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Abstract

This paper exploits a unique opportunity to evaluate the impact of improvement in the quality of prenatal care and labor and delivery services on maternal and infant mortality and morbidity. Since basic medical care has been universally available in Ukraine, implementation of the Mother and Infant Health Project allows addressing quality rather than quantity effect of medical care. Employing program evaluation methods we find that the administrative units (rayons) participating in the Project have exhibited greater improvements in both maternal and infant health compared to the control rayons. Among the infant health characteristics, the MIHP impact is most pronounced for stillbirths, as well as infant mortality and morbidity resulted from deviations in perinatal period and congenital anomalies. As for the maternal health, the MIHP is most effective at combating such complications related blood circulation, veins, and urinary-genital systems, as well as late toxicosis and anemia. The analysis suggests that the effects are due to early attendance of antenatal clinics, lower share of C-sections, and greater share of normal deliveries. Preliminary cost-effectiveness analysis shows enormous benefit per dollar spent on the project: the cost to benefit ratio is one to 85 taking into account both maternal and infant lives saved as well as cost savings due to changes in labor and delivery practices.

1 Introduction

Infant mortality/morbidity has often been a focus of health economics and medical research as a major indicator of a country's well-being. In contrast, maternal health outcomes have been much less investigated. There are several potential reasons for such negligence. One is that the rates of maternal deaths are quite low in developed countries. The second is attributed to the difficulty of measuring maternal health outcomes in developing countries where the rates of maternal mortality are particularly high. Nevertheless, the issue of maternal health attracts considerable attention of society due to the fact that most of maternal deaths and health deteriorations are preventable. Moreover, recent evidence demonstrates that improvements in health outcomes for mothers and infants are related not as much to the availability of care (structural quality), but to the way this care is provided (process quality) (Barber and Gertler, 2002). Furthermore, some studies find that access to low quality providers in fact contribute to higher child morbidity and mortality (Sodemann et al., 1997).

Notwithstanding the importance of the matter, studies of the impact of quality of prenatal care and labor and delivery services on maternal and infant health outcomes are quite rare: it is difficult to find a setting that allows separation of quality from quantity dimension. This paper contributes to the literature analyzing the impact of exogenous change in the quality of prenatal care and labor and delivery services caused by the Mother and Infant Health Project (MIHP) in Ukraine. The case of MIHP creates a unique opportunity for an identification of this quality impact: (i) unlike the situation in developing countries (where health initiatives come together with new facilities), participation in the Project has changed only quality dimension of services, since the basic prenatal and obstetrics care is universally available; (ii) un-

like the situation in developed countries (where population health compares favorably to the rest of the world), the level of maternal and infant health outcomes in Ukraine is quite poor leaving enough room for improvement; (iii) every maternity regularly reports information on maternal and infant health outcomes to regional health administration. In addition, the study investigates the mechanisms through which reductions in infant and maternal mortality and morbidity take place via estimating the impact of the MIHP on prenatal care use, intermediate health outcomes, and mortality components.

Using difference-in-difference methodology it is found that the MIHP participating rayons observe greater improvements in maternal and infant health. The results indicate that improvements in maternal morbidity (lower prevalence of anemia, blood circulation system, veins, and urinary-genital complications) and mortality may be due to earlier attendance of prenatal clinics, increased rate of normal deliveries, and reduction in rate of C-sections. The same channels may be leading to improvements in infant health: the MIHP participation significantly reduces total infant mortality and stillbirths, as well as mortality and morbidity resulted from deviations in perinatal period and congenital anomalies.

The paper is structured as follows. Next section describes the system of health care in Ukraine, the Mother and Infant Health Project, and provides an overview of related literature. Section three focuses on the empirical methodology followed by the descriptive analysis in Section four. Basic estimation results are offered in Section five. Section six follows with the robustness checks and discussion of implications. Section seven concludes with the cost-benefit considerations.

2 Background

2.1 Health Care System and Maternal Health Services in Ukraine

As a legacy from the Soviet period, the right for free health care is one of the basic Constitutional rights in Ukraine (Article 49). And, although the informal payments are widespread (Allin, Davaki, and Mossialos, 2005), certain set of basic services can be rendered by patients for free, and this is most evident with respect to maternal and infant care. Most of the health care establishments are publicly owned. By the end of 2000, Ukraine has had more than 24 thousands of health care facilities, including various support units like medical statistical centers, medical treatment facilities, spas, health resorts, blood transfusion centers etc., which employ 327 thousands doctors and 821 thousands nurses. At the same time only about 6 thousand individuals and about one thousand of legal entities are licensed to practice medicine independently Lekhan, Rudiy, and Nolte (2004). According to the same source, only about 2% of the population has medical insurance, although this number has been growing with the improvement of the economic conditions up to year 2008. However, this trend is likely to reverse in the face of the current economic crisis. According to the Ministry of Health Report the overall health care financing in the year 2007 comprised 3.9% of the GDP compared to the 3.3% in the year 2006 MHCUC (2007), which is considerably lower than in the EU and Eastern European countries.

The network of reproductive facilities consists of maternities (approximately one per rayon) and women's clinics (about 1-3 per rayon) as well as numerous pediatric clinics. Women's clinics specialize in antenatal care including (i) monthly patronage of pregnant women, (ii) routine tests (blood, pressure, and urine) and measurements (weight and height), (iii) preven-

tion of complications during pregnancy, and (iv) family planning counseling. Most rayon maternities deal with regular delivery and postpartum care, while oblast maternities focus on complicated labor and delivery cases (those with severe anemia, diseases of genital-urinary, blood circulation systems, etc.). Pediatric clinics provide regular infant care including vaccination and routine monitoring in the first year of life and thereafter as needs arise.

2.2 Mother and Infant Health Project Description

The Mother and Infant Health Project (MIHP) is an eight-year project advocating evidence-based medical practices aimed at improvement of women's reproductive and newborn healths. The first phase of the project has been initiated in September 2002 in four regions of Ukraine, but first maternities have actually joined the Project in mid-December 2003. By the end of 2006 the Project expanded to 20 maternity hospitals in twelve pilot regions. By the end of 2010, the MIHP has planned to directly cover at least 30% of all births in Ukraine and indirectly cover 50% of all births through the dissemination efforts of the selected MIHP facilities.

Following the Millennium Development Goals for the country, MIHP pioneers to introduce new evidence-based medicine (EBM) standards - developing family-friendly delivery rooms, reducing practices such as unnecessary C-sections, amniotomies, and episiotomies, as well as increasing the use of free position during delivery, immediate skin-to-skin contact, early breastfeeding, and the rooming-in of mothers and newborns. In addition the Project actively supports the provision of trainings on effective perinatal technologies for the staff of the MIHP maternities, development of "centers of excellence" that serve as models in training/education of the medical practitioners of the corresponding oblast, and organizing health awareness campaign on healthy

lifestyles.

MIHP also aims to reinforce liaisons with the local governmental institutions. The project introduces new EBM standards for mother and newborn health care, with a stronger focus on integration of these standards into a package of perinatal practices in Ukraine. It also targets revising current curricula for medical universities and colleges.

2.3 Related Literature

Although it is obvious that the determinants of maternal and infant health are closely related, there are very few works where the issue of maternal and infant health is considered jointly (Winikoff, 1988). Moreover, most of the economic literature (both theoretical and empirical, likewise in developed and developing countries) has focused on infant health almost completely ignoring the issue of maternal health. Similar trend has been observed in the medical literature. Two reasons are to be named for such a phenomena. One is that the rates of maternal death are quite low in developed countries. And the second is attributed to the difficulty of measuring maternal health outcomes, especially in developing countries. Nevertheless, even in the developed nations with their low maternal mortality ratios (which are 2-3 time lower than those in Ukraine) this issue draws considerable attention due to the fact that most of these rare deaths are preventable. Moreover, as Haas, Udvarshelyi, and Epstein (1993) claim “60 percent of women receive medical care for some complication of pregnancy and 30 percent suffer complications that result in serious morbidity” (as cited in Conway and Kutinova (2006)).

MIHP is a program that targets quality of labor and delivery services directly as well as quality of prenatal care indirectly, since most of the obstetricians in Ukraine have joint appointments in maternities and antenatal

clinics. Therefore the expected impact of the MIHP can be inferred from earlier literature on impact of antenatal and obstetric care. Antenatal care can reduce maternal mortality and morbidity both directly, through detection and treatment of pregnancy-related or intercurrent illnesses, and indirectly, through detection of women at increased risk of complications of delivery and referring them to a suitably equipped facility (Oxaal and Baden, 1996). Analysis of historical data shows that a significant fall in maternal mortality ratios in the UK and the USA can be attributed to improved obstetric care. In particular, Carroli, Rooney, and Villar (2001) emphasize that better delivery care significantly reduces maternal mortality from infections and hemorrhage. Laditka et al. (2005) in turn suggest that adequate prenatal care may reduce potentially avoidable maternity complications. However, other authors underline that the impact of antenatal care and/or certain interventions during pregnancy is more difficult to assess due to a large number of confounding factors not observed by researchers (Carroli, Rooney, and Villar, 2001). Out of the socio-economic factors, only income has been identified as a significant determinant in reducing the probability of having a complication (Laditka et al., 2005).

It is common in health economics research to find little or no effect of prenatal care use on infant health. Conway and Deb (2005) explain this by the fact that looking at all births simultaneously may obscure the effect of prenatal care on “normal” births. Some of the births result in poor outcomes due to bad maternal behavior or poor fetus condition to begin with and cannot be remedied by any prenatal care intervention. Therefore, lack of significant impact of prenatal care on infant health may be explained by data that does not distinguish between “normal” and “problematic” pregnancies. In addition, lack of the impact may be due to selection. Mothers anticipating

poor birth outcomes are more likely to seek more antenatal care and seek it earlier while still having poorer than average outcomes. Authors that use exogenous variation in prenatal care, such as “natural experiment”, find positive and significant impact of prenatal care use on birth outcomes (Evans and Lien, 2005).

Another determinant of infant health outcomes usually receiving a lot of attention from researchers is health care spending. The evidence from a cross-country study of developing countries suggest that the health care spending has no significant effect on child mortality while the access to health care and the mother and infant health programs do. The reason for the lack of effect of spending on mortality may be inexpensiveness of effective interventions so that “they do not even show up in data on ... public spending” (McGuire, 2006). Bhalotra (2007) also finds no effect of health care spending. However, when investigating separately the effect on poor and rural households, spending is found to be important in improving infant health for those groups. Goldman and Grossman (1982) find that health care spending and public policy programs in the US do have a significant impact on infant mortality, and argue that this impact runs through improvements in health of mothers, rather than the use of prenatal care per se. The evidence also shows that infant and child mortality and morbidity are determined by poverty and unemployment rate (Bhalotra, 2007; Currie and Grogger, 2000), parental education, urban residence, and maternal health (Buckley, 2003; Chou et al., 2007).

Current study contributes to the literature in two ways: (i) by evaluating causal impact of quality of prenatal and obstetric care, and (ii) by studying the mechanism through which the effect takes place.

3 Empirical Strategy

Preliminary insider assessment of the Project shows positive trends in maternal and infant health outcomes in the participating maternities along various dimensions: decreasing level of C-sections and episiotomies, neonatal mortality and morbidity, etc. However, this insider monitoring does not allow identifying the real effect of the treatment for two reasons. One is that the Project may have a spillover effect on the neighboring community, in which case the insider assessment would give an underestimate of the true effect. The other reason is that analyzing the data at the site of treatment does not allow separating the effect of the Project from the changes in the outcome measures due to other confounding factors, in which case it would be an overestimate or underestimate of the true effect depending on the sign of the correlation between the confounding factors, the treatment variable, and the outcome.

Theoretically maternal and infant health (Conway and Kutinova, 2006) depends on health inputs, including such intermediate determinants as prenatal care and access to health services (McCarthy and Maine, 1992), mother and infant health endowments, and socio-economic characteristics (distant determinants). However, in the empirical specification we omit all of these variables to avoid over controlling.¹ The simplest estimator used to evaluate the effect of the MIHP participation (treatment effect) is a difference-in-difference estimator (DD) and the empirical model takes the following form:

¹The analysis has also been performed including the full list of controls (total population morbidity, number of Chernobyl-related diseases, doctor's load, number of obstetricians, number of midwives, share of deliveries to women aged 18-34, share of first deliveries, number of colleges and universities interacted with time, logarithm of real average wage, share of employed among working age population, per capita air pollution, ratio of divorces to marriages, number of families getting utility subsidies) showing no difference in results.

$$H_{rt} = \beta_0 + \beta_P P_{rt} + T_t \beta_t + R_r \beta_R + T_t O \beta_{to} + u_{rt}^0, \quad (1)$$

where health outcome H in region r at time period t depends on treatment P , which is equal to one for the participating rayons in years after they join the MIHP. Overtime changes in health outcomes are compared between the MIHP participating rayons and the control rayons netting out the common time trend T_t , rayon-specific fixed effects R_r , and oblast-specific time effect $T_t O$ since all medical institutions are subordinated to and financed by oblast-level authorities.

In such a setting, the estimate of β_P for the treatment dummy (MIHP participating rayon) gives us the difference-in-difference (DD) estimate of the treatment effect of the MIHP participation. However, this estimate may be biased due to potential contamination of the control group. This contamination is quite likely since the MIHP sites are required to provide trainings to the personnel of all maternities of the oblast where the site is located. Thus, the model is augmented by a variable MIHP-oblast that could capture the impact of these trainings:

$$H_{rt} = \beta_0 + \beta_P P_{rt} + \beta_P^{tr} P_{rt}^{tr} + T_t \beta_t + R_r \beta_R + T_t O \beta_{to} + u_{rt}^0, \quad (2)$$

The MIHP-oblast is equal to one for rayons which belong to the same oblast as participating rayons in the treatment periods, while equal to zero for all control rayons and for rayons directly participating in the MIHP. In this case β_P^{tr} picks up the effect of trainings only and represents the lower bound of the MIHP impact.

The estimates of the MIHP impact presented above provide the average treatment effect across all MIHP rayons compared to control rayons. This

approach though is subject to several criticisms. First of all, it does not allow for heterogeneity of treatment since various components of the Project may be implemented in stages. Second, it does not account for a possibility that the Project impact may depend on the duration of participation. Finally, it does not refute the possibility that MIHP maternities are systematically different from the control group in their outcome time trend prior to the treatment and whether this difference has an impact on the validity of the Project impact estimates. To tackle these issues the MIHP indicator in Equation 1 is replaced with a set of variables reflecting the timing of the Project implementation: $(T_{-3}, T_{-2}, T_{-1}, T_1, T_2, T_3)$. All these variables are equal to zero for the control group outcomes and 1 for the treatment group at various stages of the Project implementation: three years before, two years before, one year before, one year after the Project start-up, two years after, three and more years after respectively.

However, there still exists a possibility that the resulting estimates may not reflect the true treatment effect, since the rayons could have experienced other health affecting initiatives implemented simultaneously with the MIHP. Thus, the estimated treatment effect of the MIHP would be upward-biased if other initiatives' influence on maternal and infant health outcomes is positive and downward-biased otherwise. Triple difference procedure is usually used in the literature to address this problem. But it is impossible to directly apply it in the current setting since most of the outcomes used in the study are related to infants and females of fertile age, which are exactly the targeted population groups. Consequently, two alternative estimation procedures are utilized as tests for the validity of the DD strategy.

The first procedure applies the model described in Equation (1) to the pregnancy unrelated (placebo) outcomes (e.g. prevalence of diabetes, hep-

atitis, etc.). Lack of statistically significant health improving effect on these outcomes would confirm the validity of the DD estimates of the MIHP impact on pregnancy related outcomes. The second procedure applies to the set of outcomes which are collected for the whole rayon population but can potentially be affected by the Project (e.g. hypertension). In this case it is possible to apply the DDD procedure with a slight modification of the suggested empirical model:

$$H_{rt} = \beta_0 + \beta_{PF}P_{rt}F_{rt} + \beta_P P_{rt} + \beta_F F_{rt} + Z_{rt}\beta_Z + \beta_{RF}R_r F_{rt} + \beta_{TF}T_t F_{rt} + \quad (3)$$

$$+ \beta_{TR}T_t R_r + T_t\beta_t + R_r\beta_R + u_{rt}^0,$$

where F_{rt} is the percentage of female population of fertile age. In this case the coefficient β_{PF} is the triple difference estimate of the MIHP treatment effect.

Outcome Variables. There are three groups of outcome variables to be evaluated: maternal, infant, and pregnancy-unrelated health outcomes (see Table 1). Bearing in mind difficulties that exist with the measurement of maternal mortality (Shiffman, 2000) stemming from the erroneous attribution of the cause of death, the emphasis in the current paper is put on the less arguable maternal health outcomes which can be plausibly attributed to changes in the quality of labor and delivery services. In addition, the MIHP impact on intermediate outcomes, such as early onset of antenatal care, rates of C-sections and normal deliveries is estimated.

Treatment Variables The treatment effect is represented by (i) dummy variable that takes the value of one for MIHP-participating rayon (MIHP-rayon) in treatment period, (ii) dummy equal to one for all rayons of an oblast with at least one MIHP rayon in treatment period, and (iii) a set of variables reflecting the time before and after the start-up of the Project in the treatment rayons.²

All specifications include one additional control variable which indicates whether other programs that may have an impact on maternal and infant health are being implemented in a rayon in a particular year. It should be mentioned that these programs are rather different from the MIHP. Most of them are associated with significant financial contributions, provision of new expensive equipment, etc., while the MIHP emphasizes low cost of quality improvements. This makes it absolutely necessary to control for the effect of these other programs and attempts to compare it to the MIHP impact.

4 Data and Descriptive Analysis

Since all of the treatment rayons are urban, the analysis is constrained to urban rayons (i.e. those that have at least one town or city) resulting into an unbalanced sample of about 13 treatment and 227 control rayons.³ Data is obtained from the oblast Centers of Medical Statistics (CMS) which collect periodic administrative reports from all health care establishments on a routine basis. Existing gaps in the data do not exhibit any systematic

²Some of the rayons have more than one maternity, so the whole analysis has been performed with the dummy variable substituted by the percentage of rayon maternities participating in MIHP. No qualitative difference in the results has been observed. The results are available upon request.

³Administratively, Ukraine consists of 25 large units - "oblast" - (including the Autonomous Republic Crimea), and 2 cities of the country subordination (Kyiv and Sevastopol). An oblast consists of about 13-46 small administrative units - "rayons". Rural units as well as small towns are subject to rayon governance, while big towns and cities are subordinated to an oblast. Hence, the data on towns of rayon subordination is included into a rayon statistics, while cities and towns of oblast subordination are reported separately.

patterns, since they are mostly due to the difficulties of locating records at the CMSs, unrelated to the willingness of maternities to report certain types of outcomes. The analysis covers the pre-treatment 2000-2002 and the post-treatment 2003-2006 periods.⁴

The study focuses on rayon level analysis because rayons are more homogeneous compared to the larger administrative/geographic areas and therefore the aggregated statistics is more reliable. The sample is then restricted to urban rayons only. This restriction serves two purposes. First, it allows matching the treatment rayons to more comparable control rayons, since no rural rayons have participated in the MIHP. Second, rayons with urban settlements are quite large and have more developed infrastructure to make it less likely that the individuals living in the area would seek care outside the rayon.

Sample Description. In pre-treatment period MIHP rayons are in general characterized by poorer population health outcomes (Tables 2-3), while they are on average better off with respect to overall maternal mortality ratios and the registered cases of anemia. However, in terms of maternal morbidity the non-MIHP rayons compare more favorably to the treatment rayons with more cases of morbidity due to thyroid gland complications (9 vs. 17 percent in MIHP rayons) and late toxicosis (8 vs. 12 percent). The MIHP rayons in the pre-treatment period are comparable to the control rayons in terms of early attendance of antenatal clinics by pregnant women, but are considerably worse off with respect to the share of C-sections (12 vs. 7 percent) and normal deliveries (27 vs. 37 percent). The situation is similar with respect to infant

⁴Although the MIHP project has started in September 2002, the first four maternities have joined the MIHP on December 10, 2003. Since many of the outcomes, e.g. rate of C-section, could be impacted immediately, we consider 2003 as the first year of the treatment.

health: total infant mortality and infant morbidity are considerably worse off in MIHP rayons in year 2000.

Despite the pessimistic pre-program health conditions, after the implementation of the Project the majority of the maternal and infant health outcomes have improved. Over the period from 2000 to 2006 a sharp decrease in maternal mortality (from 24 to 4 in MIHP rayons) and a drastic decline of the full set of maternal morbidity indicators are observed. The rate of normal deliveries in the MIHP sites have increased twice, while in non-program territories the increase of these indicators does not exceed 60%. The infant mortality rate, which initially exceeded the non-MIHP indicator by 2, has declined from about 14 to 9 cases per 1000 livebirths; and the rate of stillbirths, increasing in control regions, has declined in the MIHP sites.

5 Estimation Results

Maternal Health. Table 4 shows the impact of the MIHP and other programs on the maternal health outcomes. The treatment variable is measured as an indicator equal to one for the MIHP participating rayons in all time periods after they joined the Project. As could be seen from the Column (1), the difference-in-difference estimate of the MIHP impact is health improving for most outcomes, including intermediate ones: women in the MIHP participating rayons are more likely to have normal deliveries and attend antenatal clinics prior 12 weeks of gestation, and are less likely to have C-sections. With respect to the complications, mothers in the MIHP-participating rayons are less likely to experience anemia, problems with the blood circulation system, veins complications, and late toxicosis. In line with the explanations in Conway and Deb (2005), no effect is found on the problematic deliveries, which

are deliveries exhibiting ex ante deviations from the “norm” such as improper position of a fetus (face or breech presentation), abnormally small pelvis, etc.

Family Planning. The lower part of Table 4 reveals positive effect of the MIHP participation on abortion rates and on use of contraceptive pills, although the effect disappears once the MIHP oblast effect is controlled for (Columns (3)-(5) of Table 4). Small positive impact on the abortion rates may occur for at least two reasons. First, it may be suggestive of the better diagnostics leading to abortions of problematic pregnancies. Second, women may become aware of better services provided in the MIHP sites and therefore be attracted there for all kinds of procedures including abortions. It would be interesting to evaluate the MIHP impact on abortion measures by gestation age, but unfortunately such data is not available at the moment.

Infant Health. As could be seen from Table 5, the MIHP impact on infant mortality (total, stillbirths, perinatal and late neonatal mortality included) is negative and statistically significant. The evidence suggests that most of this effect is contributed by the impact of the MIHP participation on the infant mortality due to deviations in the perinatal period and congenital anomalies. The effect of the Project on all other components of infant mortality is negative, but small in magnitude and not statistically significant.

The lower part of the table presents the estimates of the MIHP impact on infant morbidity. No significant treatment effect is found for total infant morbidity and the only component of it being affected is morbidity due to deviations in perinatal period. The effect is quite large in magnitude - average treatment effect is a 16 percent decline compared to the baseline value of the outcome (-0.53 reduction from 3.65 diseases per 100 infants in year 2000).

Controlling for the oblast effect in Columns (3)-(5) leads to insignificant

impact of the MIHP on infant mortality measures by time, but a significant effect manifests itself for infant mortality related to respiratory system and perinatal deviations. The role of an inexpensive device instrumental in resuscitation (Ambu mask) and an importance of having it in every delivery room is emphasized in the MIHP trainings. This may explain such a great impact on infant mortality related to the respiratory system.

6 Robustness Checks and Discussion

Effect of MIHP Trainings. Columns (3) through (5) in Tables 4-5 show the estimates from the regressions including an indicator for the rayons which are not participating in the Project but which belong to the oblast with at least one participating maternity. The effect of this MIHP oblast variable can be interpreted as the effect of the MIHP trainings, the lower bound of the overall MIHP impact. As could be seen, the MIHP impact in Column (3) becomes stronger in some cases and vanishes in others what is expected in the case of addressing the issue of contamination of the control group. For example, after addressing the contamination issue, the impact on maternal mortality and respiratory system related infant mortality becomes statistically significant. At the same time, the impact of MIHP trainings for oblast specialists appears only for maternal mortality, normal deliveries, anemia, and infant mortality related to a respiratory system, although it is about twice smaller in magnitude than the direct effect.

MIHP Effect Over Time. In most cases there is no significant difference between treatment and control rayons in the years prior to the Project implementation (Tables 6-7). This points to the causality of the MIHP impact

with respect to all of the maternal health outcomes and some of the infant health outcomes. However, with respect to the infant health, the situation is less straightforward: for example, as to the perinatal, early and late neonatal, and total infant mortality the MIHP rayons have compared favorably to the control rayons even long before the Project start. However, the difference almost doubles after the start of the Project indicating to the presence of the Project impact. At the same time, there is a clear causal effect of the Project on the stillbirth rates and mortality due to deviations in perinatal period and congenital anomalies.

Another dimension that the reported estimates uncover is the dependence of the MIHP impact on time. For example, share of normal deliveries increases in the year of the Project start-up, the increase is even more pronounced in the year after and becomes insignificant after that.⁵ The situation is different for anemia prevalence and use of contraceptive pills - the positive effect is becoming stronger over time.

MIHP Effect on Placebo Outcomes. Column (1) of Table 8 presents the estimates of the impact of the MIHP participation on placebo outcomes. As the estimates show, no statistically significant health improving effect is observed for the number of diagnosed cases of, tuberculosis, diabetes and hypertension. The effect is significant econometrically but positive for hepatitis and teenage morbidity. This effect means that for some reason the treated rayons have suffered greater health deteriorations in terms of hepatitis and teenage morbidity than the control rayons. To test the robustness of the findings further and to allow for a possibility of the Project impact on the onset of

⁵Statistical significance of the impact estimates three years after the start-up of the project may be impacted to a great extent by small number of cases in this category. This issue shall be addressed in the follow-up study when there will be relatively more maternities participating in the project more than three years.

diabetes and hypertension which may be related to pregnancies, a triple difference estimation has been performed following the specification in Equation (2). There is no significant MIHP impact on the onset of diabetes, but there is a significant effect on the onset of hypertension.

Other Selection Issues. Potential problem with the estimates of the MIHP effect exists in case if the MIHP participating maternities after joining the Project start selecting less complicated pregnancies, ensuring better outcomes simply by the composition of the patients. However, as the evidence suggests, many of the maternities that have joined the Project are specially designated to deal with high risk pregnancies and therefore are legally obliged to admit all the high risk referrals from the surrounding areas. Another issue is that the participating maternities after joining the project could have attracted more women which could have had normal deliveries in any case, leading again to a change in the pool of patients not related to the MIHP impact. This preposition is tested by looking at the impact of the MIHP participation on the number of deliveries and comparing it to the estimates of the MIHP impact on the number of C-sections, normal deliveries, and problematic deliveries. The estimate of the impact on the number of deliveries is positive and statistically significant, but very small in magnitude compared to the estimates for the normal deliveries and C-sections. In addition, as Table 6 shows, the MIHP participating rayons have always been rayons with a greater number of deliveries than the control rayons. At the same time, the impact on C-sections and normal deliveries appears only after the start of the Project and therefore could be considered as causal.

Yet another possible problem exists in case there is a non-random movement of patients between control and treatment areas. For example, if more

health-concerned and therefore healthier women who would have chosen normal delivery in any case would go to better quality MIHP maternities, the estimated impact may be attributed to the self-selection of patients, not to the Project per se. To test this possibility, a robustness check for the whole range of outcomes is performed on a set of rayons that consists of oblast-subordinated cities (metropolitan areas). Since there are much fewer oblast-subordinated cities, they are located at quite a distance from each other, reducing the possibility of massive movement of pregnant women. In addition, these are larger cities with a better developed infrastructure and are more homogeneous in the quality of prenatal and obstetric care. Qualitatively the results are similar from these regressions (Tables 9-12), but quantitatively they are much stronger for metropolitan areas.

7 Cost-Benefit Considerations

A comprehensive cost-benefit analysis of the MIHP project is limited, since the majority of maternal and infant health indicators are hard to assess in monetary terms (e.g. increase in early neonatal visits of mothers, drop of late toxicosis and complicated deliveries; decrease in infant morbidity due to various reasons etc.). Therefore, we focus on the most “tangible” cost effectiveness indicators and compare (i) average annual per maternity cost of the Project and (ii) average annual per maternity “tangible” benefits.

The average annual per maternity cost is about 92,308 USD, and it is calculated as an overall cost of the first phase of the project - 6 mln USD - distributed over 13 treatment sites during 2002-2006 when the first MHIP phase was implemented. Set of “tangible” benefits includes savings due to (i) a switch from C-sections to vaginal deliveries, (ii) switch away from medicine-

intensive ways of leading both C-sections and vaginal deliveries, and (iii) saved lives of mothers and infants due to the implementation of the MIHP practices. Table 14 provides a summary of the benefits calculation.

One of the major findings from the current analysis is that the number of C-sections in the MIHP participating rayons decreases by 4.85% or by 136.10 deliveries on average per year. The difference in the average cost between vaginal deliveries and C-sections is 92.35 UAH per patient⁶. Hence, the aggregated savings from a “C-section towards vaginal deliveries switch” is 12,568.90 UAH (92.35 UAH times 136.10 patients), which is equivalent to 2,488.89 USD.

Switch away from medicine-intensive ways of leading both C-sections and vaginal deliveries is associated with considerable savings which are achieved through a reduction in expenditures on tests, exams, and medicines during labor and postpartum periods. According to the MIHP team’s analysis, the implementation of the MIHP technologies has significantly reduced the cost of both vaginal deliveries and C-sections. If the post-treatment year of 2005 is compared to the pre-treatment 2002, per patient cost of vaginal deliveries has dropped by 107.30 UAH, while per patient cost of C-sections has declined by 149.35 UAH. Since the average number of vaginal deliveries in 2005 is 2,464.69 and the average number of C-sections is 341.51, the aggregated savings total to 315,465.95 UAH that is equivalent to 62468.50 USD. Together with the cost savings due to a switch away from C-sections this brings 64,957.40 USD savings per year.

Moreover, the reduction in maternal and infant mortality can be taken as

⁶The average per patient cost of C-sections and vaginal deliveries has been calculated by the MIHP project team (for further details see Appendix). Per patient here combines both cost for a mother and a newborn. The cost survey has been conducted in three MIHP participating maternities in years 2002 and 2005. In the current cost-benefit calculation the average cost per delivery as estimated from these three maternities is taken as an average per delivery cost for all participating rayons.

a final measure of the effectiveness of the Project. The estimates suggest that the MIHP participation on average translates into 1.69 fewer maternal deaths per maternity per year⁷ and 8.04 fewer infant deaths (including 2.41 fewer infant deaths resulted from respiratory system complications and 5.63 fewer infant deaths resulted from deviations in perinatal period). The estimates of the value of statistical life (VSL) do not exist in Ukraine. However, evaluated at the conservative estimate of a VSL from the literature (Giergiczny (2008) reports 0.79 mln USD for Poland, country most similar to Ukraine, with existing estimates of the VSL), this would result in a tremendous benefits of 7.7 mln USD for the country, well surpassing the cost of the Project.

So overall, the project costs to benefits ratio is 1 to 85 (92 to 7,754 thousand USD) if one takes into account value of lives saved and it is 1 to 0.7 (92 to 65 thousand USD) if one considers only costs savings due to change in C-section and vaginal delivery practices and switch away from C-sections to vaginal deliveries. The latter represents the lowest bound of the Project's benefits, since it does not take into account any health-improving impact of the MIHP. Although the range is quite wide and this preliminary calculation suffers from several limitations, it seems unlikely that given the estimated impact the true costs would exceed the true benefits.

8 Conclusion

Exploiting a unique opportunity provided by the Mother and Infant Health Project in Ukraine this paper evaluates the impact of the improvement in the quality of prenatal care and labor and delivery services on maternal and

⁷According to estimates from the preferred specification from Table 4, the estimated MIHP impact on maternal mortality is 63 per 100,000 livebirths. Evaluated at the average number of livebirths in a participating maternity in year 2005 - 2681,4 livebirths - this translates into 1.69 fewer maternal deaths.

infant mortality and morbidity. This has become possible for two reasons. First is that the maternal and infant health outcomes are lagging behind those in Europe, thus allowing the identification of the effect of health-related interventions. Second, and the most important, is that the antenatal care and labor and delivery services are universally available in Ukraine. So, the estimation of the effect of the MIHP can be interpreted as an impact of the improvement in the quality of services, which is a rare opportunity in the research.

Employing program evaluation methods we find that the urban administrative units (rayons) participating in the Project have exhibited larger decline in both maternal and infant health compared to the control rayons. At the same time no effect has been found on the pregnancy unrelated outcomes, such as tuberculosis, hepatitis, and teenage morbidity, indicating the causality of the MIHP impact. The MIHP impact is most pronounced for infant mortality and morbidity resulting from deviations in perinatal period and congenital anomalies and maternal mortality and morbidity related to late toxicosis, anemia, veins, and blood circulation system disorders. The analysis suggests that the effect stems from the early attendance of antenatal clinics, lower share of C-sections, and greater share of normal deliveries.

Interestingly, the MIHP implied very little monetary intervention - all of the provided equipment has been low cost, but most of the change has occurred through trainings of the personnel and changes in their attitudes and practices. The maternities participating in the Project have become more mothers' and family friendly, practicing active partner participation in the process of labor and delivery, less involvement of medicines, and joint mother-baby accommodation. As a result, even after controlling for the overall trend in the country and oblast-specific time trend, the rayons with the MIHP-

participating maternities do observe better maternal and infant health outcomes. And the impact is more significant statistically and economically for the outcomes directly related to the quality of antenatal care and labor and delivery services: decrease in infant morbidity and mortality due to deviations in the perinatal period and due to respiratory system complications and decrease in various complications experienced by mothers during pregnancy, labor and delivery and in postpartum period.

As the preliminary cost-benefit calculation shows, the Mother and Infant Health Project seems to be associated with a tremendous return to the country. The project costs to benefits ratio is 1 to 85 (92 to 7,809 thousand USD) if one takes into account value of lives saved and it is 1 to 0.7 (92 to 65 thousand USD) if one considers only costs savings due to change in C-section and vaginal delivery practices and switch away from C-sections to vaginal deliveries. Even though these cost-benefit calculation suffers from several limitations, it seems unlikely that the true costs would exceed the true benefits.

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Table 1: List of Analyzed Health Outcomes

Maternal Health Outcomes	Infant Health Outcomes
Normal Deliveries per 100 deliveries	Stillbirths per 1,000 Newborns
C-sections per 100 deliveries	Perinatal Mortality per 1,000 Newborns
Deliveries/1,000 Population	Early Neonatal Mortality per 1,000 Livebirths
Maternal Mortality per 100,000 livebirths	Late Neonatal Mortality per 1,000 Livebirths
Per Cent of Pregnant Visited Antenatal Clinics before 12 weeks	Postneonatal Mortality per 1,000 Livebirths
Late Toxicosis per 100 Pregnancies	Infant Mortality per 1,000 Livebirths
Deliveries Complications per 1,000 deliveries	including those related to (per 10,000 livebirths):
including those related to:	Infection
Urinary-Genital System	Nervous System
Anemia	Respiratory System
Blood Circulation	Congenital Anomalies
Veins Complications	Perinatal Deviations
Thyroid Gland Complications	Total Infant Morbidity per 100 Infants
Problematic Deliveries	including those related to:
Abnormal Deliveries	Infection
	Nervous System
	Respiratory System
	Congenital Anomalies
	Perinatal Deviations
Family Planning Indicators	Pregnancy and MIHP -unrelated Health Outcomes
Abortions per 1,000 Women of Fertile Age	Tuberculosis Diagnosed per year per 100,000 Population
Use of Contraceptives among 100,000 Women of Fertile Age	Diabetes Diagnosed per 100,000 Population
	Hepatitis Diagnosed per 100,000 Population
	Hypertension per 100,000 adults
	Teenage Morbidity, cases per person

Notes: (1) “Problematic” deliveries are those exhibiting ex-ante deviations from the “norm”. For instance, improper presentation/position of a fetus (face or breech presentation), abnormally small pelvis of a mother etc. (2) Deliveries are classified as “abnormal” if a healthy woman suddenly experience abnormal labor activities, e.g. abrupt finish of labor pains during an active labor phase, too quick/too slow labor, uterus distortions etc.

Table 2: Descriptive Statistics: Maternal Health and Family Planning Outcomes

	MIHP		Non-MIHP	
	2001	2006	2001	2006
Maternal Health				
Normal Deliveries per 1,000 Deliveries	273.80 (130.74)	595.65 (152.30)	338.25 (132.79)	552.15 (160.10)
C-sections per 1,000 Deliveries	149.25 (70.36)	142.71 (36.22)	80.96 (42.04)	107.44 (67.88)
Maternal Mortality per 100,000 Newborns	13.01 (19.78)	4.84 (10.71)	28.19 (98.62)	13.51 (58.38)
Per Cent of Pregnant Fem. Visited Doctors Prior to 12 Weeks of Gestation	84.50 (8.81)	89.89 (8.35)	83.76 (8.71)	89.86 (7.08)
Late Toxicosis per 100 Pregnancies	118.96 (39.77)	73.84 (31.40)	83.67 (54.21)	70.87 (70.20)
Deliveries Complicated per 1,000 Deliveries related to:				
Urinary-Genital System	134.47 (183.21)	83.96 (57.30)	80.56 (76.07)	76.71 (75.61)
Anemia	230.13 (79.81)	124.23 (50.72)	327.61 (261.57)	247.64 (222.91)
Blood Circulation	71.62 (65.77)	28.55 (30.53)	59.53 (78.12)	34.65 (48.38)
Veins	29.61 (22.08)	18.30 (12.50)	22.88 (23.45)	21.41 (26.34)
Thyroid Gland	228.38 (323.41)	100.79 (93.93)	100.11 (153.76)	92.24 (124.13)
Problematic Deliveries per 1,000 Deliveries (1)	52.12 (38.30)	39.62 (20.80)	117.91 (155.12)	79.68 (99.87)
Abnormal Deliveries per 1,000 Deliveries (2)	62.81 (23.39)	47.74 (24.87)	133.63 (87.35)	87.26 (62.22)
Family Planning Indicators				
Abortions per 1,000 Women of Fertile Age	28.79 (12.14)	22.47 (12.78)	22.64 (10.18)	15.52 (8.86)
Use of Contrac. Pills among 1,000 Women of Fertile Age	133.34 (85.10)	194.60 (116.45)	78.58 (70.74)	136.66 (93.50)
Pregnancy Unrelated Health Outcomes				
Tuberculosis Diagnosed per 1,000 Population	67.80 (17.70)	76.27 (23.43)	66.62 (21.78)	81.84 (30.58)
Diabetis Diagnosed per 1,000 Population	136.09 (36.94)	202.37 (37.51)	137.62 (63.02)	211.15 (62.98)
Hypertension per 100,000 adults	2.45 (0.54)	2.44 (1.04)	2.60 (1.37)	2.26 (1.01)
Observations	13	13	246	246

Notes: Standard errors in parenthesis.

Table 3: Descriptive Statistics: Infant Health Outcomes

	MIHP		Non-MIHP	
	2001	2006	2001	2006
Stillbirths per 1,000 Newborns	5.06 (1.76)	5.21 (2.81)	3.27 (3.21)	4.62 (3.98)
Perinatal Mortality per 1,000 Newborns	10.40 (2.99)	8.89 (5.17)	6.75 (5.31)	8.37 (5.30)
Early Neonatal Mortality per 1,000 Livebirths	5.34 (2.80)	3.77 (3.14)	3.15 (3.13)	3.63 (3.32)
Late Neonatal Mortality per 1,000 Livebirths	2.22 (1.30)	2.41 (2.38)	1.93 (3.06)	2.28 (2.62)
Postneonatal Mortality per 1,000 Livebirths	6.04 (2.42)	3.35 (1.82)	5.42 (4.23)	4.87 (3.65)
Infant Mortality per 1,000 Livebirths	14.20 (4.17)	9.18 (3.76)	9.80 (5.73)	10.88 (5.96)
including related to:				
Infection	9.50 (8.05)	4.88 (5.00)	4.05 (9.37)	5.03 (11.62)
Nervous System	2.25 (4.03)	2.21 (3.67)	3.30 (9.51)	2.45 (8.96)
Respiratory System	4.52 (5.25)	5.14 (5.73)	7.20 (13.51)	4.94 (11.62)
Congenital Anomalies	41.86 (17.00)	26.02 (13.89)	23.60 (27.64)	26.51 (31.58)
Perinatal Deviations	60.76 (38.42)	40.26 (27.17)	27.43 (32.64)	36.44 (34.33)
Infant Morbidity per 100 Infants	250.50 (106.58)	228.59 (100.15)	197.70 (71.32)	164.92 (60.33)
including related to:				
Infection	7.74 (3.51)	4.95 (2.83)	6.24 (4.43)	4.27 (2.96)
Nervous System	8.12 (8.58)	13.70 (10.91)	4.00 (6.44)	5.67 (8.07)
Respiratory System	125.34 (58.10)	125.46 (87.65)	95.28 (43.66)	81.48 (34.00)
Congenital Anomalies	0.64 (0.46)	0.54 (0.29)	0.41 (0.30)	0.37 (0.26)
Perinatal Deviations	3.25 (1.89)	1.81 (1.51)	2.91 (1.63)	2.28 (1.38)
Pregnancy Unrelated Health Outcomes				
Teenage Morbidity per 1,000 teenagers	1.09 (0.34)	0.96 (0.23)	0.97 (0.40)	0.91 (0.27)
Observations	13	13	246	246

Note: Standard errors in parenthesis.

Table 4: Estimated Impact of the MIHP on Maternal Health Outcomes

	MIHP rayon (1)	Other Programs (2)	MIHP rayon (3)	MIHP oblast (4)	Other Programs (5)
Maternal Mortality	-7.10 (9.24)	-0.60 (16.95)	-63.06* (34.02)	-58.45* (33.73)	-2.11 (17.08)
Normal Deliveries	10.12*** (2.06)	0.04 (3.73)	18.79*** (4.79)	9.06** (4.15)	0.28 (3.69)
Deliveries/1,000 Population	1.18*** (0.34)	0.27 (0.78)	1.17*** (0.44)	-0.01 (0.41)	0.27 (0.78)
C-sections	-2.48*** (0.70)	0.75 (1.07)	-4.85*** (1.75)	-2.48 (1.56)	0.69 (1.05)
Early Neonatal Visits	2.09** (0.85)	-0.11 (1.08)	2.89* (1.58)	0.83 (1.54)	-0.08 (1.08)
Late Toxicosis	-1.92** (0.80)	-1.73 (1.37)	-2.87** (1.19)	-1.00 (1.10)	-1.76 (1.37)
Complicated Deliveries by cause:					
Urinary-Genital System	-1.82 (2.01)	-0.44 (1.41)	-4.38** (2.02)	-2.67 (1.95)	-0.51 (1.44)
Anemia	-5.02*** (1.86)	-5.05** (2.54)	-11.27*** (3.69)	-6.53* (3.62)	-5.22** (2.54)
Blood Circulation	-1.39** (0.57)	-0.45 (0.72)	-2.19* (1.17)	-0.84 (1.04)	-0.47 (0.71)
Veins	-0.54** (0.24)	-0.26 (0.33)	-0.60 (0.76)	-0.06 (0.75)	-0.26 (0.33)
Thyroid Gland	-0.96 (1.41)	-0.60 (1.66)	-4.34 (4.84)	-3.53 (4.80)	-0.69 (1.66)
Problematic Deliveries	-0.30 (0.96)	1.26 (1.83)	1.62 (1.89)	2.01 (1.85)	1.31 (1.83)
Abnormal Deliveries	1.50** (0.65)	0.84 (1.10)	0.32 (0.87)	-1.23 (0.79)	0.81 (1.11)
Family Planning Indicators					
Abortions	2.14** (0.89)	-1.36 (1.36)	2.46 (1.56)	0.34 (1.45)	-1.35 (1.36)
Use of Contrac. Pills	28.83** (11.65)	-28.89* (17.14)	9.85 (15.62)	-19.85 (15.95)	-29.42* (17.26)

Notes: (1) The sample for each regression contains 1612 observations for 244 rayons, including 13 treated rayons. (2) The estimation results are from rayon fixed effect regressions with time dummies and oblast-time interactions as additional control variables.

Table 5: Estimated Impact of the MIHP on Infant Health Outcomes

	MIHP rayon (1)	Other Programs (2)	MIHP rayon (3)	MIHP oblast (4)	Other Programs (5)
Infant Mortality	-2.68** (1.18)	-1.77 (1.58)	-5.92*** (0.65)	-3.44** (1.41)	-1.90 (1.61)
<i>Including:</i>					
Stillbirths	-0.75 (0.76)	-0.46 (0.78)	3.81** (1.70)	4.83** (1.87)	-0.29 (0.78)
Perinatal	-0.56 (1.01)	-2.68** (1.31)	1.51 (2.22)	2.19 (2.46)	-2.60* (1.33)
Early Neonatal	0.13 (0.65)	-1.81* (0.96)	-2.33** (1.00)	-2.61** (1.21)	-1.91** (0.97)
Late Neonatal	-0.51 (0.38)	-0.96* (0.56)	-0.79* (0.44)	-0.29 (0.59)	-0.97* (0.57)
Postneonatal	-0.43 (0.76)	-0.58 (0.82)	-2.81** (1.18)	-2.52* (1.43)	-0.67 (0.84)
Infection	-0.89 (2.66)	0.48 (2.75)	-2.35 (3.95)	-1.55 (4.85)	0.43 (2.82)
Nervous system	0.02 (1.54)	0.62 (2.92)	-1.51* (0.77)	-1.62 (1.81)	0.56 (2.94)
Respiratory system	-1.36 (2.35)	-0.20 (2.25)	2.35 (2.80)	3.93 (3.75)	-0.06 (2.31)
Congenital Anomalies	1.05 (5.93)	-4.75 (6.09)	-54.51*** (8.12)	-58.86*** (9.95)	-6.85 (5.92)
Perinatal Deviations	-9.08 (5.91)	-15.55 (9.81)	-21.22** (9.22)	-12.86 (11.13)	-16.01 (9.89)
Infant Morbidity	-11.32* (5.89)	8.09 (11.76)	7.35 (18.89)	19.78 (19.84)	8.80 (11.89)
<i>Including:</i>					
Infection	-0.22 (0.46)	0.61 (0.74)	-3.13 (2.15)	-3.08 (2.20)	0.50 (0.74)
Nervous system	1.61 (1.70)	-4.88 (3.75)	-11.71*** (3.75)	-14.11*** (4.12)	-5.38 (3.74)
Respiratory system	-3.46 (3.97)	-7.04 (9.65)	20.54 (13.77)	25.43* (14.33)	-6.13 (9.65)
Congenital Anomalies	-0.01 (0.05)	0.01 (0.11)	-0.22*** (0.07)	-0.22** (0.09)	-0.00 (0.10)
Perinatal Deviations	-0.52* (0.29)	0.77 (0.47)	0.27 (0.21)	0.84** (0.37)	0.80* (0.48)

See Notes to Table 4

Table 6: Estimated Impact of the MIHP on Maternal Health Outcomes: Time Dimension

	Before			After			MIHP	Other
	3 years	2 years	1 year	1st year	2nd year	3d year	oblast	Programs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Maternal Mortality	-16.78 (18.20)	8.83 (14.47)	15.09 (14.94)	-38.38 (37.94)	-60.26 (39.84)	-49.09 (41.23)	-43.35 (36.11)	-0.06 (16.72)
Normal Deliveries	-0.56 (2.60)	-1.62 (2.37)	2.29 (2.98)	21.03*** (6.43)	23.42*** (5.53)	15.66*** (5.88)	11.18** (4.61)	0.42 (3.64)
Deliveries/1,000 Population	0.73 (0.46)	1.22*** (0.47)	1.05** (0.51)	2.12*** (0.82)	2.49*** (0.87)	3.72*** (0.97)	0.68 (0.63)	0.18 (0.77)
C-sections	0.73 (1.04)	0.87 (0.85)	-1.06 (0.73)	-5.78*** (2.21)	-6.57*** (2.00)	-6.05** (2.44)	-3.91** (1.66)	0.69 (1.06)
Early Neonatal Visits	-0.90 (0.89)	-0.22 (1.09)	-0.56 (1.00)	2.94 (1.97)	1.47 (2.08)	-0.09 (2.34)	0.25 (1.70)	0.11 (1.08)
Late Toxicosis	-1.25 (1.20)	-1.54 (1.30)	-2.18* (1.17)	-5.04** (2.05)	-5.67*** (2.09)	-6.23** (2.84)	-2.50* (1.34)	-1.67 (1.42)
Complicated Deliveries by cause:								
Urinary-Genital System	2.29 (2.66)	1.22 (1.58)	1.18 (1.70)	-2.09 (2.72)	-4.39 (3.61)	-5.41 (6.01)	-2.78 (2.39)	-0.33 (1.60)
Anemia	-7.33 (4.67)	-7.25 (4.54)	-10.34* (5.65)	-21.65*** (7.84)	-24.72*** (7.39)	-25.55*** (8.11)	-13.13** (5.45)	-4.84* (2.63)
Blood Circulation	-0.11 (0.94)	0.76 (1.09)	-1.52** (0.72)	-3.78** (1.60)	-4.12*** (1.50)	-3.97** (1.71)	-2.46** (1.24)	-0.49 (0.71)
Veins	0.14 (0.38)	-0.06 (0.32)	-0.18 (0.36)	-0.46 (0.89)	-1.28 (0.92)	-1.60 (0.99)	-0.37 (0.80)	-0.19 (0.31)
Thyroid Gland	-3.76* (2.21)	-0.90 (1.76)	-0.99 (1.55)	-3.65 (4.55)	-8.80 (5.55)	-6.09 (5.24)	-3.58 (4.65)	-0.25 (1.87)
Problematic Deliveries	3.30 (2.72)	-0.80 (1.48)	0.01 (1.58)	1.99 (2.57)	1.05 (2.67)	1.16 (2.95)	1.31 (2.22)	1.33 (1.81)
Abnormal Deliveries	0.16 (0.93)	-0.50 (1.02)	0.01 (1.30)	0.24 (1.72)	0.18 (1.82)	1.77 (2.09)	-0.97 (1.31)	0.77 (1.13)
Family Planning Indicators								
Abortions	-0.59 (1.23)	-0.08 (1.38)	-0.10 (1.19)	1.50 (2.14)	3.52 (2.39)	4.53* (2.67)	0.74 (1.56)	-1.56 (1.20)
Use of Contrac. Pills	-5.01 (16.76)	10.93 (12.92)	6.17 (12.50)	7.25 (22.03)	27.27 (23.32)	49.01 (38.57)	-10.76 (17.65)	-31.83** (15.73)

Table 7: Estimated Impact of the MIHP on Infant Health Outcomes: Time Dimension

	Before			After			MIHP	Other
	3 years	2 years	1 year	1st year	2nd year	3d year	oblast	Programs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Infant Mortality	0.68	-1.90*	-2.24*	-4.69	-7.22**	-5.04	-1.70	-1.99
	(1.11)	(1.03)	(1.31)	(2.93)	(3.07)	(3.39)	(2.80)	(1.52)
<i>Including:</i>								
Stillbirths	-0.08	0.04	-0.46	-1.32	-1.94	-1.50	0.15	-0.15
	(0.81)	(0.87)	(0.81)	(1.87)	(1.90)	(2.11)	(1.71)	(0.68)
Perinatal	-1.25	-1.89**	-1.88**	-2.64	-3.75*	-2.71	0.55	-2.24**
	(0.90)	(0.94)	(0.96)	(1.78)	(1.98)	(2.57)	(1.66)	(0.97)
Early Neonatal	-1.17**	-1.98***	-1.51**	-1.43	-1.90	-1.24	0.31	-1.97***
	(0.57)	(0.58)	(0.63)	(1.27)	(1.33)	(1.66)	(1.07)	(0.75)
Late Neonatal	-0.11	-0.58	-1.21**	-1.91*	-2.02*	-2.04*	-1.04	-1.11**
	(0.57)	(0.52)	(0.52)	(1.01)	(1.08)	(1.20)	(0.88)	(0.47)
Postneonatal	1.85**	0.48	-0.23	-2.06	-2.68	-1.44	-1.96	0.13
	(0.80)	(0.79)	(0.98)	(1.88)	(1.96)	(2.00)	(1.82)	(0.84)
Infection	1.28	-1.69	-5.45*	-0.30	-3.16	-0.65	1.53	3.31
	(2.67)	(2.82)	(3.01)	(5.90)	(6.15)	(6.69)	(5.63)	(2.34)
Nervous system	-0.90	2.13	-2.10	2.10	3.04	4.63	5.08	3.92*
	(1.33)	(1.87)	(1.75)	(6.68)	(7.18)	(7.41)	(7.01)	(2.04)
Respiratory system	1.03	-1.74	-2.99	-13.24**	-12.47*	-8.91	-12.31**	-1.41
	(2.79)	(2.84)	(2.89)	(6.35)	(6.66)	(7.04)	(5.55)	(2.35)
Congenital Anomalies	5.64	-2.61	-2.78	-23.23	-27.73	-18.67	-16.50	-0.85
	(6.98)	(5.84)	(6.27)	(21.22)	(21.24)	(22.15)	(20.75)	(5.63)
Perinatal Deviations	-1.13	-7.49	-11.52**	-33.11***	-35.31**	-30.69*	-15.35	-9.83
	(6.27)	(5.63)	(5.85)	(12.00)	(13.71)	(15.80)	(10.82)	(8.28)
Infant Morbidity	-5.62	5.22	-6.09	-38.13	-47.38	-57.34	-43.13	-0.34
	(12.88)	(10.41)	(9.82)	(46.18)	(45.91)	(46.31)	(44.06)	(12.08)
<i>Including:</i>								
Infection	-0.91	-0.86	-0.32	1.68	1.38	2.12	2.50*	0.68
	(1.13)	(0.90)	(0.90)	(2.05)	(2.09)	(2.18)	(1.45)	(0.66)
Nervous system	3.21*	4.45**	2.86	3.08	2.29	6.93*	1.13	0.56
	(1.76)	(1.89)	(1.95)	(3.68)	(3.57)	(3.86)	(2.79)	(2.27)
Respiratory system	-1.96	13.10	4.35	-35.53	-36.91	-62.93	-53.40	-17.55*
	(10.83)	(8.98)	(8.18)	(46.09)	(45.24)	(46.45)	(44.52)	(10.00)
Congenital Anomalies	0.01	0.07	0.05	-0.04	-0.07	-0.05	-0.05	-0.10
	(0.09)	(0.08)	(0.10)	(0.15)	(0.15)	(0.16)	(0.11)	(0.11)
Perinatal Deviations	-0.07	-0.37	-0.63**	-0.71	-0.54	-0.56	0.14	0.53
	(0.26)	(0.26)	(0.26)	(0.56)	(0.58)	(0.64)	(0.49)	(0.42)

Table 8: Estimated Impact of the MIHP on Placebo Outcomes

	DD			DDD		
	MIHP rayon (1)	MIHP oblast (2)	Other Programs (3)	MIHP rayon (4)	MIHP oblast (5)	Other Programs (6)
Tuberculosis Morbidity	-5.07 (4.32)	0.39 (4.15)	0.39 (4.15)	-1.08 (0.67)	-0.32 (0.33)	3.63 (4.00)
Diabetis Morbidity	3.66 (18.82)	0.10 (18.48)	0.10 (18.48)	-0.08 (1.50)	-1.41* (0.76)	-11.69 (18.64)
Hepatitis	112.15* (62.95)	113.00* (64.48)	113.00* (64.48)	-3.42 (3.35)	1.07 (1.16)	-10.83 (14.11)
Hypertension	-0.20 (0.56)	-0.73 (0.64)	-0.73 (0.64)	-0.09** (0.05)	0.05*** (0.02)	-0.18 (0.29)
Teenage Morbidity	0.24*** (0.08)	0.21*** (0.08)	0.21*** (0.08)			

See Notes to Table 4

Table 9: Estimated Impact of the MIHP on Maternal Health Outcomes: Metropolitan Areas

	MIHP rayon (1)	Other Programs (2)	MIHP rayon (3)	MIHP oblast (4)	Other Programs (5)
Maternal Mortality	-2.83 (10.76)	-1.12 (15.43)	-21.58* (11.53)	-19.87 (16.18)	-1.83 (15.70)
Normal Deliveries	7.74*** (2.40)	0.24 (3.96)	37.34*** (2.90)	31.37*** (3.62)	1.36 (3.78)
Deliveries/1,000 Population	0.72 (0.44)	-0.08 (0.77)	2.15** (0.92)	1.51 (1.03)	-0.02 (0.77)
C-sections	-2.05*** (0.76)	0.15 (1.19)	-11.22*** (2.64)	-9.71*** (2.72)	-0.20 (1.12)
Early Neonatal Visits	3.54*** (1.30)	-1.15 (1.39)	4.16*** (1.33)	0.66 (1.92)	-1.12 (1.41)
Late Toxicosis	-1.31 (1.22)	-2.93* (1.72)	-5.76** (2.45)	-4.72* (2.76)	-3.10* (1.73)
Complicated Deliveries by cause:					
Urinary-Genital System	-2.98 (3.58)	0.59 (2.49)	-1.30 (2.08)	1.78 (4.32)	0.65 (2.62)
Anemia	-5.15* (2.77)	-3.14 (3.64)	-12.25*** (4.24)	-7.53 (5.14)	-3.41 (3.68)
Blood Circulation	-0.96 (0.79)	-1.56 (1.35)	-6.55*** (2.48)	-5.93** (2.60)	-1.78 (1.34)
Veins	-0.52** (0.26)	-0.36 (0.48)	-0.89 (1.25)	-0.39 (1.28)	-0.37 (0.48)
Thyroid Gland	-0.36 (1.33)	0.10 (2.06)	-1.90 (2.81)	-1.63 (3.14)	0.04 (2.08)
Problematic Deliveries	0.75 (1.40)	2.19 (2.07)	6.59*** (1.95)	6.19** (2.43)	2.41 (2.09)
Abnormal Deliveries	1.64 (1.01)	1.35 (1.71)	-0.70 (1.17)	-2.49 (1.58)	1.26 (1.73)
Family Planning Indicators					
Abortions	4.87*** (1.34)	-3.23* (1.81)	1.56 (1.24)	-3.51* (1.88)	-3.35* (1.84)
Use of Contracep. Pills	32.35* (17.58)	-33.76 (21.33)	-12.98 (16.18)	-48.07* (24.57)	-35.48 (21.76)

Notes: (1) The sample for each regression contains 602 observations for 93 rayons, including 11 treated rayons. (2) The estimation results are from rayon fixed effect regressions with time dummies and oblast-time interactions as additional control variables.

Table 10: Estimated Impact of the MIHP on Maternal Health Outcomes: Time Dimension, Metropolitan Areas

	Before			After			MIHP	Other
	3 years	2 years	1 year	1st year	2nd year	3d year	oblast	Programs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Maternal Mortality	-1.20 (15.78)	6.52 (15.04)	6.09 (17.20)	-14.74 (24.08)	-23.68 (29.42)	-16.28 (31.55)	-18.86 (23.94)	-2.19 (15.99)
Normal Deliveries	2.28 (2.84)	3.01 (2.67)	6.96*** (2.44)	44.65*** (3.78)	46.19*** (5.24)	39.75*** (5.56)	35.18*** (3.99)	1.31 (3.72)
Deliveries/1,000 Population	0.20 (0.59)	0.48 (0.57)	0.28 (0.58)	2.72** (1.12)	3.33** (1.43)	4.17*** (1.52)	2.35** (1.12)	-0.06 (0.83)
C-sections	0.59 (1.04)	0.89 (0.99)	-0.95 (0.88)	-12.53*** (2.68)	-14.09*** (3.06)	-13.74*** (3.16)	-11.89*** (2.74)	-0.21 (1.10)
Early Neonatal Visits	0.01 (1.29)	0.48 (1.54)	0.73 (1.33)	4.43** (1.97)	3.51 (2.90)	0.89 (3.48)	-0.41 (2.66)	-1.08 (1.46)
Late Toxicosis	-1.33 (1.92)	-1.83 (2.03)	-3.11 (1.95)	-9.45*** (3.55)	-10.22** (4.02)	-9.83** (4.39)	-7.23** (2.92)	-3.00* (1.71)
Complicated Deliveries by cause:								
Urinary-Genital System	3.98 (4.17)	2.27 (2.46)	1.04 (2.48)	-0.38 (3.81)	-1.34 (5.95)	-2.18 (10.01)	0.27 (3.36)	0.54 (2.67)
Anemia	-1.95 (3.89)	-2.90 (4.28)	-3.70 (4.19)	-16.58** (6.79)	-18.35** (8.30)	-16.63* (9.57)	-10.37 (6.56)	-3.30 (3.60)
Blood Circulation	0.20 (1.49)	1.45 (1.44)	-0.90 (1.19)	-7.69*** (2.83)	-8.75*** (3.01)	-8.15** (3.32)	-7.67*** (2.55)	-1.80 (1.34)
Veins	0.31 (0.48)	0.40 (0.40)	-0.21 (0.44)	-1.35 (1.32)	-2.28 (1.42)	-2.66* (1.36)	-1.54 (1.24)	-0.37 (0.47)
Thyroid Gland	-0.93 (2.08)	-0.38 (2.11)	0.52 (2.18)	-1.38 (3.70)	-4.13 (3.95)	-1.90 (4.85)	-1.89 (2.81)	0.01 (2.14)
Problematic Deliveries	0.25 (3.07)	-5.47* (2.79)	-3.40 (2.57)	2.52 (3.34)	3.42 (3.99)	1.92 (4.23)	4.33 (3.02)	2.60 (2.13)
Abnormal Deliveries	0.03 (1.44)	-0.36 (1.60)	0.06 (1.72)	-0.21 (2.45)	0.45 (3.06)	2.35 (3.31)	-1.18 (2.43)	1.22 (1.73)
Family Planning Indicators								
Abortions	1.14 (1.88)	2.04 (2.22)	2.48 (2.03)	5.10* (2.66)	7.37** (3.33)	8.94** (3.93)	0.21 (1.79)	-3.48** (1.69)
Use of Contrac. Pills	7.15 (21.35)	34.65* (17.96)	18.00 (15.70)	17.84 (26.44)	39.45 (34.15)	76.75 (52.02)	-11.61 (23.00)	-37.35* (19.19)

Table 11: Estimated Impact of the MIHP on Infant Health Outcomes: Metropolitan Areas

	MIHP (1)	Other Programs (2)	MIHP rayon (3)	MIHP oblast (4)	Other Programs (5)
Infant Mortality	-2.68** (1.18)	-1.77 (1.58)	-5.92*** (0.65)	-3.44** (1.41)	-1.90 (1.61)
<i>Including:</i>					
Stillbirths	-0.75 (0.76)	-0.46 (0.78)	3.81** (1.70)	4.83** (1.87)	-0.29 (0.78)
Perinatal	-0.56 (1.01)	-2.68** (1.31)	1.51 (2.22)	2.19 (2.46)	-2.60* (1.33)
Early Neonatal	0.13 (0.65)	-1.81* (0.96)	-2.33** (1.00)	-2.61** (1.21)	-1.91** (0.97)
Late Neonatal	-0.51 (0.38)	-0.96* (0.56)	-0.79* (0.44)	-0.29 (0.59)	-0.97* (0.57)
Postneonatal	-0.43 (0.76)	-0.58 (0.82)	-2.81** (1.18)	-2.52* (1.43)	-0.67 (0.84)
Infection	-0.89 (2.66)	0.48 (2.75)	-2.35 (3.95)	-1.55 (4.85)	0.43 (2.82)
Nervous system	0.02 (1.54)	0.62 (2.92)	-1.51* (0.77)	-1.62 (1.81)	0.56 (2.94)
Respiratory system	-1.36 (2.35)	-0.20 (2.25)	2.35 (2.80)	3.93 (3.75)	-0.06 (2.31)
Congenital Anomalies	1.05 (5.93)	-4.75 (6.09)	-54.51*** (8.12)	-58.86*** (9.95)	-6.85 (5.92)
Perinatal Deviations	-9.08 (5.91)	-15.55 (9.81)	-21.22** (9.22)	-12.86 (11.13)	-16.01 (9.89)
Infant Morbidity	-11.32* (5.89)	8.09 (11.76)	7.35 (18.89)	19.78 (19.84)	8.80 (11.89)
<i>Including:</i>					
Infection	-0.22 (0.46)	0.61 (0.74)	-3.13 (2.15)	-3.08 (2.20)	0.50 (0.74)
Nervous system	1.61 (1.70)	-4.88 (3.75)	-11.71*** (3.75)	-14.11*** (4.12)	-5.38 (3.74)
Respiratory system	-3.46 (3.97)	-7.04 (9.65)	20.54 (13.77)	25.43* (14.33)	-6.13 (9.65)
Congenital Anomalies	-0.01 (0.05)	0.01 (0.11)	-0.22*** (0.07)	-0.22** (0.09)	-0.00 (0.10)
Perinatal Deviations	-0.52* (0.29)	0.77 (0.47)	0.27 (0.21)	0.84** (0.37)	0.80* (0.48)

See Notes to Table 9

Table 12: Estimated Impact of the MIHP on Infant Health Outcomes: Time Dimension, Metropolitan Areas

	Before			After			MIHP	Other
	3 years	2 years	1 year	1st year	2nd year	3d year	oblast	Programs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Infant Mortality	1.56	-1.11	-1.43	-7.64***	-10.30***	-7.92***	-5.81***	-1.94
	(1.14)	(1.20)	(1.53)	(1.96)	(2.46)	(2.98)	(2.00)	(1.57)
<i>Including:</i>								
Stillbirths	-0.11	-0.14	0.01	3.98*	4.37*	4.93*	5.38**	-0.30
	(1.03)	(1.07)	(1.08)	(2.29)	(2.65)	(2.89)	(2.24)	(0.77)
Perinatal	-0.41	-1.79*	-1.06	0.40	-0.24	1.22	1.85	-2.58**
	(0.93)	(0.97)	(1.20)	(2.98)	(3.73)	(3.89)	(3.04)	(1.26)
Early Neonatal	-0.48	-1.78**	-1.22	-3.76**	-4.77**	-3.78*	-3.52**	-1.87**
	(0.69)	(0.71)	(0.79)	(1.58)	(1.98)	(2.17)	(1.54)	(0.95)
Late Neonatal	-0.11	-0.05	-0.52	-1.48*	-2.01**	-2.03*	-1.11	-0.96*
	(0.58)	(0.56)	(0.55)	(0.77)	(0.98)	(1.11)	(0.72)	(0.57)
Postneonatal	2.37**	0.80	-0.39	-3.17*	-3.45*	-2.63	-3.53**	-0.74
	(0.94)	(0.91)	(1.20)	(1.75)	(2.00)	(2.17)	(1.74)	(0.83)
Infection	5.12*	1.19	-2.47	-5.65	-8.60	-8.12	-7.21	0.35
	(2.71)	(2.90)	(3.31)	(5.57)	(7.29)	(8.07)	(6.78)	(2.79)
Nervous system	1.65	3.36*	0.79	-0.07	0.67	3.05	-0.68	0.39
	(1.42)	(1.81)	(1.91)	(2.46)	(3.79)	(4.43)	(3.19)	(2.73)
Respiratory system	-2.09	-2.60	-4.53	-2.73	-4.94	-1.55	0.62	0.02
	(3.61)	(3.69)	(3.78)	(5.02)	(5.80)	(7.42)	(3.80)	(2.20)
Congenital Anomalies	6.80	-1.44	-1.94	-56.61***	-61.90***	-55.65***	-63.23***	-7.06
	(8.04)	(6.90)	(6.56)	(11.79)	(14.00)	(16.75)	(12.11)	(5.82)
Perinatal Deviations	-2.67	-9.30	-9.43	-31.72**	-42.39**	-28.75	-20.92	-15.96*
	(7.87)	(6.79)	(7.78)	(14.28)	(19.12)	(19.94)	(15.03)	(9.13)
Infant Morbidity	2.53	-3.57	-3.50	1.11	-5.64	-11.80	9.78	9.05
<i>Including:</i>								
Infection	0.88	0.13	1.01	-2.15	-3.37	-3.30	-3.21	0.47
	(0.78)	(0.75)	(0.71)	(2.62)	(2.91)	(3.12)	(2.65)	(0.70)
Nervous system	3.60	4.21	1.21	-9.77**	-11.95**	-6.63	-14.35***	-5.68
	(2.31)	(2.95)	(2.59)	(3.84)	(4.69)	(4.53)	(3.26)	(3.74)
Respiratory system	-2.96	-1.95	-0.73	16.41	14.45	-3.23	17.86	-5.58
	(5.62)	(6.81)	(6.80)	(15.38)	(16.15)	(21.37)	(13.76)	(8.03)
Congenital Anomalies	0.15*	0.20**	0.14	-0.07	-0.13	-0.18	-0.23	-0.01
	(0.09)	(0.08)	(0.14)	(0.17)	(0.19)	(0.21)	(0.15)	(0.10)
Perinatal Deviations	-0.01	-0.46	-0.53	-0.35	-0.19	-0.36	0.50	0.82*
	(0.37)	(0.37)	(0.38)	(0.48)	(0.63)	(0.71)	(0.42)	(0.48)

Table 13: Estimated Impact of the MIHP on Placebo Outcomes: Metropolitan Areas

	DD			DDD		
	MIHP rayon (1)	MIHP oblast (2)	Other Programs (3)	MIHP rayon (4)	MIHP oblast (5)	Other Programs (6)
Tuberculosis Morbidity	-3.20 (2.22)	-1.14 (4.81)	6.41 (4.67)	-0.98 (0.93)	-0.51 (0.96)	3.62 (4.02)
Diabetes Morbidity	-4.19 (7.53)	5.30 (5.72)	9.75 (12.01)	0.30 (1.67)	1.12 (1.96)	-8.53 (16.75)
Hepatitis	19.80 (30.81)	-17.47 (14.86)	-15.05 (23.11)	1.75 (3.28)	2.84 (2.61)	-15.46 (14.20)
Hypertension	0.08 (0.19)	0.24** (0.12)	0.11 (0.29)	-0.11** (0.05)	0.04 (0.03)	-0.12 (0.29)
Teenage Morbidity	0.18* (0.09)	0.17 (0.01)	0.04 (0.07)			

See Notes to Table 9

Table 14: Per Mother and Child Cost Savings Calculation

	C-section (CS)	Vaginal delivery (VD)	CS-VD	
Post-MIHP 2005	118.40	26.05	92.35	
Average number of deliveries in 2005				2,806.20
Estimated impact on CS, percent				-4.85
Number of VD that would have been CS without the MIHP				136.10
Cost Savings Due to a Switch from CS to VD				12,568.90
Pre-MIHP 2002	267.75	133.35	134.40	
Post-MIHP 2005	118.40	26.05	92.35	
2002 to 2005 change in cost	149.35	107.30		
Average number of deliveries in 2005	341.51	2,464.69		
Cost savings due to a change in technology	51,005.20	264,460.75		315,465.95
Total, UAH				328,034.85
Total, USD				64,957.40
Average number of live births in 2005				2,681.40
Mothers' lives saved per year (63 per 100,000 livebirths)				1.69
Newborns' lives saved per year (30 per 10,000 livebirths)				8.04
Total value of saved lives (VSL=0.79 mln USD)				7,689,450.78
Total Benefits (including saved lives)				7,754,408.18

Notes: (1) The cost includes the cost of the procedure for both mother and newborn. (2) The cost is given in 2005 prices. (3) Exchange rate for year 2005 is 5.05 UAH/USD. (3) Average number of deliveries and livebirths per rayon is calculated for all participating rayons in year 2005.

APPENDIX

Description of the Cost Impact Study implemented by the MIHP (Lefevre-Cholay et al., 2006)

The Cost Impact Study (CIS) was designed to evaluate the financial impact of the MIHP interventions in the Project pilot maternities and to provide health facilities and policy makers with information for replication of MIHP practices.

The Project management team has selected three MIHP facilities: Lutsk, Kovel, and Donetsk No. 3. There were two criteria for selection. First, the annual number of deliveries is to exceed 1,000 cases. Second, the maternities are to be involved with the project since 2003.

For the purpose of CIS, the project management team has collected the data using the following tools: the Patient Record Review Form, the Prices and Supply Costs Form, and the Interview Guide.

The Patient Record Review Form was randomly offered to patients who gave birth in the target facilities. A total of 200 records were reviewed in each facility - 100 from 2002 and other 100 selected in 2005. The Form covered topics such as admission and discharge time, type of delivery, types of lab tests performed and medicines used, as well as other information helpful for comparing delivery-related practices before and after MIHP interventions.

The Prices and Supply Costs Form was aimed at quantifying the resources used for MIHP practices, which were revealed via the Patient Record Review Form. The types of resources included drugs, injection supplies, lab tests and diagnostic procedures, and infant formula. Initially, the study design involved collecting prices of each resource from the facility pharmacies and local pharmacies, and calculating an average price. However, this data was extremely sensitive to local market imbalances. Thus, eventually it was decided to use the "standard prices" based on the lowest wholesale offers found in the national electronic trading system (www.apteka.com.ua). Unit prices were collected solely from 2005. This allows the

analysis to isolate the changes in costs due to changes in practices and resources used as opposed to changes in prices.

The Interview of the facility staff was conducted to corroborate the use of practices, drugs and supplies listed in the Patient Record Review Forms. It was also aimed to reveal under-reporting, over-reporting, miss-reporting, and unexpected practices that arose during the record review process. A total of 3 senior obstetrics-gynecologists, 3 midwives, and 3 neonatologists at the three MIHP pilot facilities were interviewed.