipality in Chile (refer to [Figure D4a](#) for geographic distribution). These health centres are distributed much more sparsely in less populated northern and southern regions of the country. Secondary and tertiary care are provided in hospitals which are located in each region of the country. Births attended in the public health centre are delivered in these hospitals. The geographical distribution of hospitals is displayed in [Figure D4b](#), where once again these are concentrated in the central region of the country where the largest population resides.

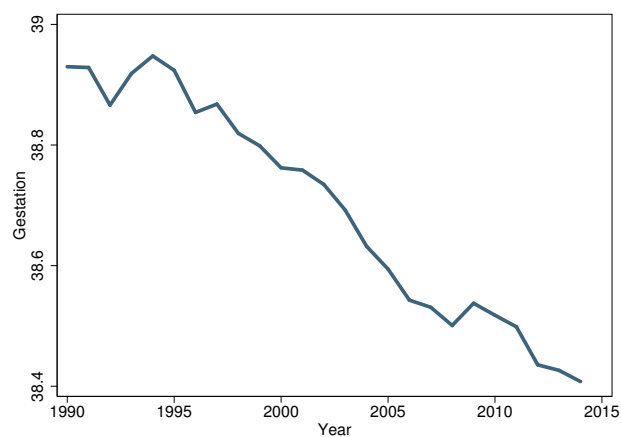
Figure D3: Longer Term Trends in Birth Outcomes in Chile



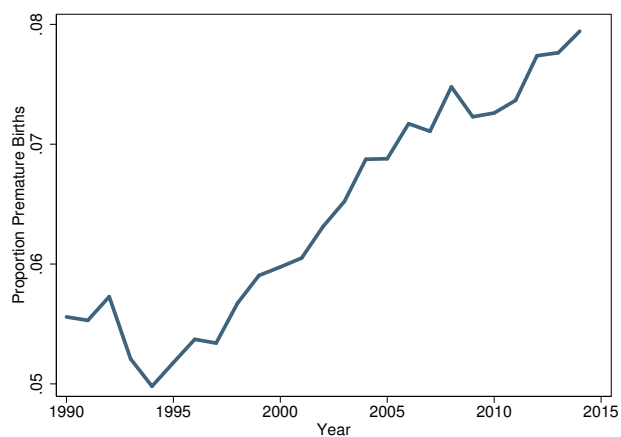
(a) Birth Weight



(b) LBW



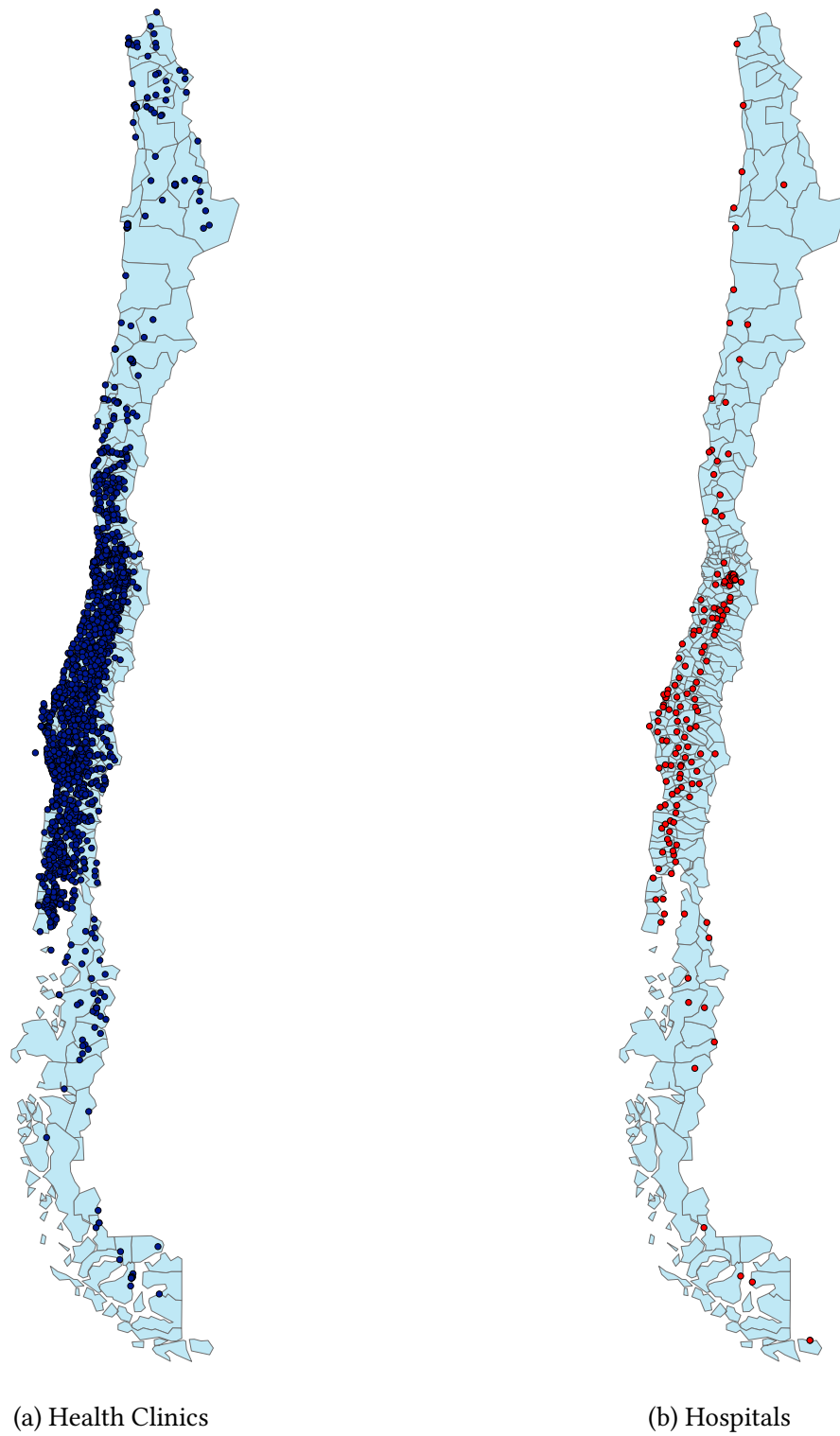
(c) Gestation



(d) Prematurity

NOTES TO FIGURE D3: Yearly averages of birth weight, the proportion of low birth weight births (< 2500 grams), weeks of gestation, and the proportion of premature births (< 37 weeks) from Ministry of Health (DEIS) microdata covering all births in Chile between 1990 and 2015.

Figure D4: Geographic Distribution of Health Centres and Hospitals



NOTES TO FIGURE D4: Geo-referenced hospital and Health Clinic information from the Ministry of Health of Chile. All points represent public hospitals and health clinics.