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An Impact Evaluation of the Safe Motherhood Program in China

Yan Guo [1], Xinglin Feng[2], Guang Shi[3], Yan Wang[4], Ling Xu [5], Hao Luo, Juan Shen, Hui Yin

Abstract

Using 11 years of county level panel data, fixed effect models are estimated to evaluate the impact of the Safe Motherhood Program in China. Propensity score matching is used to select comparable factual and counterfactual counties. Out of 2013 counties in China, 283 are selected for the treatment group and 1052 for the control group. The results support the dose response relationship between the program and its targeted outcomes: 7 years' treatment of the program increases hospital delivery rate by 3.992 per 100 live births and decreases Maternal Mortality Ratio(MMR) due to hemorrhage by 10.229 per 100 live births. Further modeling supports the conclusion that the program reduces MMR by enhancing MCH care. With an average annual incremental unit cost for the program of about 318.0 thousand RMB(39.8 thousand USD) per county, we conclude that the Safe Motherhood Program is effective in reducing MMR through the enhancement of hospital delivery.

Key Words: Safe Motherhood, Impact Evaluation, Maternal Mortality, MDG 5, Propensity Score Matching, Fixed Effect Model

Institution conducting the research: Department of Health Policy and Administration, School of Public Health, Peking University Health and Science Center. 38# Xueyuan Road, Beijing. 100191

[1] Professor, Department of Health Policy and Administration, School of Public Health, Peking University Health and Science Center. 38# Xueyuan Road, Beijing. 100191
Email: guoyan@bjmu.edu.cn Tel:86-10-82805061 Fax: 86-10-82805061
[2] Lecturer, Department of Health Policy and Administration, School of Public Health, Peking University Health and Science Center. 38# Xueyuan Road, Beijing. 100191
Email: fengxinglin@bjmu.edu.cn Tel: 86-10-82805394 Fax: 86-10-82805061
[3] China Health Economics Institute, Peking University Health Science Center, Beijing, China.
Email: sg@nhei.cn
[4] Professor, Director of the Department of Child , Adolescent and Women's Health, Vice Dean of School of Public Health, Peking University Health Science Center, Beijing, China
[5] Research Fellow, Renmin University of China, Beijing, China

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1. Introduction

The Millennium Summit held in 2000 included the reduction of maternal mortality as the fifth Millennium Development Goal (MDG5). The target of MDG5 is to reduce the maternal mortality ratio (MMR) by 3/4 between 1990 and 2015, which requires the annual reduction rate of MMR to be at least 5.5%. Yet as the Maternal Mortality Working Group (Hill, Thomas, Abouzahr, Walker, Say, & Inoue et al., 2007) estimated, till 2005 the world lagged much behind this goal with an annual reduction rate of only 2.5%.

Although significant declines in MMR have been witnessed since the liberation of China, the process has been slowing down since the 1990s. Evidence shows that rural areas are marginalized and great geographical inequalities exist across China (MOH, UNICEF, WHO, & UNFPA, 2006). As the biggest developing country, China bears a large burden of worldwide maternal mortality, and was therefore categorized into the 68 “countdown” countries to attain MDG5 (Countdown Coverage Writing Group, 2008; UNICEF, 2008). All these factors created new challenges in developing MCH policies for the Chinese government.

To accelerate achieving the MDG 5, the Chinese government initiated the national Safe Motherhood (SM) Program in 2000. The program aims to reduce MMR through the enhancement of MCH care. The goal of this study is to evaluate the impact of the program. To this end, we collected eleven years of secondary panel data for all the counties across China, used propensity score matching (PSM) to select comparable counties, and then employed fixed effect models to estimate the impact. The results support the existence of dose response relationships between the program and its targeted outcomes.

The paper is organized as follows: the second section describes the SM Program; the third section presents the empirical strategy, including how the samples are selected using PSM, and a description of the formal econometric models used to estimate impact; the fourth section introduces the data we are using; and the fifth section presents the results for PSM, descriptive statistics and the impact evaluation results. The last section provides some discussion, summarizes our conclusions, and reports some cost information of the SM Program.

2. Program Description

The Safe Motherhood Initiative in China was introduced by UNICEF in 1999. In 2000 the Ministry of Health (MOH), the National Working Committee for Children and Women and the Ministry of Finance jointly organized and implemented the National Safe Motherhood Program (in Chinese the full name is the Program to Reduce Maternal Mortality and Eliminate Neonatal Tetanus "? ") (MOH, UNICEF, & NWCWC, 2003). The rationale of the program is to reduce the risk of maternal mortality by enhancing qualified hospital delivery. A three-cycle model (Figure 1) was used to describe the key partners of safe motherhood and the program strategy (Department Of MCH, 2002): "families, communities, community supporters and health system should make concerted efforts for the promotion of hospital delivery." Based on the strategy, three main measures were carried out to improve hospital delivery: health education, health infrastructure enhancement and social mobilization**.** The Program has two main innovations. Firstly, subsidy strategy changed from the traditional supply side reimbursement to demand side one, where pregnant women could get direct subsidies from local government or maternal care institutions managed by the local government. Secondly, ad hoc obstetric experts from provincial tertiary hospitals were assigned to primary maternal care centers for at least two weeks to help reinforcing local capacity, setting up referral green channels and training local health staff.

Figure 1 to be inserted

As official documents noted, the program is carried out at county level and there are three criteria for selecting program candidates: (1) being national poverty counties with basic capacity to carry out the Program; (2) with base line MMR and neonatal tetanus incidence ratio (NTR) above the county's provincial average; and (3) with budget provided by provincial government capable of matching the central government's contribution at least 1:1. However, the actual selection procedure might differ from official statement. For example, as we checked, only 68% first stage counties were really national poverty counties. In the first two-year stage (2000-2002) the program covered 378 counties in 12 central and western provinces. From 2002 on, the program expanded to 428 counties (the second stage). In 2005 the program was extended to 1,000 counties (the third stage). Table I illustrates coverage and funding of the Program, which shows there has been totally 1 billion RMB invested in the Program from 2000-2006.

Table I to be inserted

3. Empirical Strategy

The goal of the study is to evaluate the impact of the Safe Motherhood Program in China. Empirically, we raise two questions to establish the causal relationship:

(1) Does the Program have intended positive Ceteris Paribus effect of reducing MMR?

(2) How much of the effect could be attributed to the enhancement of MCH care?

3.1. Modeling the Impact

Retrospective panel data at county level across China from 1996 to 2006 were collected and fixed effect models are used to estimate impact, drawing heavily on Jacobson, LaLonde, & Sullivan's methodology (1993) which is a generalization of the widely used Differences-in-Differences(DiD) strategy in the health policy evaluation literature (Wagstaff & Yu, 2007) .

We denote Y_{it} as MMR of county i in year t and let D_{it}^{s} =1 if county i was carrying out the program for s years in year t and D_{it}^{s} =0 otherwise. Our data cover the period 1996 to 2006, since the program began in 2000, so $s \in \{1, 2, ..., 7\}$. Therefore the impact of being treated in the program for s years could be defined as:

$$E(Y_{it} \mid D_{it}^{s} = 1, Z_{it}) - E(Y_{it} \mid D_{it}^{s} = 0, Z_{it}) \ldots (1)$$

Through such a definition, we constrain s years treatment effects for the first stage program counties to be the same as s years effects for the second stage countries those not involved in the first stage. Thus, for county “Alpha” beginning the program in 2000 and county “Beta” beginning in 2004, we constrain the effects of the program for county “Alpha” in the year 2002 to be the same as the one for county “Beta” in the year 2006. Such a constraint is consistent with our intention to establish dose response relationship.

To answer the first question, the model could be specified as

$Y_{it} = D_{it}^{s} t^{s} + Z_{it} h + g_{t} D_{t} + a_{t} + e_{it} \ldots$(2)

Where Z_{it} consists of the observed, time-varying characteristics of county i; D_{t} is a set of year dummies to allow different trends; and a_{t} is the fixed effects summarizing the time invariant unobserved effects among different counties such as the enthusiasm to be involved and different progress to fully carry out the program. The first factor is described in the literature as the self-selection bias and the second as maturation trends (Rossi & Freeman, 1993; Windsor, Thomas Baranowski, & Cutter, 1984). The coefficients of the dummy variables D_{it}^{s} (s=1, 2…7) jointly represent the impact of the program. If the dose response relationship does exist, the coefficients of D_{it}^{s} should be monotonically increasing with respects to s.

To answer the second question, i.e. the pathway of the program to reduce MMR through the enhancement of MCH services, we just add the interaction terms of MCH services variables X_{it} with D_{it}^{s} and test whether the coefficient d equals zero. The model is specified as (3)

$$Y_{it} = D_{it}^{s} t^{s} + D_{it}^{s} X_{it} d + X_{it} b + Z_{it} h + g_{t} D_{t} + a_{t} + e_{it} \ldots (3)$$

The Maternal Mortality Working Group (Hill, Thomas, Abouzahr, Walker, Say, & Inoue et al., 2007) predicts the world MMR using GDP, general fertility rate and proportion of births with skilled attendants. Pregnancy malnutrition has also been suggested as a predictor. Based on this information and data availability, we finally chose 6 indicators as possible time varying confounding factors Z_{it} : the log of income, the logit transformation of birth rates, urbanization rates (% of urban population over total population), household density, hospital beds per 1000 population, and malnutrition rate of children under 5 years old. Household density and hospital beds per 1000 population are used as proxy variables for the accessibility of health care, and the malnutrition rate is used to control for the general nutrition level for pregnant women across counties. Although the literature suggests that mother's education is a good predictor of MCH services utilization (Say & Raine, 2007), and therefore might be highly correlated with MMR, since our analysis is based on county level aggregated data, and since we do not believe the average education level in a county would change much in 11 years, we consider that their effects could be adequately captured by the fixed effect.

3.2. Sample Selection

As previously described, the Safe Motherhood Program did not select counties for treatment randomly, but based on the three criteria mentioned earlier. The treated and non-treated counties are likely to vary greatly in their characteristics. Although we may control the confounding factors by de-meaning the fixed effects, we run the risk of an endogeneity problem caused by the nonrandomized origination of the initial selection procedure. Also, the DiD identifies the average treatment effect on the treated based on the assumption that:

$$E(Y_{i0} \mid D = 1, Z) = E(Y_{i0} \mid D = 0, Z) \ldots (4)$$

Where Y_{i0} refers to the untreated outcomes. Although our definition of the impact generalized the DiD strategy by making comparisons both between the treated and untreated and the treated before treatment really taking effects, we still have a risk of the violation of assumption (4).

To take the above two considerations into account, we adopt propensity score matching (PSM) (Becker & Ichino, 2002; Dehejia & Wahba, 2002; Heckman, Ichimura, & Todd, 1998) to trim the full sample of counties to comparable treatment and control counties. We then estimate the impact of the program by applying the fixed effects model to the matched sample.

In the first stage the selection propensity for each county is estimated by a probit model specified as:

$$\mathrm{Prob}\{D_i = 1 | X_i\} = \Phi(h(X_i)) \ldots(4)$$

Where Prob() denotes the probability, Di is a dichotomous variable equal to 1 if the county is in the program and 0 if not. And $h(X_i)$ are linear combinations of a series of baseline vectors and their interactions or higher order terms. Φ is the cumulative normal distribution function. We set a small range of bandwidth (0.005) to identify all counterfactual counties whose estimated propensity score is located in this range for each factual county. The method is known in literature as radius matching (Becker & Ichino, 2002).

4. Data

The data we propose to use include three main secondary sources:

(1) MCH annual report (MAR) data system, routinely collected by MOH each year,

mainly provides left hand variables at county level from 1996 to 2006. These variables include maternal mortality by cause[2], neonatal and infant mortality; incidence of neonatal tetanus, live births, hospital deliveries and antenatal visits. The data base also provides some right hand time-varying variables such as nutrition status for children under 5 years old.

(2) A panel data base collected from the Statistical Bureau annual report system (SBD) at county level year1996 to 2006, including twelve raw variables: GDP, annual income of rural population, annual government financial input, rural population, total population, male population, female population, number of households, number of beds for health care, land areas, whether a minority population autonomous county or not, whether a poverty county or not. This data base provides both information for PSM and time varying variables.

(3) The Fourth Census data base (FCD) provides county level information for 2000: population aged 0-14, population aged 15-64, population aged above 64, illiteracy rate above 15 year-old, mortality rate, and urban employment rate. These data are used in the PSM exercise.

Originally we collected the data based on the MAR system which provides information for all county level units in China, a total of 3,255. However the Statistical Bureau data system could only provide statistics for each county or city[3], and, although districts in large cities are treated as county level units, data for these

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2 Four categories of causes of death are reported, they are hemorrhage, puerperal infection, hypertension, and internal causes.

3 Some clarification of the administration system in China: County is a basic unit which includes districts in the urban region and villages in the rural region. City is larger than county which is also comprised with both districts and villages. However Some city is prefecture city—or because of other reasons,— their districts are treated as county level in the system.

units are not available. So we have to combine those county level districts collected from the MAR system. The aim in this combination process was to make sure the boundary and meanings for each observation in the data base remained unchanged across time. To make the observations comparable, we dropped 278 prefecture cities, since some of them reported aggregated data at the prefectural level. After this, the total number of observations fell from 3,255 to 2,013.

5. Results

5.1. PSM Estimation

5.1.1. Predicting selection

To project the program selection procedure, we introduced the 19 indicators listed in Table II into the Probit model. Since the program began in 2000, the baseline data in 1999 were used for this exercise. Although FCD only provides data in 2000, to fully utilize the available information, we also inserted these variables in the Probit model.

The results (Table II) show that generally the coefficients for each predictor of selection are consistent with common sense. Counties with a higher neonatal mortality ratio and lower governmental financial input (transfer) were more likely to be selected. The counties selected also have higher birth rates, higher mortality rates and younger population. Minority autonomous counties and poverty counties face higher probability to be chosen. With the quadratic form of log income, the coefficient of first order term becomes positive. The inflexion point is 6.80 and the mean of log income in the sample is 7.53, which suggests that the probability of selection increased with income for those least developed counties. However, when income approaches the average level, counties with lower income are more likely to be selected. The finding is consistent with the first selection criteria that the program counties should be those that have basic capacities to carry out the program.

Table II to be inserted

5.2. Propensity Score Matching

To get the treatment and control group perfectly matched, we inserted all indicators listed in Table II and outcome variables[4] in 1998 and 1999 into the Probit model to estimate the selection propensities. Using common support criteria, we finally matched 1,052 counterfactual counties to 283 first stage program counties with a bandwidth of 0.005. Figure 2 shows the results for support and table III displays the distribution of these counties in each stage of the Program.

The matching results (Figure 2) illustrates that counties which were treated concentrated much more in the lower selection propensity range and none of them had an estimated propensity larger than 0.8. This would remove treated counties with high propensities using common support and match more counterfactual counties with low propensities for the fixed effects models. Weighted estimates were used to deal with the second problem. However, the first challenge might bias the real effects of the Program by not taking into consideration of the counties with high selection

[4] MMR and MMR broken down by causes, NMR, CMR, IMR, NTR

propensities. However one should remind that the Probit model suggested that counties with high selection propensities had higher birth rates and maternal mortality. And according to the rule of marginal effects decreasing, we consider that the program should have more impact on those high propensity treatment counties than those that were trimmed. So the impact of the program might be underestimated and our estimator is the conservative one.

Figure 2 to be inserted

Table III to be inserted

5.3. Descriptive results

Since the procedure of radius matching results in different numbers of matched counties for each observation in the treatment group, and as Figure 2 shows, factual counties with low projected propensity match more than one counterfactual one; we use the inverse of the total number of matches for each observation in the treatment group to weight the control group data. Table IV provides weighted background statistics in the year 1999 for the counties selected by PSM. The results show that these cases become quite balanced in their baseline indicators. For example, before trimming the sample, IMR for the first stage program were 35.619(se 0.931) compared with the non-program county average 20.853(0.370). And as Table IV illustrated, the results changed to 33.636(0.952) versus 35.780 (0.838) after the matching exercise; where we could observe that both the average level and standard errors were getting closer.

Table IV to be inserted

Figure 3-7 illustrate trends of those outcome variables for the matched counties separated by treatment and control groups. We use the same weights as before for the control group observations. The results show that MMR for the two groups converged in 2003, with the rate for the treatment group falling below that of the control group thereafter. The various causes of maternal mortality display almost the same trends. Figure 4 shows that the treatment group's MMR due to puerperal infection has been falling quickly compared to that of the control group. These finds suggest the positive effect of the program in reducing MMR.

As for the case of NMR, trends of convergence have not emerged until 2004, whereas neonatal tetanus incidence ratio for the treatment group dropped very quickly down to the level of the control group after 2000, which suggest the positive impact of the program to reduce neonatal tetanus.

Figure 3-7 to be inserted

With respect to the trends of MCH care, descriptive results(Figure 8-9) show that the baseline hospital delivery rate for the treatment group was lower than for the control group, however the two groups present patterns of convergence. As for antenatal visits, the level of utilization for the treatment group increased dramatically and exceeded the control group since the commencement of the program. These findings suggest that the program does improve MCH care.

Figure 8-9 to be inserted

5.4. Impact Results

Using model (2), we estimated the impact of the program. Preliminary modeling results showed that urbanization rates and household density are not significant at 0.3 levels, so we dropped them. Table V reports the results estimated by fixed effect models weighted by the inverse number of matched counties.

Table V to be inserted

The results show that generally the coefficients of Ds increase with s when MMR, and MMR broken down by hemorrhage, puerperal infection and hypertension act as dependent variables. So generally the results support the hypothesis that dose response relationship exists between the program and the intended health outcome, MMR. Although the effect of the Program on NMR is not so obvious, the program impact on the reduction of neonatal tetanus rate is significant.

In terms of the effects of the Program on the enhancement of MCH care, the coefficients are not only statistically significant but also monotonically increasing for the hospital delivery case. To highlight the results, as the models suggest, 7 years' treatment of the program could increase hospital delivery rate by 3.992 per 100 live births and decrease MMR due to hemorrhage by 10.229 per 100,000 live births.

As for those time varying confounders, the coefficient of birth rates is negative in the OLS regression suggesting that higher birth rates could predict lower MMR, a counter-intuitive result.

To test the pathway of the Program's impact by enhancing MCH care**,** we generate the interaction terms of hospital delivery ratios and antenatal visits ratios with the seven policy dummy variables and insert them in model (3). Table VI presents the results, which shows that the coefficients of hospital delivery and antenatal visits for MMR and its breaking down causes are all negative and significant. The results suggest that MCH care does has positive effect on the reduction of MMR. Furthermore as predicted, the coefficients of the interaction terms are all negative, where 6 years treatment could explain 0.176 and 0.143 per 100,000 live births reduction of MMR due to hemorrhage through the Program's effects on the enhancement of hospital delivery and antenatal visits respectively. And as Table VI suggests, generally there are signs of dose response relationships for both hospital delivery and antenatal visits in the interaction terms.

Table VI to be inserted

6. Discussion and Conclusions

Based on 11 years' county level panel data, our study used a fixed effects model which is a generalization of the widely used Difference-in-Differences strategy to evaluate the impact of the Chinese national Safe Motherhood Program. PSM procedures were used to select comparable program and non-program counties. Generally, the results establish a causal relationship between the program and its targeted outcome, and therefore support the hypothesis that the program does have the desired effect of reducing MMR.

Further modeling shows that the interaction terms of hospital delivery and antenatal care with the program are significant, thereby supporting the claim that the program could reduce MMR through the pathway of enhancing MCH care. The results are consistent with the literature that MCH care might reduce the risk of maternal mortality (Adam, Lim, Mehta, Bhutta, Fogstad, & Mathai et al., 2005; Buor & Bream, 2004; Ronsmans & Graham, 2006).

Since the launch of the Program, the coverage expanded from 378 to 1,000 counties in China during the past 7 years. Based on Table I, we estimated the costs of the program to be 318.0 thousand RMB（39.8 thousand USD[5]） per county each year, of which 227.2 thousand RMB (28.4 thousand USD) per county were paid by the central government. Although it looks like a modest investment for such a significant outcome, one should remember that this calculation only captures the INCREMENTAL cost, since the program did not cover salaries for local health staff

[5] The exchange rate of RMB vs USD was around 8:1 in 2006.

and other routine costs. Nevertheless, we can conclude that the SM Program does achieve its goal of accelerating the attainment of MDG5 at reasonable cost.

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8. Tables and Figures

Table I Coverage and Funding of the Program

year	No.of counties	Central government's funds(? 10,000)	Provincial governments' Contribution(? 10,000)
2000 - 2001	378	10,000	10,000
2002 - 2003	428	1,481	1,481
2004	440	5,080	5,000
2005	1,000	13,000	13,000
2006	1,000	44,187	0
Total	1,000	73,748	29,481

Source: Department of MCH, MOH, China

Table II Probit Models to Predict the Selection Procedure

Dependent variable: 1-First stage program county 0-otherwise

Description	Variables	Estimates
Mortater Mortality Ratio with logit transformation,log(mmr/(100000-mmr)+1)	ltmmr	-1.208 (20.348)
Child Mortality Ratio with logit transformation,log(nmr/(1000-nmr)+1)	ltnmr	11.217*** (3.269)
logarithm of income per capita (rural population)	lgincome	6.423*** (1.797)
square of lgincome	sqlginc	-0.471*** (0.126)
logarith of annual governmental financial input	lgfina	-0.765*** (0.121)
dummy variable to label whether the county is a poverty county or not	poverty	-1.951** (0.883)
lgfina*poverty	finapo	0.485*** (0.152)
dummy variable to label whether the county is mornority atonomous or not	mzx	0.422*** (0.103)
birth rate with logit transformation, log(birthrate/(100-birthrate))	ltbir	0.564*** (0.109)
illiteracy rate above 15 with logit transformation, log(illiab15/(100-illiab15))	ltill	0.007 (0.060)
mortality rate with logit transformation, log(mortrate/(100-mortrate))	ltmor	0.617*** (0.236)

urbanization rate, 1 minus proportion of rural population	urbanr	0.096
		(0.194)
average population per household	housize	-0.011
		(0.025)
sex ratio, population of male over female	sexr	0.622
		(0.391)
household density, number of househoulds over land areas	houdens	-0.001
		(0.001)
dependent rate of child, (population aged 0-14/population aged 15-64)*100	depratio_chi	0.009
		(0.006)
dependent rate of elder, (population aged >64/population aged 15-64)*100	depratio_old	-0.163***
		(0.026)
employment rate	emprate	0.010
		(0.007)
beds density, number of beds for health care over land areas	beddens	0.061
		(0.110)
beds per thousand population, No. of beds for health care/population*1000	bedpop	-0.004
		(0.015)
	Constant	-15.967**
		(6.677)
	LR_chi2	-611.277
	Pseudo_R2	.3580294
	N	2048

* p<0.10, ** p<0.05, *** p<0.01

Table III Distribution of matched counties in each stage of the program

	First stage Program	Non First Stage Program	Total
Second Stage	277	47	324
Non Second Stage	6	1005	1011
Third Stage	279	475	754
Non Third Stage	4	577	581
Total	**283**	**1052**	**1335**

Table IV Baseline statistics of the PSM selected counties in 1999 (Control group weighted by inverse of matched county number)

	First Stage	Second Stage	Third Stage	Non program
Maternal Mortality Ratio(per 100,000)	12.025	11.747	11.417	12.162
	(0.674)	(0.618)	(0.430)	(0.460)

mmr for hemorrhage	69.221	68.304	65.194	67.579
	(4.427)	(4.087)	(2.746)	(2.911)
mmr for hypertension	18.263	17.118	15.014	14.196
	(2.869)	(2.617)	(1.613)	(1.623)
mmr for puerperal infection	7.721	7.046	7.269	10.517
	(1.303)	(1.177)	(0.899)	(1.464)
Neonatnal Mortality Ratio	21.233	21.221	21.383	22.210
	(0.635)	(0.601)	(0.384)	(0.377)
Infant Mortality Ratio	33.636	33.100	33.903	35.780
	(0.952)	(0.820)	(0.798)	(0.838)
Infant Mortality Ratio within 7 days	12.806	12.882	12.703	12.616
	(0.986)	(0.901)	(0.525)	(0.261)
Neonatal Tetanus Incidence (per 1,000)	0.418	0.438	0.443	0.454
	(0.058)	(0.055)	(0.036)	(0.032)
income	1415.160	1394.605	1388.821	1384.375
	(36.790)	(34.094)	(21.178)	(15.140)
birth rate	11.664	11.580	11.661	11.676
	(0.265)	(0.248)	(0.219)	(0.210)
urbanization rate	14.876	14.589	13.022	14.853
	(1.584)	(1.447)	(1.316)	(1.214)
household density	36.935	36.377	36.491	35.767
	(3.655)	(3.338)	(2.023)	(1.296)
hospital beds per 1000 population	2.370	2.324	2.453	2.550
	(0.148)	(0.137)	(0.086)	(0.071)
illiteracy rate above 15	18.756	18.848	18.712	19.532
	(0.829)	(0.774)	(0.535)	(0.515)
mortality rate	6.788	6.814	6.852	6.894
	(0.071)	(0.066)	(0.049)	(0.048)
malnutrition rate under 5 years old	20.988	23.003	24.085	27.125
	(1.759)	(1.700)	(1.133)	(1.028)
national poverty county	0.652	0.675	0.685	0.593
	(0.028)	(0.026)	(0.017)	(0.015)
ethnical minority county	0.543	0.530	0.521	0.538
	(0.030)	(0.028)	(0.018)	(0.015)

a. Standard errors reported in the bracket
b. Second stage refers to counties which were not involved in the first stage but in the second stage.
c. Third stage refers to counties which were not involved in the first and second stage but in the third stage.

Table V Impact of the SF Program on Outcomes with OLS Fixed Effects

(weighted)

Dependent Variable	MMR	MMR_PI	MMR_HE	MMR_HY	NMR	NTR	HDR	AVR
D1	-0.510	0.653	-5.630	-0.217	0.041	-0.022	0.908*	1.368***
	(0.564)	(1.084)	(3.816)	(2.354)	(0.357)	(0.031)	(0.486)	(0.527)
D2	-0.697	1.986*	-6.226	-1.169	-1.357***	-0.113***	2.600***	2.408***
	(0.565)	(1.088)	(3.817)	(2.361)	(0.358)	(0.031)	(0.487)	(0.529)
D3	0.639	-0.264	2.523	-1.456	0.161	-0.064	2.206***	2.024***
	(0.712)	(1.597)	(4.811)	(2.973)	(0.451)	(0.040)	(0.614)	(0.666)
D4	-1.320*	-0.873	1.450	-14.970***	-0.818*	-0.147***	3.566***	3.355***
	(0.784)	(1.765)	(5.290)	(3.271)	(0.497)	(0.044)	(0.675)	(0.733)
D5	-1.960**	-3.410*	-14.070***	-7.215**	-0.326	-0.147***	3.853***	3.106***
	(0.792)	(1.776)	(5.346)	(3.306)	(0.502)	(0.044)	(0.683)	(0.741)
D6	-3.028***	-2.348	-20.360***	-10.902***	0.559	-0.079	2.436***	2.170***
	(0.869)	(1.917)	(5.872)	(3.629)	(0.550)	(0.048)	(0.748)	(0.812)
D7	-1.837**	-4.421**	-10.229*	-13.070***	-0.326	-0.033	3.992***	2.276***
	(0.869)	(1.918)	(5.869)	(3.629)	(0.551)	(0.048)	(0.749)	(0.813)
yeargr1	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
yeargr2	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
yeargr3	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
yeargr4	4.261***	0.000	-1.004	0.160	0.455	0.365***	-3.527***	-1.242**
	(0.700)	(0.000)	(3.520)	(2.922)	(0.330)	(0.039)	(0.449)	(0.487)
yeargr5	5.088***	-0.027	0.000	0.571	0.000	0.415***	0.000	0.000
	(0.684)	(0.867)	(0.000)	(2.855)	(0.000)	(0.038)	(0.000)	(0.000)
yeargr6	2.841***	-2.448***	-7.002*	-1.953	-1.098***	0.229***	3.773***	2.810***
	(0.604)	(0.868)	(3.732)	(2.521)	(0.350)	(0.034)	(0.476)	(0.517)
yeargr7	1.840***	-1.366	-18.797***	-0.866	-3.915***	0.169***	6.723***	3.004***
	(0.676)	(0.908)	(3.803)	(2.821)	(0.357)	(0.038)	(0.485)	(0.527)
yeargr8	4.341***	-0.835	-4.773	7.149***	-2.336***	0.320***	6.448***	-0.871
	(0.659)	(0.929)	(4.049)	(2.753)	(0.380)	(0.037)	(0.517)	(0.561)
yeargr9	1.754***	-2.365**	-13.039***	-2.322	-5.544***	0.167***	11.616***	2.807***
	(0.663)	(0.950)	(4.116)	(2.769)	(0.386)	(0.037)	(0.526)	(0.570)
yeargr10	2.328***	-2.968***	-12.242***	2.561	-7.430***	0.079**	18.441***	5.343***
	(0.681)	(1.102)	(4.016)	(2.843)	(0.375)	(0.038)	(0.511)	(0.554)
yeargr11	0.000	-2.686**	-26.027***	0.000	-7.496***	0.000	21.671***	5.740***
	(0.000)	(1.137)	(4.617)	(0.000)	(0.433)	(0.000)	(0.590)	(0.640)
ltbir	-2.571***	-0.958	-15.970***	2.206	-1.046***	-0.130***	-1.599***	-4.653***
	(0.562)	(1.044)	(3.798)	(2.348)	(0.356)	(0.031)	(0.485)	(0.526)

malr_ch	-0.015**	-0.007	-0.051	-0.055**	0.012***	-0.001**	0.010*	0.050***
	(0.006)	(0.011)	(0.040)	(0.025)	(0.004)	(0.000)	(0.005)	(0.006)
income	0.001***	0.001*	0.005***	0.004***	0.000	0.000***	0.001***	0.000
	(0.000)	(0.000)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
bedpop	0.182*	0.070	1.766**	0.083	0.028	-0.000	-0.244***	0.291***
	(0.105)	(0.219)	(0.707)	(0.437)	(0.066)	(0.006)	(0.090)	(0.098)
Constant	1.037	1.382	25.396***	16.231**	18.619***	-0.271***	42.298***	66.174***
	(1.512)	(2.611)	(9.249)	(6.313)	(0.867)	(0.084)	(1.180)	(1.281)
N	10654	10629	10648	10645	10659	10632	10659	10659

a.* p<0.10, ** p<0.05, *** p<0.01

b.Standard errors reported in the bracket

c. MMR_PI, MMR_HE and MMR_HY refers to MMR for Puerperal Infection, MMR for hemorrhage and MMR for hypertension respectively

Table VI Impact of the SF Program through MCH care with OLS fixed effects (weighted)

	MMR	MMR_HE	MMR_HY		MMR	MMR_HE	MMR_HY
hdr	-0.082***	-0.631***	-0.071	avr	-0.088***	-0.469***	0.015
	(0.013)	(0.085)	(0.053)		(0.011)	(0.077)	(0.047)
hdr_D1	-0.008	-0.043	-0.030	avr_D1	-0.002	-0.019	-0.032
	(0.009)	(0.059)	(0.037)		(0.007)	(0.044)	(0.027)
hdr_D2	0.001	-0.045	0.000	avr_D2	-0.002	-0.044	-0.034
	(0.008)	(0.056)	(0.035)		(0.006)	(0.044)	(0.027)
hdr_D3	0.012	0.071	-0.025	avr_D3	0.011	0.051	-0.028
	(0.011)	(0.074)	(0.046)		(0.008)	(0.054)	(0.033)
hdr_D4	-0.029**	-0.077	-0.161***	avr_D4	-0.015	0.032	-0.189***
	(0.012)	(0.080)	(0.050)		(0.009)	(0.061)	(0.038)
hdr_D5	-0.011	-0.068	-0.097**	avr_D5	-0.013	-0.093	-0.087**
	(0.011)	(0.076)	(0.047)		(0.009)	(0.060)	(0.037)
hdr_D6	-0.033***	-0.176**	-0.170***	avr_D6	-0.029***	-0.143**	-0.166***
	(0.011)	(0.077)	(0.048)		(0.009)	(0.064)	(0.040)
hdr_D7	-0.012	-0.089	-0.134***	avr_D7	-0.015	-0.076	-0.172***
	(0.011)	(0.074)	(0.046)		(0.009)	(0.064)	(0.040)
ltbir	-2.593***	-16.418***	2.784	ltbir	-2.994***	-18.148***	2.226
	(0.561)	(3.788)	(2.350)		(0.563)	(3.807)	(2.357)
malr_ch	-0.014**	-0.045	-0.058**	malr_ch	-0.011*	-0.028	-0.057**
	(0.006)	(0.040)	(0.025)		(0.006)	(0.040)	(0.025)
income	0.001***	0.006***	0.004***	income	0.001***	0.005***	0.004***
	(0.000)	(0.002)	(0.001)		(0.000)	(0.002)	(0.001)
bedpop	0.164	1.638**	0.035	bedpop	0.211**	1.923***	0.100
	(0.104)	(0.705)	(0.437)		(0.104)	(0.706)	(0.437)

yeargr2	-	-	-	yeargr2	-	-	-
	-	-	-		-	-	-
yeargr3	-	-	-	yeargr3	-	-	-
	-	-	-		-	-	-
yeargr4	2.650***	10.148**	0.000	yeargr4	3.862***	23.340***	0.000
	(0.701)	(4.735)	(0.000)		(0.675)	(4.566)	(0.000)
yeargr5	3.721***	11.827**	1.264	yeargr5	4.694***	23.204***	1.569
	(0.688)	(4.644)	(2.006)		(0.666)	(4.504)	(2.127)
yeargr6	1.570**	7.625*	-2.093	yeargr6	2.660***	18.550***	-1.327
	(0.611)	(4.124)	(2.049)		(0.592)	(4.002)	(2.153)
yeargr7	1.147*	-1.240	-0.176	yeargr7	1.727***	6.948	-0.527
	(0.664)	(4.482)	(2.236)		(0.659)	(4.460)	(2.323)
yeargr8	3.806***	16.459***	4.793**	yeargr8	4.044***	19.848***	7.312***
	(0.653)	(4.405)	(2.301)		(0.648)	(4.385)	(2.408)
yeargr9	0.894	3.969	-1.897	yeargr9	1.394**	10.846**	-2.434
	(0.642)	(4.335)	(2.434)		(0.648)	(4.382)	(2.480)
yeargr10	2.208***	8.810**	4.595	yeargr10	2.328***	11.058**	4.568
	(0.657)	(4.448)	(2.801)		(0.665)	(4.508)	(2.780)
yeargr11	0.000	0.000	-0.284	yeargr11	0.000	0.000	1.010
	(0.000)	(0.000)	(2.938)		(0.000)	(0.000)	(2.828)
Constant	6.017***	39.670***	20.598***	Constant	7.069***	31.359***	15.189**
	(1.664)	(11.234)	(5.904)		(1.674)	(11.341)	(6.358)
N	10654	10648	10645	N	10654	10648	10645

a. * p<0.10, ** p<0.05, *** p<0.01
b. Standard errors reported in the bracket
c. hdr refers to hospital delivery ratio (No. of hospital delivery/No. of live births*100)
d. avr refers to antenatal visits ratio (No. of antenatal visits/No. of live births*100)
e. MMR_HE and MMR_HY refers to MMR for hemorrhage and MMR for hypertension.

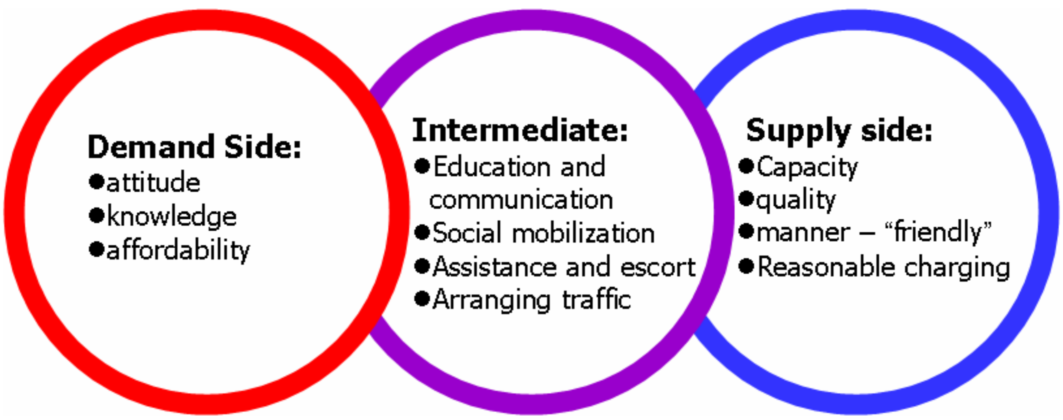

Figure 1 Three cycle strategy for the Safe Motherhood Program in China

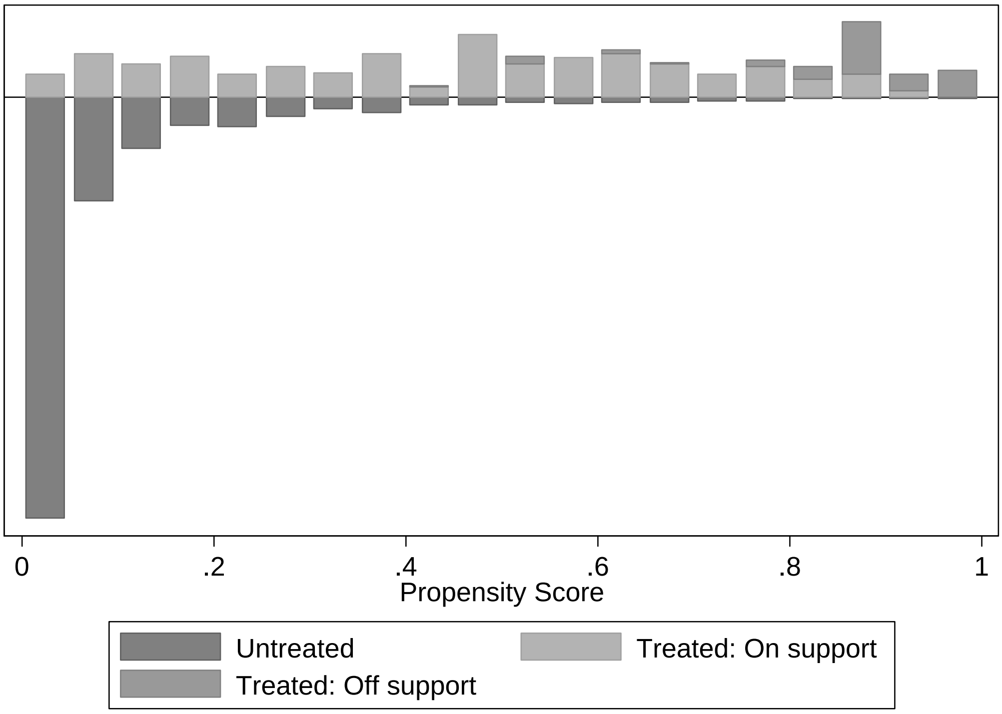

Figure 2 PSM results using all indicators in 1999 and outcome variables in 1998

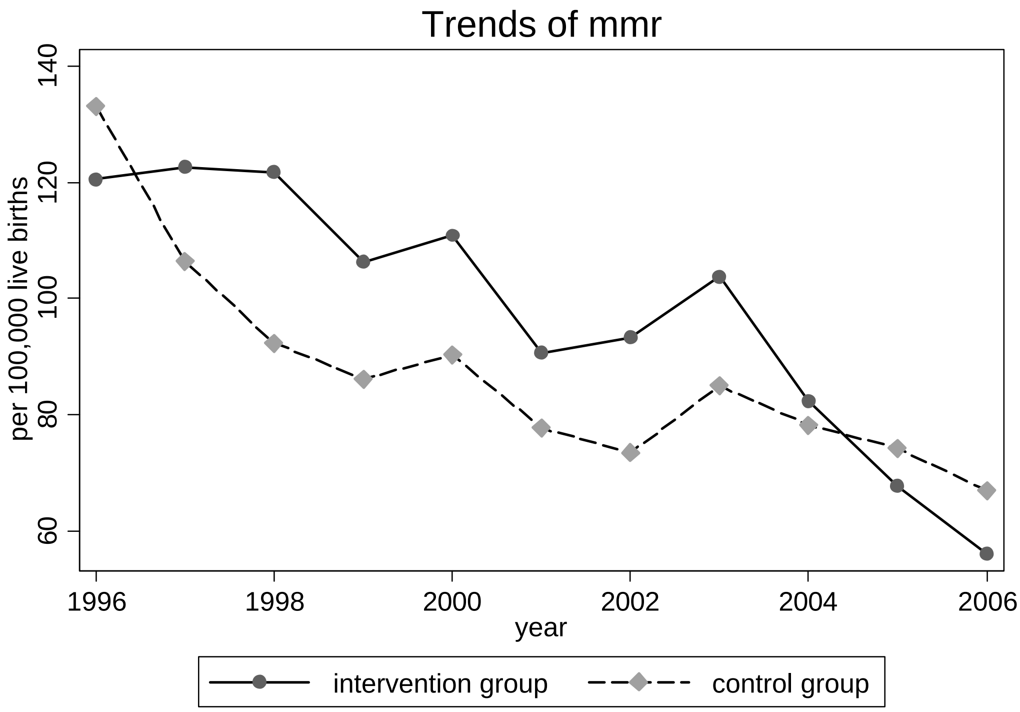

Figure 3 Trends of MMR for counties selected by PSM

(Control group weighted by the inverse of the total number of counties matched to each case in the treatment group)

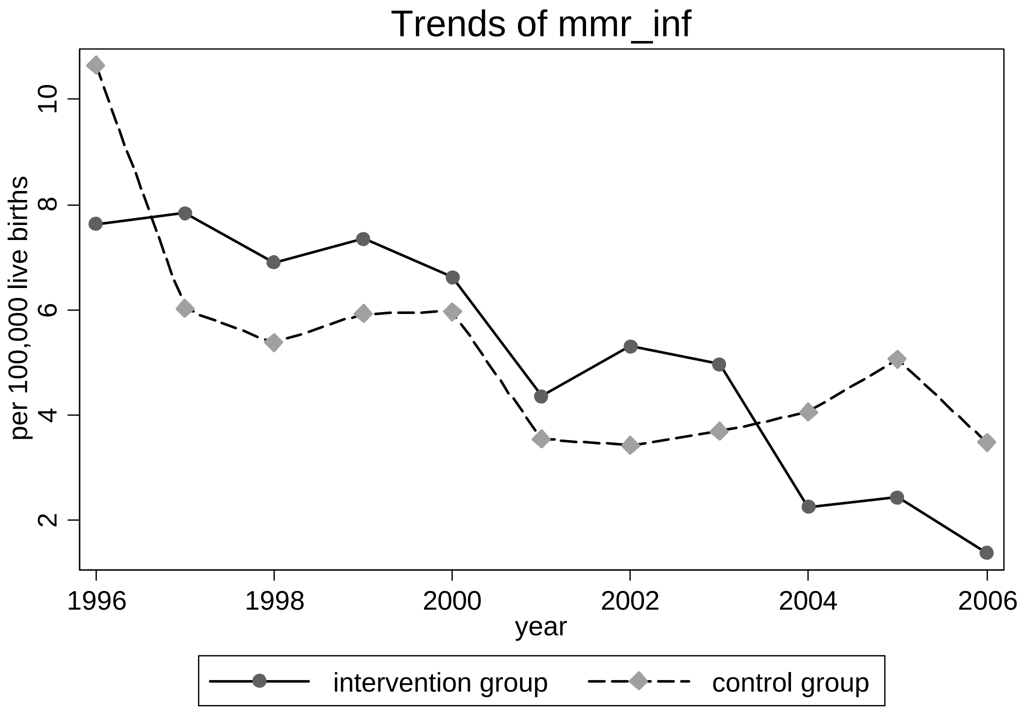

Figure 4 Trends of MMR for puerperal infection
(The same weight)

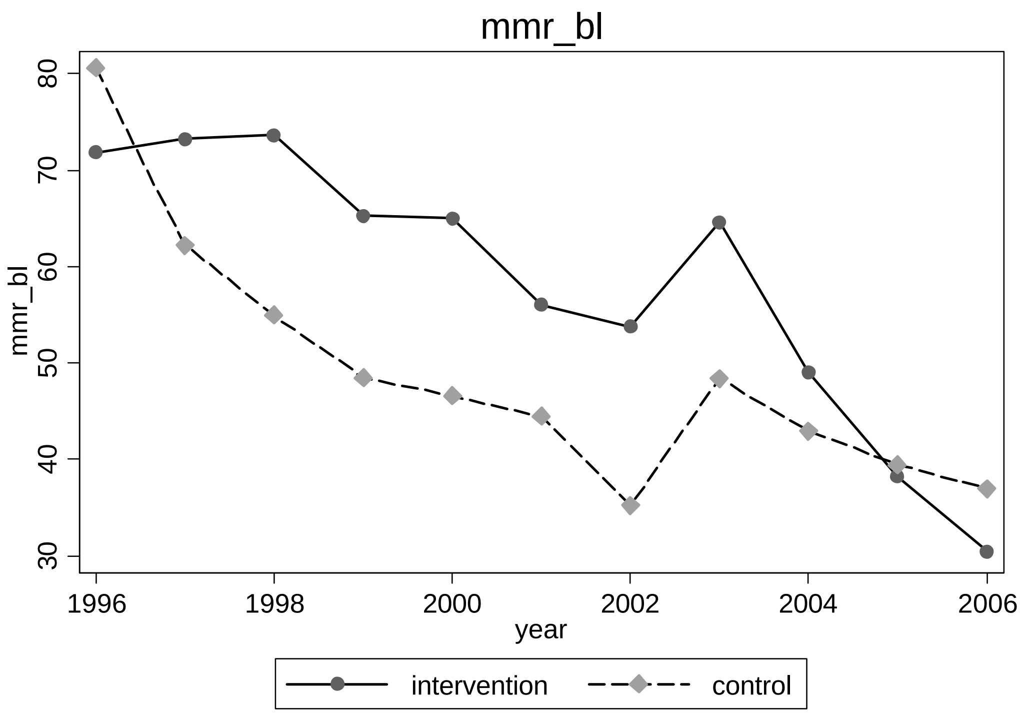

Figure 5 Trends of MMR for hemorrhage
(The same weight)

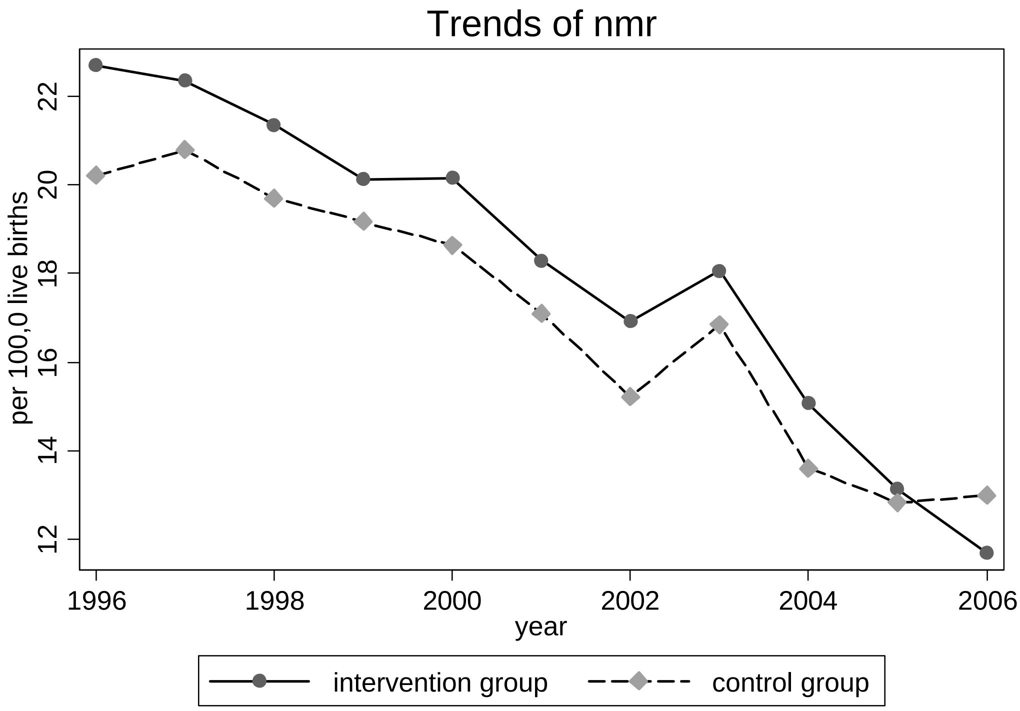

Figure 6 Trends of NMR
(The same weight)

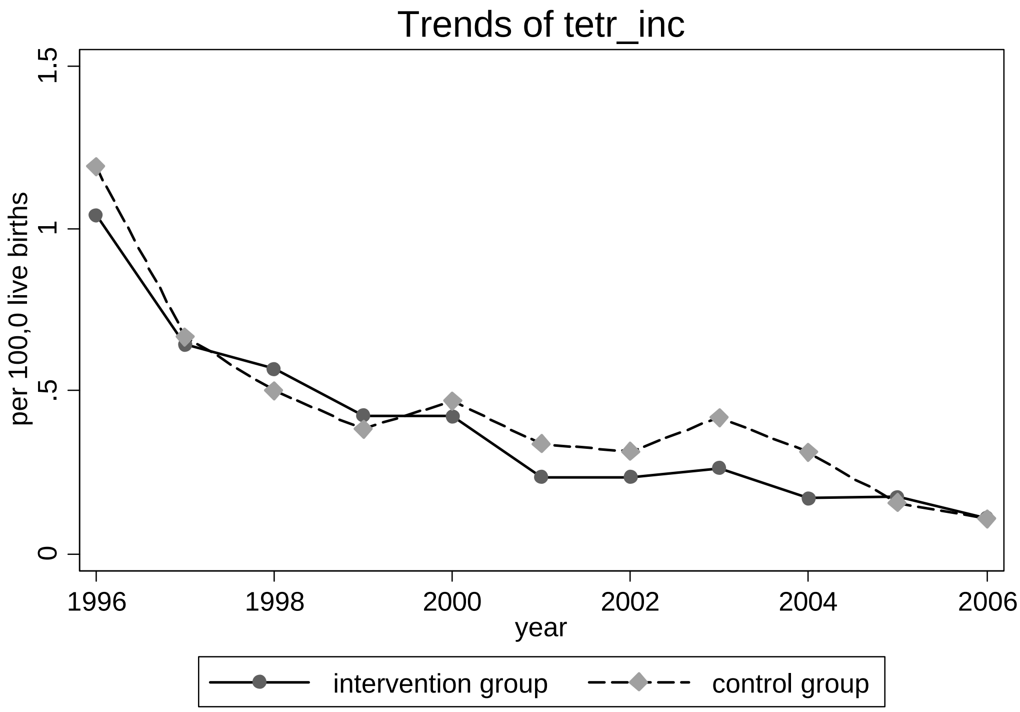

Figure 7 Trends of neonatal tetanus incidence ratio for counties selected by PSM
(The same weight)

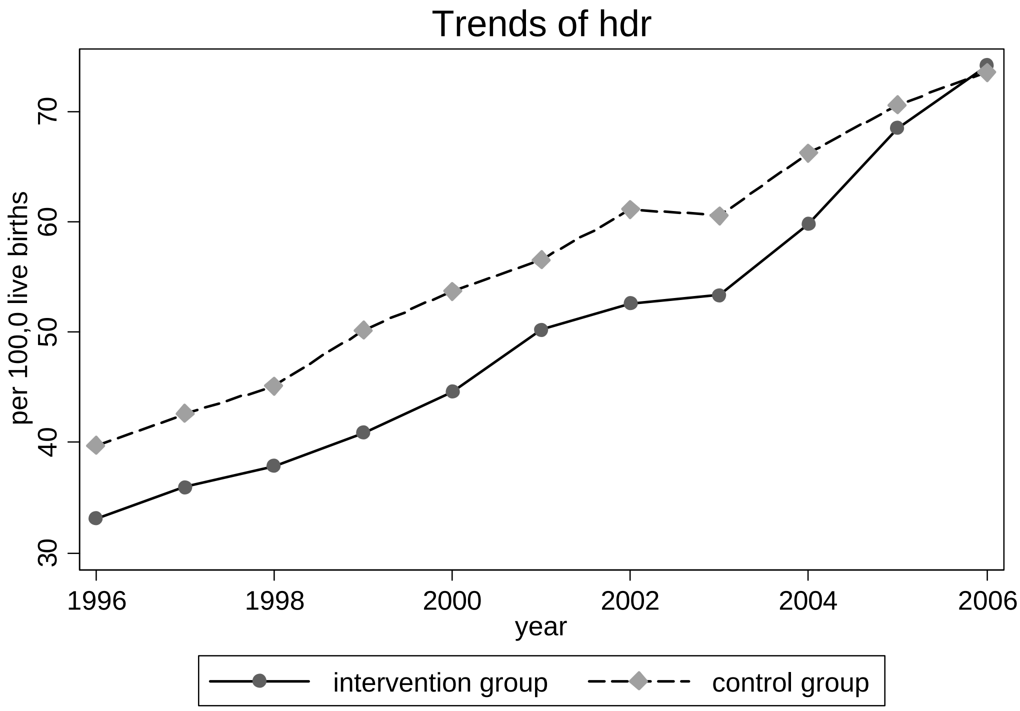

Figure 8 Trends of hospital delivery rate for counties selected by PSM (The same weight)

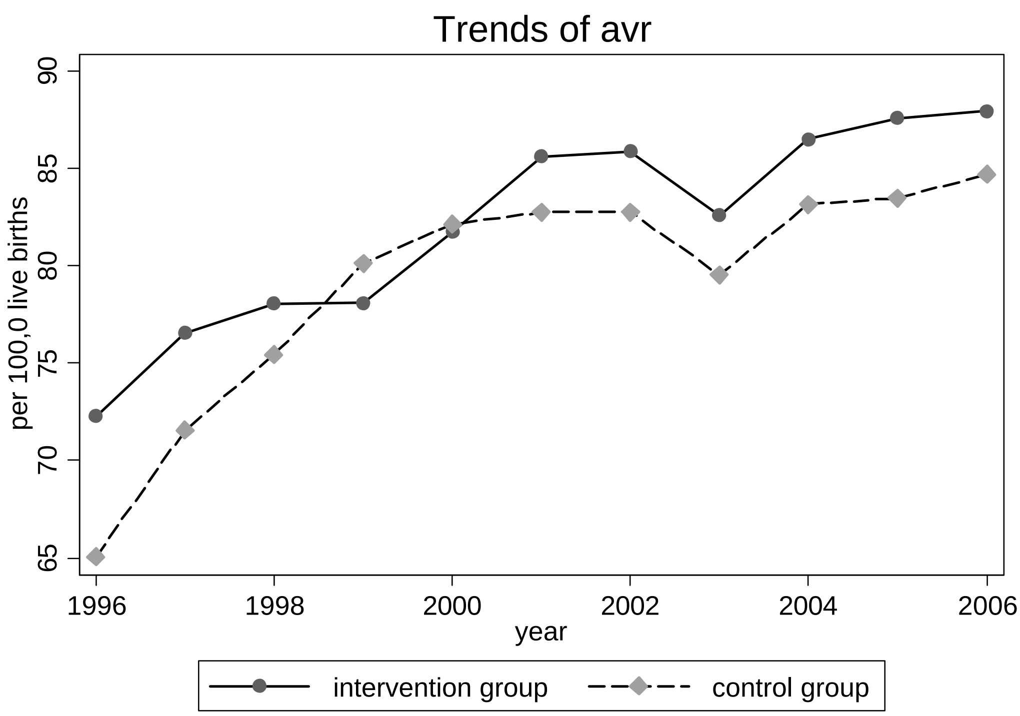

Figure 9 Trends of antenatal visit frequencies for counties selected by PSM (The same weight)