It’s a long walk

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It’s a long walk

Lasting effects of maternity ward openings on labour market performance

Volha Lazuka

Abstract

Studies showing that large-scale public health interventions in early life have lasting economic consequences are still scarce and rarely disclose the mechanisms. Being born in a hospital versus having a traditional birth attendant at home represents the most common early life policy change worldwide. Knowing the consequences of this policy is also important given the ongoing enlargement of maternity hospitals. In 1931–1946, the Swedish state subsidized the opening of new maternity wards, which led to the gradual decline of home deliveries assisted by midwives. Maternity wards offered improved conditions for mothers and newborns, including hygiene, surgical proficiency and medications, and health monitoring. By applying a difference-in-differences approach and geocoding techniques to register-based individual-level data on the total population, observed from birth until the age of 65, this paper explores the long-term economic effects of access to better health services at birth using the opening of maternity wards throughout the country as an early life quasi-experiment. The paper first finds that the reform substantially reduced neonatal mortality in the short term by 19.0–26.5 deaths per 1000. Capturing survivors of the affected cohorts at the ages of 47–64, it then shows sizable long-term effects of the introduction of maternity wards on labour income (2.4–4.7 per cent) and disability pensions (4.4–11.9 per cent). The effects run directly through better health and indirectly through higher levels of schooling. Small-scale local maternity wards yield a larger social rate of return than large-scale hospitals, stemming from the treatment of normal births.

Key words: Early life, maternity ward, labour income, efficiency, Sweden

JEL codes: I18, I38, J24, N34

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I. Introduction

Public investments in early life have been linked theoretically and – more recently – empirically, based on methods of causal inference, to human capital accumulation and adult economic performance (Almond, Currie, and Duque 2018; Cunha and Heckman 2007). The overwhelming majority of the empirical literature suggests high efficiency of investments during the prenatal stage, while other studies, remaining scarce to date, point out the similar magnitude of the effects in early life after birth. However, the majority of the events or interventions with large returns represent 'black boxes', for which, due to the specificity of the reform or a lack of information, researchers are unable to disclose particular treatment components and age intervals in early childhood as being critical (Currie and Rossin-Slater 2015). The provision of additional resources close to the birth event in a maternity ward represents one of the most common health care interventions that is used by clinicians in their daily work with basic laboratory facilities and inexpensive medicines (WHO 2014). Having been understood as a basic right of every woman to receive high-quality maternity care, the overwhelming majority of the developed countries have replaced the home childbirth setting with hospitals and clinics, and Sweden, on which the analysis in this paper focuses, was one of the first and most rapid to do so (Myrdal 1944). Such a transformation is a 'natural experiment' in the advancement of health technology in a very narrow age window – at birth and shortly after birth – that in the long term could generate sizable economic returns at both the individual and the social level.

Recent research has shown that large-scale health interventions as early-life resources are able to boost long-term economic returns (recent reviews in Almond, Currie, and Duque [2017]; Currie and Rossin-Slater [2015]). In grasping the size of the effects during prenatal stage, one can refer to the study by Black, Devereux, and Salvanes (2007) for the Norwegian cohorts in 1967–1997 that showed that the increase in birth weight from low to average, or roughly by a kilogram, leads to 3.7 percent higher earnings in adulthood and is as valuable in the labor market as a year of education. Studies showing that interventions during prenatal stage have economic consequences are extremely limited (e.g. Adhvaryu et al. 2018; Hoynes, Schanzenbach, and Almond 2016). Investing in early childhood could be at least as efficient. One strand of recent research has shown a sizable long-term economic impact of various eradication programs or medical innovations against childhood diseases (Bleakley 2007; Bhalotra and Venkataramani 2013; Lazuka Forthcomingb). For instance, as Bhalotra and Venkataramani (2011) show, arrival of sulpha drugs against infant pneumonia led to, as a reduced-from difference-in-differences, 3.1 percent increase in family income among men in the United States. There are similar results for both sexes in Sweden (Lazuka Forthcomingb). Results from other studies that explicitly analyzed the economic effects of public programs targeted small children are inconclusive, ranging from similarly large effects from provision of cash transfers to poor mothers in the United States (Aizer et al. 2016) and infant care program to general population in Norway (Bütikofer, Løken, and Salvanes 2018), to no effects from similar programs in Denmark or Sweden (Hjort, Sølvsten, and Wüst 2017; Knutsson 2018). It points to the relative efficiency of different treatment components, largely the focus on either nutrition or disease prevention and treatment. The bulk of the literature on the lasting effects of medical care in childhood rests on the provision and expansion of public health insurance, Medicaid in the United States as natural experiments, and finds them for certain subpopulations (Boudreaux, Golberstein, and McAlpine 2016; Brown, Kowalski, and Lurie 2015; Miller and Wherry Forthcoming).

Recently, we began to learn that hospital resources at birth have positive consequences in the short and medium term. For the United States, Mazumder, Chay, and Guryan (2009) argue that narrowing of the racial gap in academic achievements closely tracks cohort convergence in measures of health and hospital access in the years immediately following birth. Bharadwaj, Løken, and Neilson (2013) have found that low-birth-weight infants, presumably treated by extra medical care at birth, experience lower mortality during the first year of life and higher academic achievements as adolescents in Chile and Norway. Kronborg, Sievertsen, and Wüst (2016) have found that lower medical resources at birth, measured with the same-day post-childbirth discharge, leads to a significantly lower academic achievements for at-risk children in Denmark. Based on a quasi-experiment in Indonesia, Frankenberg, Suriastini, and Thomas (2005) show that expansion of access to midwives, who provided services during the prenatal and early childhood periods, led to short-term improvements in height in early childhood. Pointing to the effects beyond the medium term and relying on a historical population in Sweden, Lazuka (2018) has shown that assistance of birth at home by a qualified versus a traditional midwife not only substantially reduced risk of neonatal death, but also that it improved skills and reduced risk of death due chronic diseases. Lazuka (Forthcoming) has shown that the expansion of primary care in the first year of life due to openings of health districts, together with openings of isolation hospitals and employment of licensed midwives, yields lower mortality and higher incomes as far as in oldest-old ages.

There is also a growing literature that studies the efficiency of different health care institutions (reviews in Giancotti, Guglielmo, and Mauro 2017; Skinner 2012). Regardless of a much broader scope of this literature adding to our understanding of the long-term economic consequences of public health institutions (Mokyr 2005), so far it has tackled exclusively contemporaneous aspects. Some of this literature has focused on the short-term health effects of healthcare institutions differing in available health technologies. Cutler, Meara, and Richards-Shubik (2012) have shown that medical innovations, such as the establishments of intensive care units, explains one fifth of the infant mortality decline in the United States. In contrast, Currie and MacLeod (2008) have found that while damage caps reduce induction and stimulation of labor, Cesarean sections, and complications of labor and delivery, they have little impact on infant health in the United States. In the Netherlands, where home births are widespread even nowadays, Daysal, Trandafir, and van Ewijk (2015) have shown that giving birth in a hospital leads to substantial reductions in newborn mortality. Several studies also analysed the efficiency and social welfare effects (in terms of costs and health outcomes) of hospital competition in the modern context of the developed countries and found that hospital enlargement leads to welfare losses, in terms of higher prices and worse patients' outcomes (Avdic, Lundborg, and Vikström 2018; Kessler and McClellan 2000; Schmitt 2018). More specifically for maternity wards, Avdic, Lundborg, and Vikström (2018) have recently shown that their enlargement, which occurred in Sweden in 1990–2004, led to higher probability of maternal trauma and lower APGAR scores for newborns.

Providing grounds for the above findings, medical literature suggests that resources during neonatal period could have lasting health consequences. These propositions fall into the recently developed concept of biological imprinting explaining that nutritional and environmental stimuli in early life could become 'embedded' in the developing body, remain latent until adulthood but with limited or absent opportunity for modification by later experiences (Waterland and Michels 2007). Early on, based on the analysis of individual birth records from hospitals and midwifery journals throughout the archives in Britain connected to death certificates, Barker (1994) showed that low weight at birth and during infancy and exposure to respiratory or diarrhoeal infections during infancy predicted death from cardiovascular disease, diabetes, and lung obstructive diseases in adulthood. Whereas in later works Barker strongly emphasised the importance of intrauterine environment, other scholars have claimed the relative importance of exposure to infectious diseases early in life, especially in infancy (Finch and Crimmins 2004). Better hygiene and reduced exposure to microbial infectious diseases in the early neonatal period are associated with markers of chronic inflammation and morbidities (Finch 2007). The amount of maternal and specialist care, such as time spent nursing, in the early neonatal period could have a critical influence on the development of stress response that similarly alters the long-term inflammatory process (Danese and McEwen 2012). Measurements of newborns' health in the hospitals detect disease conditions and could help to divert additional resources to the child, potentially discouraging the development of future disease (Calkins and Devaskar 2011). All environmental factors acting in early life can affect almost any aspect of the immune system, leading up to chronic diseases (Leifer and Dietert 2011). Within this mechanism, prolonged breastfeeding has been shown to be vital (Andersson et al. 2009).

In 1931–1946, the Swedish state reformed the childbirth institutional system that led to the openings of the new maternity wards (MW) of different types, and to the gradual decline in home deliveries assisted by midwives. MWs offered improved childbirth conditions, including hygiene, surgical proficiency and medications, health monitoring after birth, and the rest to the mother. This paper uses this quasi-experiment to explore the long-term economic, educational and health effects of access to better health services at birth (during and 10 days after maternal delivery), by employing a difference-in-differences method and geocoding techniques. In doing so, it contributes to the emerging literature on the long-term effects of large-scale public health interventions (Almond and Currie 2011; Almond, Currie, and Duque 2018), and, as one innovation, pioneers the investigation of the MW reform. It has also high external relevance, because, as a tool of improving infant and maternal health, institutionalization of childbirth occurred in almost all developed countries in the past and is ongoing in developing countries. No study so far has investigated the long-term efficiency of different childbirth institutions (Giancotti, Guglielmo, and Mauro 2017; Skinner 2012), which presents another innovation of the paper. A number of developed countries undergo the closures of maternity wards (OECD 2017), and this paper therefore points to the plausible long-term economic consequences of these decisions. In 1938, a new health technology, such as sulphonamides against puerperal fever, arrived to Sweden, and this paper exploits this exogenous variation to clarify what role its equal distribution plays in long-term efficiency. As one more innovation, this study discloses the mechanisms leading up to the adult outcomes by employing high-quality detailed data. Based on register-based datasets, this paper is able first to demonstrate the effects of the reform on neonatal mortality, and next to look at several adult outcomes, such as labour income, disability, health and schooling. Making it possible to clarify the most productive components of early-life treatment, multiple archival materials together with geo-coded information provide information on characteristics of the reform and its setting. The calculation of a social rate of return by type of childbirth institution, done in this paper, measures relative efficiency of investments between different institutions and between different stages of life cycle.

II. The Reform

In the context of the falling fertility and stagnating infant mortality in the 1920s, Swedish state authorities began to reform the childbirth institutional system. To equalize the quality of the midwifery services in different parts of the country, the law obliged the parishes to employ a licensed midwife already in 1908, although midwives with different expertise practiced in the countryside for a few decades afterwards (Högberg 2004). The nationwide system of midwife-assisted home childbirth was finally formed in 1920, with both a division of the country into small healthcare units, 2,103 districts supervised by midwives, and their predominantly public provision. Out of 3,022 midwives practicing that year, 2,189 had contracts with the parishes, 776 kept own practice, and 57 worked in the maternity wards in the cities (Socialstyrelsen 1920). Midwife-assisted homebirth accounted for 88.6 percent of births (see Figure 1). In the 1920s, the districts began to undergo a gradual enlargement to prevent oversupply of the midwifery services in certain regions. In parallel, the number of deliveries in maternity hospitals among the poor parturient women, all subsidized by the parishes, and those referred from the midwives as complicated deliveries, increased from 11.4 to 22.8 percent. Large specialized maternity clinics, 8 in total, had been in operation in largest cities to handle puerperal and other complicated cases for a long time, earliest – *Serafimerlasarettet* in Stockholm – since 1752 (Socialstyrelsen 1927). Maternity departments in lying-in county hospitals (*Type I* henceforth, 33 in total) provided similar services. Poor expectant mothers gave birth in a variety of small-scale institutions (*Type II* henceforth), such state-, parish- or privately-owned charity, maternity and elderly homes, and Red Cross maternity hospitals, whereas better-off women could attend private homes for a fee (Vallgårda 1996). The number of these small-scale institutions flourished from 17 to 83 in the 1920s (Skatteförvaltningen 1989). The institution of at-home midwifery assistance was abolished in 1947, by when 89.6 percent of births occurred in the hospital setting.

[Figure 1]

The year 1931 marks an increase in the state subsidies related to childbirth, which from then had to be paid to all mothers, either from insurance or state funds, in the amount 2 SEK per day for 10 days equal to the fee at county hospitals (Socialdepartamentet 1954). The insured women received additional financial support for childbearing that soon covered everyone. Related to the supply side, few years before, a new hospital legislation stressed that county councils *should* (in reality interpreted as *must*, Gröne 1949b) provide inpatient childbirth care, and an the investigation by the Health Board calculated the lack and the need of the opening of the MWs in all locations within a 5.5 km radius (Socialdepartamentet 1929). Hereby gynecology and obstetrics became recognized as a clinical specialty. These formulations encouraged the organization of the maternity units in all existing health- and social care institutions and openings of new ones by the county means, prioritizing the allocation of resources to larger establishments (Gröne 1949a). From 1937, the state subsidized the lion share of all costs: fixed costs 2,500 SEK per a new hospital bed in large maternity hospitals and *Type I* hospitals and 1,000 SEK in *Type II*, and operating costs to old and new institutions 3 SEK per day for 10 delivery days (Socialdepartamentet 1954). The available data shows that such investments led to the expansion of mainly *Type I* (65 new wards) and *Type II* MWs (103 new wards), with only two specialized maternity clinics established in 1931–1946 (see Figure 2). The average distance from the parish to the closest MW decreased from 29,023 to 55 kilometers and access to hospitals in terms of childbirth beds per 1000 increased from 0.2 to 1.2 in 1931–1946 (Skatteförvaltningen 1989). Facing an increasing demand in childbirth services, these specialized clinics, together with multiple MWs, established in the rapidly urbanizing areas, which previously possessed a hospital (254 out of 2529 parishes). The overwhelming, more rural, locations arranged completely new MWs in both large- and small-scale hospitals, of *Type I* and *Type II*, with MWs in cottage hospitals supplemented the former group.

[Figure 2]

The use of inpatient institutions for childbirth has gradually increased to the extent that the technological development in childbirth progressed and home birth became less healthy or popular. By the 1930s, the skilled delivery by midwives at homes included the use of manual techniques and obstetrical instruments, preventive measures, surveillance of the third stage of labour, monitoring of a lying-in woman and a child after delivery for at least 10 days, and even neonatal resuscitation (Lazuka 2018). Maternity hospitals, equally affordable, had several advantages. The first is the emergency care, needed in 10–15 percent of all unforeseen cases, including the Cesarean section, because doctors were always available in the hospitals and the technical possibilities of the medical institutions could be used without delay (Socialdepartamentet 1935). Such rationale underlid the encouragement of investments into larger institutions that provided the best emergency care and equipment, for example, newborn revival apparatuses (Wachenfeldt 1931). Unsurprisingly, early neonatal mortality at the *specialized clinics*, which handled the most complicated cases, was at the beginning higher in comparison to that at homes, although differences in the share of preterm deaths is likely to reflect the accuracy of registration (see Table 1). As contributions to maternal health and recovery, hospitals provided pain relief in the form of nitrous oxide and other pain-killing drugs, hormone therapy, and opportunity of hourly monitoring and of resting for all mothers for at least 10 days, greatly valued by working-class women (Gröne 1949a). Avoidance of overcrowding and infection represents one more advantage. Noteworthy, long stays after childbirth at large establishments were more likely to cause infectious disease than at smaller ones, attributed to the incidence of 'cross-infection' (Landolt 1947). However, preventive measures, and the arrival of sulphonamides against puerperal fever, and in general against streptococcal and staphylococcal infections in 1938–1939 and its availability at the hospitals favoured each but home midwifery. The long distances that rural women in labour had to travel to reach the city and county clinics possibly contributed to higher risks of perinatal mortality, pointing to the additional value of access to wards close to the place of residence (Gyllenswärd 1946).

[Table 1]

III. Empirical Strategy

To estimate the long-term effects of the openings of the maternity wards, this paper applies a DiD approach in the following baseline specification:

$$y_{ipb} = \alpha + \beta new\ MW\ catchment\ area_p \text{ x } post_b + \delta_p + \mu_b + \varepsilon_{ipb} \quad (1)$$

where *new MW catchment area*$_p$ denotes parishes of birth treated by a newly established maternity ward; $post_b$ are cohorts born since a maternity ward was established in the parish; δ_p are parish-of-birth fixed effects; μ_b are year-of-birth fixed effects. Eq.1 thus estimates β by comparing the difference in outcomes between individuals born before and after the opening of the MW in the covered parishes to the difference in outcomes between individuals of the same cohorts born in the non-covered parishes across cohorts in 1931–1946. The estimate β provides the reduced-form effect of the early-life policy for several long-term economic outcomes y_{ipb}, such as the natural logarithm of labour income and disability pension receipt, and mediators, such as length of stay in hospital and schooling. Due to the treatment defined at a geographical level, parishes that fall into the catchment area of MWs established prior to the reform, in 1931, are not included into the estimation sample as already treated. The areas of the *specialized clinics* are not included precisely due to this reason, but only of the more common types of institutions –*Type I* and *Type II* – in the parishes that did not have access to a MW before the reform. Partially in order to remedy this, individual-level data for the case of parishes in southern Sweden used in this study allows me to estimate the effects of being born in *specialized clinics*. As the treatment initiation varies over a 16-year period and the size of the median Swedish parish in the estimation sample is 52 square kilometers, I compare the outcomes at many points in time and within small geographical areas.

Parturient women could choose any maternity ward or a birth attendant at home for child delivery, and the model first defines a catchment area in line with the regulations of the National Board of Social Affairs (Socialdepartamentet 1929), which is a 5.5-km straight-line buffer area centered in the parish of MW's location (defined as a geographical centroid). This corresponds to the walking distance to the hospital of around one hour, in tight accordance with the road and surface conditions of the time (Socialdepartamentet 1929) and even with current healthcare standards (WHO 2013). Only few large hospitals had in their possession ambulance cars that could deliver patients twice as fast, and the majority had horse-drawn ambulances, driving at a speed similar to walking, or did not provide this service at all (Andersson-Skog and Krantz 1999). Walking or horse-drawing were the most common modes of travel in case of emergency, and a developed network of railways was used in normal occasions. A motorized transport was gaining its propagation slowly, and its availability amounted to only 0.022 vehicles per capita by 1946; the majority of the roads were unsurfaced and cars or buses were primarily used for the short routes inside the cities (Statistiska Centralbyrån 1960). Parturient women usually arrived to the hospital after the start of labour, although rarely, especially under the risk of birth complications, were admitted several days prior (Genell 1945). The chosen threshold distance distinguishes different treatment groups in closeness to the numbers provided in the official statistics (Socialstyrelsen 1931-1946): the share of 0.15 was admitted to *specialized clinics*, 0.44 – to the *Type I* MWs, 0.15 – to the *Type II* MWs, and the share of 0.26 was assisted by *midwifery at homes*.

This paper utilizes two other measures of spatial access to maternity wards in the form of the treatment intensity, benefiting from the recent developments in the spatial modelling that takes costs of travel into account. One is a *linear distance* to the nearest MW that is equivalent to the least cost path. Another measure is a *gravity-based access* – hospital beds allocated for child delivery per capita adjusted with the travel time, which takes into account not only a distance to the nearby hospital but also the availability of the hospital facilities (supply) relative to the demand of these facilities from surrounding populations (Crooks and Schuurman 2012). The demand is adjusted with a decay coefficient following the rationale that women are attracted to larger services (in this case also to those of presumably better quality) and this attraction diminishes with distance and costs. Following this literature, for walking times less than or equal to 60 minutes, I do not apply any decay; for 60 to 180 minutes, I use a ⅒ implying that the travel impedance increases linearly; for walking time more than 180 minutes, the hospital is considered as not accessible (see Appendix A). The constructed gravity-based measure is relevant because, as discussed previously, the sizes of the MWs differed largely. Also, it is easy to see that this measure allows me to mete flexibly access to the nearest hospital for parishes that with a threshold measure based on a linear distance fall into the untreated category. Variations with a linear distance, such as adjustments for urban and rural areas or with a decay coefficient provide similar results, supporting my choice of the prevailed modes of travelling (available upon request). To ease interpretation, both measures of spatial access have been normalized by dividing by their two standard deviations. The empirical formulations for the baseline specifications are as before:

$y_{ipb} = \alpha + \beta$ *linear distance to the closest MW* $+ \delta_p + \mu_b + \varepsilon_{ipb}$ (2)

$y_{ipb} = \alpha + \beta$ *gravity-based access to the MWs* $+ \delta_p + \mu_b + \varepsilon_{ipb}$ (3)

The counterfactual group includes individuals who were predominantly assisted by midwives in home settings in the parishes that are not covered by the newly opened MW (for a discontinuous treatment variable), or the propensity of being treated in a MW diminishes with distance or access (for continuous treatment variables). The identification assumption of the DiD method is that in the absence of the reform implementation, the outcomes of the groups treated by MWs and by midwifery would follow parallel trends over time. This allows the DiD to account for unobserved variables, which are assumed to remain fixed over time. This paper addresses the potential threat to identification arising from these and other shocks in several ways. First, I additionally control for the pre-treatment time trends across urban (including small, less than 10,000 inhabitants, and large cities) and rural regions (49 regions). This should eliminate the treatment effect from secular trends at the relatively large geographical levels that differed in unobservable conditions that could instead develop into similar outcomes. Second, I include interactions between the array of baseline region-of-birth characteristics in 1930 and linear time trends to control for the effects of health, income and other regional factors on development of later-life outcomes across cohorts. It can be also seen as a balancing test for the covariates across regions of birth. As important socio-economic and infrastructure changes occurred in relatively small geographical areas, as the third check, I introduce interactions between observable parish-level characteristics measuring income and provision of healthcare and other public goods, and linear time trends. Fourth, I introduce parish-of-birth-specific linear time trends to eliminate the effects of all observable and unobservable characteristics at the parish-of-birth level. Inclusion of quadratic trends instead produces similar results across all checks. Moreover, I run the analysis on the sample of parishes that received larger access to the hospitals within 5.5 km – ever implementing parishes – which should be similar on unobservable characteristics. Section VII also presents the robustness analyses to the potential influences from the overlapping reforms and population movements on the main results.

The intervention could initiate selective migration or fertility responses among parents of the cohorts under study. If such responses change the composition of cohorts in favour of children with high levels of human capital, this would provide an alternative explanation for the long-term results. I tackle this concern with individual and family data in Appendix B. First, I examine whether the reform initiation affected the composition of the cohorts, distinguishing high- versus low-resource families, and detect no systematic patterns. Second, I analyse more closely the heterogeneity of the processes that affected such composition – fertility and migration of families. While the reform reduced the fertility of mothers, by around 4.2 percent, it did so similarly across different socio-economic groups. Results show no effects of the reform on migration in total and across subsamples. From these analyses, one should discern that the reform lowered fertility, and hence the long-term effects could include a social effect in addition to the biological effect of being born in a maternity hospital. These effects are not driven by compositional changes. To rule out any intervention-led changes in unobserved heterogeneity at the family level, Eq.1–Eq.3 were further estimated adding mother fixed effects. Mother fixed effects were preferred to mother-and-father fixed effects as the sample of siblings born to the same mother is more comparable to the baseline sample. The separate specifications account for the observable parental characteristics.

IV. Data

A. Historical Data on Reform and Regional Characteristics

The main source of the data on the hospital openings is the registry of maternity wards throughout Sweden from Skatteförvaltningen (1989). Information on the MWs' dates in operation, their names, types, and parish locations comes in this report as an effort to facilitate the identification of the places of birth. It is based on a variety of administrative and archival sources, including information from the National Board of Social Affairs, the first provincial doctors' annual reports and a number of other sources. The supporting information in the registry highlights that the list of maternity institutions should be regarded as complete, although some small maternity wards owned and run by midwives are probably forgotten. Similarly to the supervision of the home-assisted midwifery, these homes would be inspected annually by the first provincial physician, and handed-in the childbirth registries. Only 0.56

percent of parturient women gave birth in the homes of midwives (Socialstyrelsen 1931-1946), and the list records their majority. I verify the MW's dates in operation and types (see the classification above) in their annual reports located in the archives of the National Health Board (Riksarkivet 2018a). In addition to this information, I gather data on various characteristics of the MWs, such as patients' demographic information, hospital beds and costs, and childbirth outcomes, from the official statistical sources of the National Board of Social Affairs (Socialstyrelsen 1931-1946) and from the same archive. To assure (geographical) consistency with the individual's parish of birth information, the hospital location is a centroid of its parish location. Parish boundaries come from the GIS maps prepared by the Swedish National Archives (Riksarkivet 2016). The database contains geo-coded vector features of the parishes for each year thereby covering the period under analysis with precise information on the administrative divisions. Both data on MWs and parish geographical characteristics contain actual parish name and code that made their matching perfect.

Additional pre-treatment (for the year of 1930) regional-level variables were also collected from official statistical sources (see Appendix C for the sources). A subset of these variables comes at the county and urban/rural levels. It includes demographic variables (stillbirth rate, crude birth rate, share of women, share of population under age 15, share of population above age 65, crude death rate, infant and pneumonia mortality rates), socio-economic and investment variables (real regional GDP per capita, real wage of worker, share of economically active population in agriculture and in industry, medical personnel per 1000 (separately the number of doctors, nurses and midwives), number of pharmacists per 1000, real spending on hospitals per 1000, and number of school-rooms and teachers per 1000 pupils), and variables measuring transport and communications (traffic turnover per 1000 and length of railways). In September 1939, the National Health Board made an inventory of all medical drugs in stock across the pharmacies, and I therefore could collect information on the supply of sulphonamides against puerperal fever in compatible units across the country (Riksarkivet 2018b). Another subset of variables comes at the parish level. These are the different types of investments, such as those in healthcare, welfare, primary schooling, churches and other public goods (Statistiska Centralbyrån 1930), and population size (Folknet 2018). Parish investments could also approximate local income because half formed from the local taxes. The number of neonatal deaths has been obtained and aggregated to the parish of birth from the Swedish register of deaths, which is complete for the period under analysis (Släktforskarförbund 2017). Parish-of-birth population at risk comprises the number of survivors to the age 37 from SIP (2014) and deaths until the age 37 from Släktforskarförbund (2017).

B. Individual-Level Data

This study uses individual-level outcome data from a number of administrative registers for individuals born between 1931 and 1946 in Sweden. Several registers with yearly date from 1968 to 2012 are linked through unique personal identifiers have been combined into the Swedish Interdisciplinary Panel (SIP), administered at the Centre for Economic Demography (Lund University, Sweden). The SIP contains individual information on date of birth (month and year) and place of birth (county, municipality and parish). In the dataset, place of birth is accurately obtained from the parish records and overwhelmingly indicates place of mother's (and child's) residence, although in certain occasions – place of child delivery (parish of the MW's location) (Skatteförvaltningen 1989). The baseline analysis is conditional upon individuals having survived to the adulthood and not migrated permanently from Sweden before 1960 (this population suits as at-risk for the short-term effects) or before any respective starting year of the register. Of the cohorts 1931–1946, 96.4 percent of one-year survivors are recorded in the database (see Appendix D). To avoid the use of the place of MW's location instead of the place of birth, I identify which maternity hospitals and when registered births instead of maternal parishes based on parish church books that are available in full completion for 1860–1947 (Riksarkivet 2018d). The parishes of birth located within 5.5 km radius from these maternity hospitals have been excluded from the estimation sample in the respective registration years (0.7 percent of parish-years and 7.6 percent of individuals). The results from this sample are not statistically different from those in the full sample, although I prefer the former for the sake of internal validity. Noteworthy, specialized clinics and some large hospitals located in urbanized areas registered births at their locations, which appeared treated from the beginning, hence the final estimation sample changes marginally in regard to the regional characteristics and, in line with the passage of the reform, is representative of rural or semi-urban locations (see Appendix D).

The dataset provided abundant information on the long-term outcomes, which are obtained for the same age intervals for all cohorts to assure their proportionate contribution. An individual's labour income and a disability insurance receipt are available from 1978 and 1981 onwards on annual basis respectively from the income and taxation register (*Inkomst- och Taxeringsregistret*). Labour income was constructed as an average of the real labour income in age interval, between ages 47 until a year prior to death or age 65, and is entered into the models in a logarithmic form to avoid the disproportionate influence of the extreme values. For a disability insurance, I created an indicator whether an individual received it in ages 50–64. To assure that this indicator is related to chronic disability and not to a unemployment insurance or a temporal disability status, only individuals with permanent disability – for each observable year – are attributed to the disabled. Among mediators, I constructed the variable for education based on the population and housing census 1970 (*Folk- och Bostadsräkningen 1970*) and the education register (*Utbildningsregistret*) available from 1990, which report information on highest completed schooling and postschooling degree. Following Fischer, Karlsson, and Nilsson (2016), I transformed these levels of education into the years of schooling. The health variable has been created from the national inpatient register (*Slutenvårdregistret*) that provides information on hospital admissions, their duration and associated diagnoses, gradually covering counties with records for the total population from 1968 onwards. Relying on the coverage of the counties by this register (Ludvigsson et al. 2011) and based on population at risk from 1968, I constructed the average length of stay in hospital in ages 37–64. In order to measure pathology in health exclusively, I excluded hospital admissions due to external causes (2 percent of person-years) and observations with no need for further treatment (0.01 percent of person-years).

Individuals are linked to their parents through the multigenerational register (*Flergenerationsregistret*) thereby giving a unique family identifier. This information is available for all individuals in the sample conditional on their survival to the year 1991. I identified siblings as individuals having the same biological mother, because this sample was similar to the baseline (across the estimation samples 80.9–82.1 percent of individuals linked to their mothers). Due to the availability of family links, it became possible to merge socio-economic and demographic information of the family to the individual data. The parental background characteristics included maternal education and paternal socio-economic class and sector of employment of father (*Folk- och Bostadsräkningen 1970*). In the latter case, information was available only for the post-treatment child's ages, although for paternal education should have been completed by the child's birth and branch of work had to stabilize. Socio-economic status is further grouped into high (farmers, business owners, higher professionals and managers) and low (workers, military, lower professionals and managers, and clerical and sales personnel). Paternal employment in agriculture represents low-income group, as the average wages in agriculture were lower compared to those in the industry or the service sector (e.g. Statistiska Centralbyrån 1940). Descriptive statistics for the estimation samples is presented in Table 2.

[Table 2]

One more source, such as register-based individual-level data from the Scanian Economic Demographic Database version 6.1 (Bengtsson et al. 2018), is used for the case study. It covers the total population in the five parishes (around 6,500 residents), which are located in close proximity to each other in southernmost Sweden and appear to be representative of rural and semi-urban area. Individuals are observed within the parishes from birth until 1968, and after 1968 are tracked across the entire country based on personal identifiers through Swedish national registries, thereby providing the outcome variables identical to the sample for a total population. The quality of the data, where family reconstitutions were performed using register-type data, is high and discussed elsewhere (Bengtsson and Dribe 2010). From this source, the place of maternal residence and place of birth – home or a particular hospital – is known, so I am able to accurately analyse the average treatment effects. In terms of childbirth institutionalisation, the area follows the national pattern. More specifically, starting from 1931, the share of normal childbirths taking place in hospitals sharply increased and surpassed the home-based midwifery system (Lazuka 2018). There had been no new openings in the area, instead existing maternity hospitals in the nearby cities (two *specialized clinics* and two *Type I* MWs) opened their doors to the rural parturient women. Based on the dataset and in consistency with the main analyses, I supplement the indicator of treatment in the hospital with parental background information, such as father's socio-economic class and sector of employment at birth (based on HISCLASS, van Leeuwen, Maas, and Miles 2002) and the maternal presence in childhood.

V. The Immediate Impact of the Policy Experiment

In this section, I analyse the impact of the openings of MWs on neonatal mortality. The estimates based on the sample for the whole Sweden, across the set of specifications described above, are presented in Table 3. The results suggest a strong and highly statistically significant impact of the policy on reductions in neonatal mortality. Derived from the baseline specification, the estimates show that being born in the catchment area of a new MW leads to a decrease of 22.8 deaths per 1000, which is around two thirds of the mean. The effect is relatively stable within 19.0–26.5 deaths per 1000 across specifications with additional control variables, those accounting for trends in observable and unobservable pre-treatment characteristics. The results based on the treatment intensity, such as a linear distance to the closest MW or a weighted access to the MWs, are also strong and statistically significant. One should observe that shortening of the remote location of the MW with 2SD of the distance leads to the decrease of a 15.2 neonatal deaths per 1000. While the estimates for the linear distance are positive implying that the longer distance is associated with higher neonatal mortality, in line with new openings and thus decreasing distance to the hospitals, it is more convenient to read them vice versa. Mirroring this pattern, expansion of the access to maternity hospital beds with 2SD leads to sizable reductions in neonatal mortality. Death rates due to malformations were rather stable or even increasing across the period while those due to infectious causes declined as much as the magnitude of the effects detected due to the policy (Statistics Sweden 1931–1946). I additionally estimate the effects of the reform on mortality until the age of 37, when individuals are caught in the population registers (see Appendix E). Following the treatment at the MW, there are reductions in the post-neonatal period, albeit not statistically significant across all specifications. The reform had not impacted the survival of the individuals in later ages, suggesting that the marginal survivor of the reform is negatively selected, and that the long-term economic effects could be underestimated.

[Table 3]

VI. The Long-Term Impact of the Policy Experiment

The main sections presents and discusses the results for the long-term effects of the openings of MWs on economic, health and education outcomes, based on the sample for the whole of Sweden. It then analyses the impact by the type of the MW, as well as, as the case study, presents the effects for the area in Southern Sweden.

A. Main Results

The reduced-form results for the impact of the openings of the new MWs in early life on the labour market performance in late adulthood are presented in Table 4. They suggest the positive effects of a sizable magnitude across all specifications. Being born in a parish closely located to the new MW (5.5 km or 2SD change in a linear distance) leads to the increase in average labour income by 3.4–4.4 percent (between ages 47–64) in the baseline specification, compared to the individuals born prior to the openings and those born afterward in parishes with no such access. The estimates stay robust to the inclusion of different control variables, correcting for any parish and region differences existing prior to the reform initiation. Even in the specification with parish-specific year-of-birth trends, the estimates remain sizable – between 2.9–3.8 percent. While using a natural logarithm of the distance to the closest hospitals instead of a linear measure, the effects are even larger, supporting the non-linearity (see Appendix F). In measuring the availability of the MW with a weighed number of hospital beds per capita, results are again strong and highly statistically significant across all specifications, suggesting the advantage of 2.4–2.9 percent from an increase in access of 2SD. As for the disability insurance receipt as an outcome, the results are even stronger and again statistically significant. Access to the services of the maternity hospital in a year of birth leads to the reduction in propensity of being on a disability insurance (between ages 50–64) by 0.003–0.008 percentage points, which is 4.4–11.9 percent of the mean. Average rate of return to one year of schooling is around 3.9 percent for the period under analysis (Palme and Wright 1998), so the reduced form estimates for labour income obtained in this paper are roughly equivalent to having a one more year of schooling. These are the intention-to-treat effects, and to transform them into the treatment effects on the treated, one can divide the estimates by the participation rate: the share of inpatient births in total was 0.398 for the rural areas (Socialstyrelsen 1931-1946). The treatment effects on the treated are hence estimated to be 7.3–9.5 percent and appear to be roughly equivalent to a return to 2 years of schooling.

[Table 4]

Results in Table 5 help to disclose the mechanisms leading up to the long-term economic effects. The negative effects of the MW's reform on morbidity, measured with the average length of stay in hospital (between ages 37–64), are relatively stable across different specifications, albeit are marginally statistically significant. More specifically, cohorts born in the parishes with better access to the MWs have 0.034–0.062 less nights in inpatient care while adults, which is a reduction of 4.8–8.5 percent of the mean. Additionally, I perform the analysis by the cause of admission to the hospital, and find that morbidity due to cardiovascular disease (up to 0.115 days equivalent to 9.7 percent of the mean) and due to degenerative diseases (up to 0.144 days equivalent to 7.1 percent of the mean), largely arthritis, are reduced the most (see Appendix G). While these results suggest beneficial effects on morbidity, additional analyses show that there are no effects on all-cause or cause-specific mortality. The estimates for the years of schooling as outcome suggest rather small effects arising due to the early-life health reform. For instance, at most, the treatment by the reform, measured with 2SD decrease in closeness to the nearest MW, leads to the increase in the years of schooling by 0.12 years (1.3 percent of the mean), and these effects are not statistically significant across some specifications. Instead, the positive effects of the policy on the propensity to complete high school are noticeable – +0.007–0.010 percentage points (6.5–9.4 percent of the mean) in the baseline specification, although they lose statistical significance in several specifications. If to distinguish by sex, the effects on education emerge to be stronger for women compared to men, as well as for the former they stay robust (available upon request).

[Table 5]

B. The Effects by Type of Institution and the New Technology

I analyse the short- and long-term efficiency of the maternity hospitals by looking at the effects by type of a childbirth institution. The health authorities encouraged the establishment of the larger maternity hospitals (*Type I*), which were deemed to have better technical possibilities to handle complicated cases and thus received two times larger subsidies for the establishment and maintenance of the hospital beds for childbirth (Socialdepartamentet 1929). Such complicated cases, however, would constitute 5–10 percent of total. The opponents of the decentralization in childbirth and healthcare, achievable if there are small local MWs (*Type II*), argued that local childbirth institutions have several advantages, such as incurrence of less travel expenses and easy access in case of emergency (Gröne 1949b). As an evidence to the latter's arguments, the share of preterm births remained stable in 1931–1946 (Socialstyrelsen 1931-1946), as well as any differences in perinatal mortality across institutions were not driven by the mortality among preterm births (Gyllenswärd 1946). Inspection reports of small-scale maternity wards gathered in 1929–1936 suggest that isolation, prevention of infections, resting and encouragement of breastfeeding had been practiced there similarly to other institutions (Riksarkivet 2018c). Given the purposes of this paper, I therefore hypothesize that a childbirth health technology in general should be similar across these institutions, with the contemporary technology, highlighted by the reformers, having limited opportunities to cure preterm births. If so, the efficiency of the institutions should be relatively similar. To support this rationale, I exploit the arrival of a new component of health technology, such as the introduction of sulphonamides efficient against puerperal fever into medical practice in hospitals. These drugs, originally imported and further produced by the local pharmaceutical firms, were available in each part of the country shortly after their introduction, in 1938, in the amounts sufficient to cure all maternal causes (see Figure 3). I therefore operationalize this positive exogenous shock through its influence on maternal survival (and hence to early-life health) and add the respective terms to the models (see Appendix H).

[Figure 3]

Results for both immediate outcomes (neonatal mortality) and long-term economic, health and education outcomes are presented in Table 6 (in odd columns – for the effects by the types of childbirths institutions, and in even columns – adding the treatment by the sulphonamides). Across all outcomes, in both short and long term, I cannot reject the hypothesis that the effects of treatment is different by the size of the MW. In the years after the parishes fall into the catchment area of the new *Type I* MW, there is a 21.2 (deaths per 1000) smaller neonatal mortality compared to that in the prior years and parishes in the same periods that do not have a closely located hospital; for the *Type II* MW this reduction equals to 23.4 deaths. As for the long-term outcomes, the effects on the ln labour income for the *Type I* and *Type II* MWs are 4.2 and 4.7 percent respectively, and for the disability pension receipt – 0.005 versus 0.009 percentage points. Sizable and statistically significant estimates for a plausibly exogenous reduction in puerperal fever suggest that sulphonamides had an independent and beneficial impact on neonatal survival and later in life on labour market outcomes. This drug treatment, however, only slightly mediates both effects, relatively equally across different types of institutions. A larger share of complicated cases was treated at the *Type I* institutions, hence obtaining the cure for the puerperal fever could have prevented more deaths there. However, the bulk of the impact from the treatment by maternity hospitals should be attributed to the common technology of assisting normal births.

[Table 6]

C. The case of 5 parishes in Southern Sweden

For a small area in Southern Sweden, I analyse the effects of being born in a MW for survival within up to 28 days from birth and for economic outcomes when reaching late adulthood in Table 7. The parishes were closely located to the *specialized clinics* and *Type I* maternity hospitals and I observe an individual-level treatment at these hospitals and at homes by midwifery, as well as a total population of born in the parishes across many demographic and economic characteristics. Maternity hospitals functioned before 1931, albeit, following the reform, created additional hospital beds for childbirth and began to admit parturient women from the neighbouring rural areas. So, the operationalization of the effect is rather correlational in nature, compared to the main analyses, although the specifications presented in the table rule out from the treatment estimates any differences specific to the parish of residence and to the year of birth. With these considerations in mind, consistent with the results for the whole of Sweden, I find that the proportion of neonates dying is 0.046–0.047 percentage points lower if they are delivered in maternity hospitals compared to those assisted by midwifery at homes (the mean is 0.035). In correspondence to the main sample, I catch survivors in their late-40s until death or the age of 64 in their labour market outcomes. Albeit being statistically significant only at a 10 percent level, the estimates suggest a strong effect of being born in a hospital: 26.1–28.7 percent for the average labour income and 0.060–0.063 percentage points for the chronic disability pension receipt (the mean is 0.044). As expected, these effects, which are the average treatment effects, are larger compared to the reduced-from effects in the main analysis.

These results are similar between the specifications and robust to adding a variety of other family- and mother-specific controls (available upon request), suggesting that the main pattern is likely to be driven by access to hospital services at birth.

[Table 7]

D. Social rate of return

Investments in maternity wards yielded high societal returns in long run. To measure the returns, I compare the discounted increase in the individual's labour earnings in ages 47–64, summed across the cohorts, with costs of treatment. For this calculation, I rely on the estimates for the long-term effects of openings of maternity hospitals of different types (4.1 percent for *Type I* MW and 4.6 percent for *Type II* MW). Gains in labour income should be discounted with the real long-term government bond yields 1931–1946 (3.4 percent, based on Waldenström 2014) for the investment period – up to the age of 47. Statistical and archival data on the maternity wards provide detailed information on total expenditures, including fixed and variable costs, and maternal and neonatal deaths. Table 8 provides results of these calculations. Indeed, larger hospitals had lower costs per birth compared to those in smaller hospitals. However, remarkably, a social rate of return to respective investment is lower – 18.5 versus 19.4. Regardless of better expertise in emergency care, deliveries at larger hospitals were associated with lower maternal and neonatal survival in comparison to small-scale institutions. Taking into account the total value of saved neonatal lives, based on the short-term estimates (-69.1 for *Type I* and -66.4 for *Type II*) increases a social rate of return to 28.5 and 30.9 respectively. In general, a social rate of return from openings of maternity wards is large, affirming that health technologies with a large public good dimension have substantial economic value not only in short (e.g., Murphy and Topel 2006) but also in long run.

[Table 8]

VII. Robustness Analyses

The main analyses has already comprised estimations of several specifications that account for the observable and unobservable pre-treatment differences across parishes of birth, and the effects appeared to be robust to their inclusion (specifications 2–6). At the time of the reform initiation, there has been a migration of the population from rural areas and from agriculture to thickly populated industrial places (Gyllenswärd 1946). The urbanizing areas also exhibited the relatively higher income growth (Bäcklund 1988). As discussed previously, the reform was accompanied by the introduction of the childbearing benefits in 1938 that could affect fertility and, indirectly, child investments. In Table 9, I present the results from specifications that control for observable and unobservable characteristics at the family level and for influences from overlapping reforms or population movements. Adding paternal SES indicators and maternal education (Panel A), which should control for compositional differences across the treatment groups, does not alter the coefficients although it slightly improves the education outcomes. Adding maternal fixed effects, which should account for any heterogeneity in fertility and migration responses across different families, is extremely demanding as it compares siblings who were treated by the reform to those untreated (Panel B). It produces the coefficients similar in sizes to those from the baseline specification for all outcomes, although some of the estimates lose statistical significance due to the loss of efficiency.

[Table 9]

The main results of the paper are unlikely to be explained by other programs or events that overlapped with the reform implementation. To account for the effects of the overlapping events, I explicitly introduce the terms measuring their impact into the baseline specification (Panel C). The introduction of sulphapyridine against pneumonia, as previously found by Lazuka (Forthcoming), has a strong and statistically significant effect on long-term economic outcomes, although it runs independently from the MW reform. In line with conclusion by Knutsson (2018), there are no long-term effects from inception of infant care program, neither it confounded the main effects. The children in the estimation samples in the overwhelming majority were exposed to the same compulsory schooling systems after age 5 (Holmlund 2008). The introduction of the seventh compulsory grade has been completed for the studied cohorts, with the exception of several municipalities (out of 949) that introduced the reform in 1931–1936 (Fischer, Karlsson, and Nilsson 2013). An introduction of a nine-year comprehensive school yields its own sizable impact on education of the cohorts under analysis. During the WWII, Sweden was neutral, but there were regional problems with supply of food and fuels; studies looking at the impact of food shortage on either child's health (Angell-Andersen et al. 2004) or female labour force participation (Gustafsson and Jacobsson 1985) do not reveal any differences. Additionally, I test the robustness of the results to the region-specific influence on food production during the WWI, that leave the effects unchanged. Finally, because other programs affected certain but not all cohorts under analysis, I find that the effects for subsamples are similar, suggesting the unlikely confounding (available upon request).

To assure that the results are unaffected by the differences in the registration of birth (either at the parish of hospital location or at the parish of maternal residence), the main estimation sample excludes parishes that received access to the new maternity hospital within 5.5 km. I conduct several robustness estimations in order to show that the main results remain unbiased by the changes in registration of the place of birth. First, I exclude from the sample each parish for which the closest maternity hospital registered births (1,272 parishes remained) and re-estimate the models. Results from Panel D suggest that the effects of the openings of the MWs on long-term labour market outcomes are larger for this subsample, so one should view the main results as conservative. Second, I condition the sample on the parishes that at the onset of the reform did not have access to any maternity hospital – those located more than 20 km further from the nearest hospital (Panel E). Moreover, I define the parish of birth based on the parish of maternal residence derived from the Population and Housing Census 1960 (*Folk- och Bostadsräkningen 1960,* Panel F). Both procedures provide the effects similar to main ones.

VIII. Conclusion

This paper studies the effects of the reform that led to the openings of the maternity hospitals throughout Sweden in 1931–1946 on the individual's economic and health outcomes in adulthood, including average labour income, disability pension receipt, hospitalisations, and educational attainment. This paper adds to the previous literature on the early-life investments (Almond, Currie, and Duque 2018) by being the first to find sizable long-term economic and health effects of the openings of new MWs. It first finds that the reform led to the reductions in neonatal mortality in short term, which are the effects that align with expectations of the reformers. These reductions equal to up to two thirds of the level of neonatal mortality and remain statistically significant in all specifications. The long-term (reduced-form) effects on economic outcomes are sizable and robust: up to 4.7 percent for labour income and 11.9 percent for a disability pension receipt. The reduced-from income effect from investments in maternity wards is roughly equal to the return to one year of schooling in the same period. Turning to the mediators, the paper finds beneficial effects of the reform on both schooling (up to 9.4 percent for high school completion) and length of stay in the hospital (up to 8.5 percent for all-cause hospitalisations), although in some specifications these results lose statistical significance. The effects on disability pension receipt, which reflect chronic disability, are stronger compared to those for other mediators suggesting that the groups below median in health distribution are affected most. The results from the case study of the local area in southern Sweden, which are average treatment effects, support that being born in the maternity hospital compared to quality home assistance is associated with strong beneficial effects on neonatal survival in short term and on labour market performance in long term. The results appear robust to multiple analyses that operationalize the effects of the overlapping reforms, selective migration and fertility, and a plausible measurement error.

The increased propensity of being born in a maternity hospital because of the reform had an imprint on individuals in a very narrow age window – at birth and up to 10 days after birth. Together with the beneficial effects on neonatal survival in the first stage, the body of evidence for the presence of sizable long-term economic effects point to the early neonatal period as critical for human capital accumulation. This paper shows that, for health capital such accumulation occurs specifically targeting cardiovascular diseases (up to 9.7 of the mean) and arthritis (up to 7.1 of the mean), in line with a chronic inflammatory hypothesis (Finch 2007). The counterfactual treatment in this study is a midwifery-assisted birth at home; therefore, hospital services provided towards neonates and mothers could be viewed as responsible for the effects. Accounting for the beneficial shock to maternal survival and health – arrival of sulphonamides against puerperal fever, which was one of the components of early-life health technology, mediates the effects to a negligible extent. This paper also provides evidence for the long-term efficiency of different childbirth institutions thereby opening a new page in the related literature, prior focused exclusively on short-term efficiency (e.g. Schmitt 2018). This study finds that the short- and long-term effects are similar across different types of maternity hospitals, such as large and remotely located maternity hospitals versus small local maternity wards. While reform organisers argued that large maternity hospitals had more technological opportunities in terms of providing emergency care, the bulk of the short- and long-term effects is driven by normal births. Social rate of return to investments in maternity wards is high, and suggests the relative efficiency of decentralization in the provision of childbirth hospital facilities, under the condition of an equal distribution of early-life health technology.

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Figures

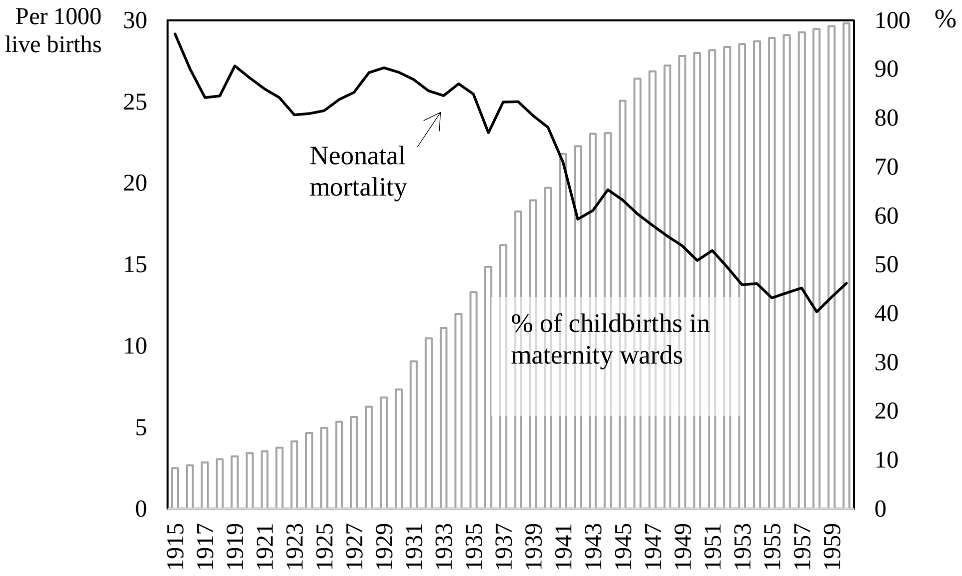
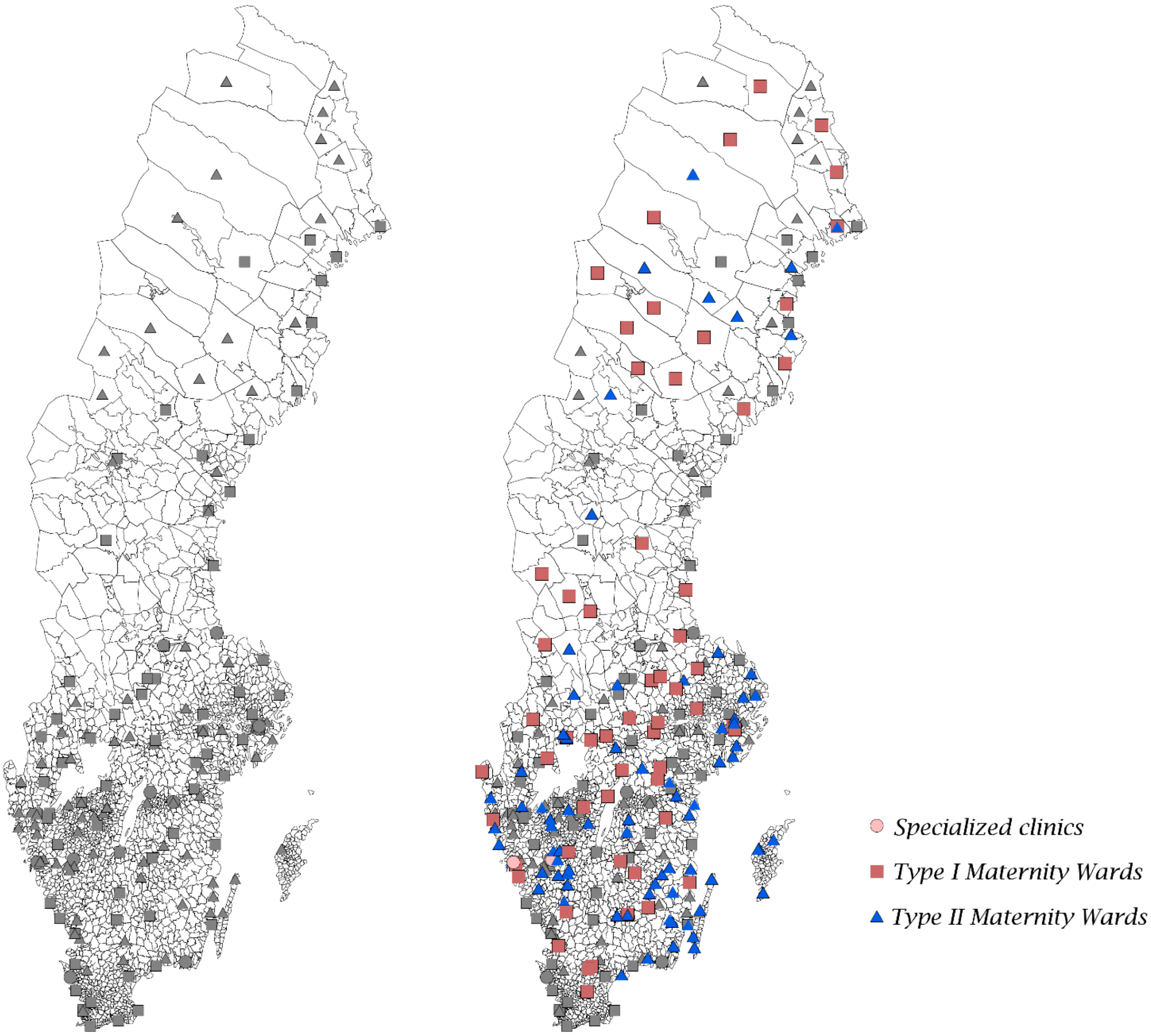


Figure 1 – The use of maternity wards for childbirths (as a share of total childbirths) and neonatal mortality in Sweden, 1915–1960

Source: Socialstyrelsen (1915–1960)



(A) Existed in 1931 (B) Opened in 1931–1946

Figure 2 – Openings of maternity wards by type in Sweden in 1931–1946

Sources: Skatteförvaltningen (1989) and data decribed in Appendix C.

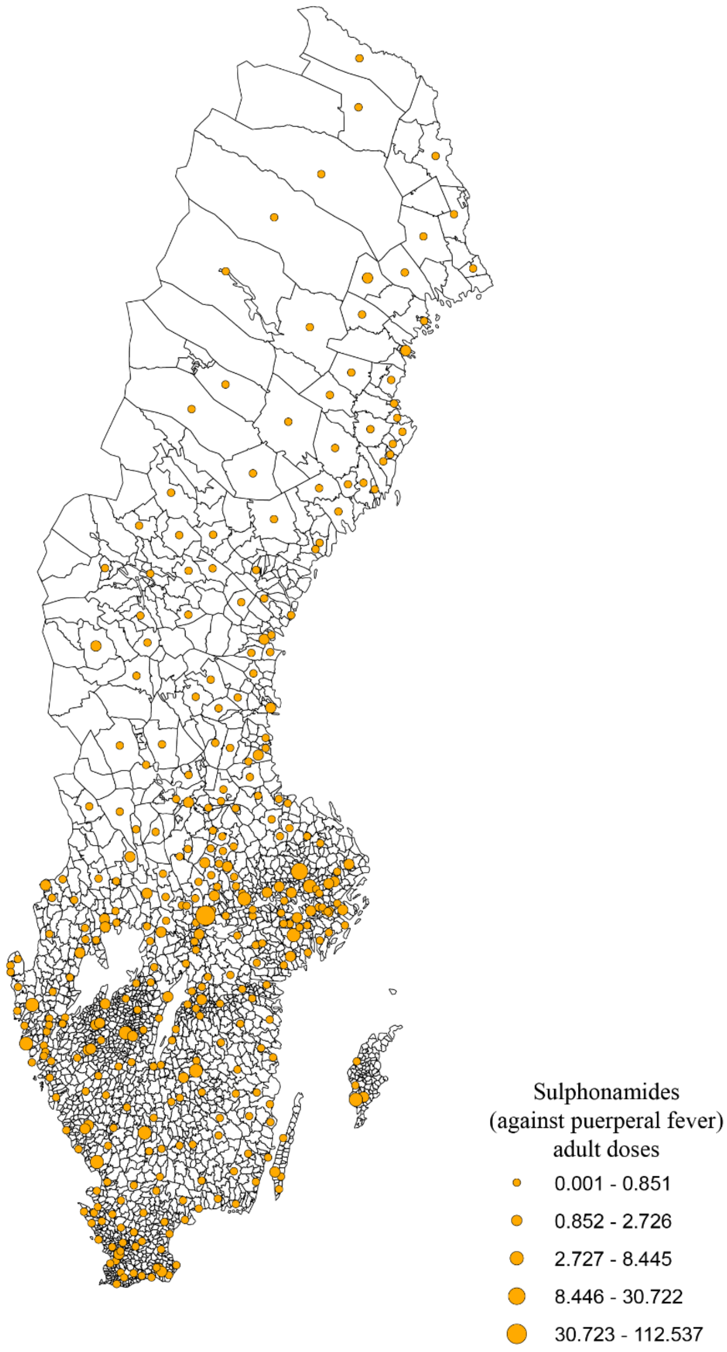


Figure 3 – Availability of adult doses of sulphonamides (against puerperal fever), per 1000 in Sweden in 1939

Source: Riksarkivet (1939a, b).

Tables

Table 1 – Characteristics of childbirth institutions in Sweden in 1931, 1939, and 1945

		Parturient women			*Supply*				*Outcomes*			
		Share as patients	*Share in ages ≤30*	*Share unmarried*	*N institutions/ midwives*	*N beds, average*	*Hospital days per patient*	*Costs, per day*	*Maternal mortality, per 1000*	*Stillbirth rate, per 1000*	*Preterm births, per 1000*	*Early neonatal mortality, per 1000*
1931	Specialized clinics	0.14	0.63	0.21	11	49.08	11.61	7.82	3.51	26.04	67.91	18.82
	Type I	0.13	0.63	0.21	67	19.75	11.52	5.48	4.91	37.91	68.20	19.96
	Type II	0.11	0.62	0.19	95	5.98	13.37	7.27	1.26	28.42	27.13	13.35
	Midwifery	0.62	na	0.14	2,511	na	10.13	5.84	2.30	22.93	38.82	na
1939	Specialized clinics	0.17	0.51	0.25	12	59.83	10.83	11.01	1.58	24.84	60.19	16.33
	Type I	0.39	0.51	0.22	86	17.30	9.75	7.70	3.04	30.69	58.99	18.54
	Type II	0.14	0.46	na	101	5.24	10.16	6.79	2.18	21.43	40.39	10.86
	Midwifery	0.30	na	0.11	1,731	na	10.12	7.80	1.30	23.61	38.92	na
1945	Specialized clinics	0.10	0.53	0.18	13	47.25	10.67	11.44	1.44	22.75	57.23	9.68
	Type I	0.67	0.48	0.20	120	24.36	8.78	12.62	1.22	25.49	45.65	13.77
	Type II	0.12	0.53	na	100	5.13	8.97	10.27	na	16.32	27.33	8.78
	Midwifery	0.11	na	0.09	1,441	na	10.13	12.00	0.80	17.52	32.31	na

Sources: Riksarkivet (2018c); SOU (1929, 1936, 1954); Socialstyrelsen (1931, 1939, 1945); Skatteförvaltningen (1989)

Note: *Specialized clinics* denotes large-scale specialized maternity hospitals (*barnbördshuset* and *kvinnokliniken*). *Type I* denotes maternity wards in large-scale county and cottage hospitals (*barnbördsavdelning i lasarett* and *barnbördsavdelning i sjukhuset). Type II* denotes small-scale maternity wards in state-, county-, parish- or privately-owned charity, nursing, elderly and childbirth homes, or Red Cross maternity homes (*övriga förlossningsanstalter*). *Midwifery* denotes state and private midwives assisting home birth. In 1931–1946, in total, the new openings were: 2 *specialized clinics*, 65 *Type I* institutions, and 103 *Type II* institutions. See Socialstyrelsen (1973) for more detail.

Table 2 – Summary statistics for estimation samples, cohorts 1931–1946

	Means (Standard deviations)	N
Short-term outcomes (parish-level)		
Neonatal mortality, <28 days per 1000	35.240 (88.243)	30,379
Long-term outcomes (individual-level)		
Ln average labour income, ages 47–64	7.900 (1.574)	484,523
On disability pension, ages 50–64	0.067 (0.250)	480,807
Average length of stay in hospital, ages 37–64	0.730 (3.196)	491,025
Years of schooling, completed	8.985 (2.343)	487,162
High school graduate, completed	0.107 (0.308)	487,162
Treatment (parish-level)		
post X new MW catchment area ≤ 5.5 km	0.208 (0.405)	484,523
linear distance to the closest MW, km	20.822 (19.573)	484,523
gravity-based access to MW, MW beds per 1000	0.243 (0.516)	484,523
post X new MW *Type I* catchment area ≤ 5.5 km	0.074 (0.260)	484,523
post X new MW *Type II* catchment area ≤ 5.5 km	0.134 (0.341)	484,523
Control variables (region-level) in 1930		
Ln trafficked road length, km per 1000	1.934 (0.592)	484,523
Ln length of railways, km	6.578 (0.363)	484,523
Ln real regional income	17.740 (0.571)	484,523
Share employed in agriculture	0.418 (0.159)	484,523
Share employed in industry	0.368 (0.092)	484,523
Regional GDP per capita, relative to the national	0.925 (0.148)	484,523
Ln doctors	3.361 (0.662)	484,523
Ln midwives	4.355 (0.565)	484,523
Ln medical nurses	3.604 (0.870)	484,523
Ln hospitals	1.180 (0.495)	484,523
Ln real hospital expenditures	13.356 (0.581)	484,523
Share females	0.498 (0.016)	484,523
Share under age 15	0.256 (0.108)	484,523
Ln crude death rate per 1000	2.478 (0.068)	484,523
Share disabled	0.010 (0.006)	484,523
Ln primary schools	6.359 (0.559)	484,523
Ln live births	7.888 (0.558)	484,523
Ln pharmacies per 100,000	2.462 (0.661)	484,523
Ln mid-year population	12.005 (0.478)	484,523
Ln infant mortality rate per 1000 live births	3.977 (0.204)	484,523
Ln maternal mortality rate per 1000	-3.172 (1.002)	484,523
Ln pneumonia mortality per 1000	-0.423 (0.226)	484,523
Puerperal fever, normalized per 1000	0.637 (0.281)	484,523
Control variables (parish-level) in 1930		
Ln health care investment, parish	7.888 (1.382)	484,523
Ln other investment, parish	11.854 (1.071)	484,523
Ln population, parish	8.092 (1.004)	484,523
Control variables (family-level)		
Mother only primary schooling	0.307 (0.461)	484,523
Mother more than primary schooling	0.034 (0.181)	484,523
Mother schooling unknown	0.659 (0.474)	484,523
Father high SES	0.098 (0.297)	484,523
Father low SES	0.261 (0.439)	484,523
Father unknown SES	0.641 (0.480)	484,523
Father in agriculture	0.085 (0.278)	484,523
Father in industry	0.183 (0.386)	484,523
Father in service	0.091 (0.288)	484,523
Father sector unknown	0.642 (0.480)	484,523

Note: Means and standard deviations (in parentheses). Parish- and region-level variables are presented for *Ln average labour income* sample.

Table 3 – The short-term effects of the openings of MWs on neonatal mortality, Sweden 1931–1946

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
post X new MW catchment area 5.5 km	-22.803***	-21.401***	-22.285***	-26.320***	-26.505***	-19.011***
	(4.444)	(4.756)	(4.680)	(4.513)	(7.162)	(5.664)
Rsq	0.175	0.181	0.180	0.177	0.276	0.199
linear distance to the closest MW	15.189***	14.380***	15.849***	18.506***	12.784***	10.281***
	(2.730)	(3.128)	(3.005)	(2.879)	(3.942)	(3.192)
Rsq	0.175	0.181	0.180	0.177	0.275	0.195
access to MW (gravity)	-5.451***	-5.827***	-6.014***	-6.018***	-4.765***	-4.593***
	(1.198)	(1.290)	(1.292)	(1.260)	(1.603)	(1.336)
Rsq	0.175	0.181	0.180	0.176	0.275	0.197
Mean of dep. variable	35.240	35.240	35.240	35.240	35.240	26.185
Birth parish x birth years	30,379	30,379	30,379	30,379	30,379	2,626
Birth year FEs	yes	yes	yes	yes	yes	yes
Birth parish FEs	yes	yes	yes	yes	yes	yes
Region-specific linear birth year trends		yes				
Region controls 1930 x linear birth year trends			yes			
Birth parish controls 1930 linear birth year trends				yes		
Birth parish-specific linear birth year trends					yes	

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. All models include parish-of-birth fixed effects (2,274 for the Models 1–5 and 205 for the Model 6) and year-of-birth fixed effects. All models are estimated according to Eq.1–3 plus additional controls. Models 2 additionally include region-of-birth-specific linear birth year trends (49 regions, county urban/rural and Stockholm). Models 3 additionally include interactions between region-of-birth characteristics in 1930 and linear birth year trends. Models 4 additionally include interactions between parish-of-birth characteristics in 1930 and linear birth year trends. For the region- and parish-of-birth characteristics see *IV. Data. A. Historical Data on Reform and Regional Characteristics.* Models 5 additionally include parish-of-birth-specific linear birth year trends. Models 6 are estimated according to Eq. 1–3 for the sample of ever-implementers.
*** p<0.01, ** p<0.05, * p<0.1.

Table 4 – The long-term effects of the openings of MWs on economic outcomes, Sweden cohorts born in 1931–1946

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Ln average real labour income, ages 47–64						
post X new MW catchment area 5.5 km	0.043**	0.046**	0.045***	0.046**	0.037*	0.045**
	(0.018)	(0.018)	(0.017)	(0.019)	(0.020)	(0.020)
linear distance to the closest MW	-0.035**	-0.037**	-0.036**	-0.037**	-0.029**	-0.031*
	(0.017)	(0.016)	(0.016)	(0.017)	(0.015)	(0.018)
access to MW (gravity)	0.028***	0.028***	0.026***	0.029***	0.027***	0.024***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)
Mean of dep. variable	7.900	7.900	7.900	7.900	7.900	7.957
Individuals	484,523	484,523	484,523	484,523	484,523	137,938
On disability pension, permanent status in ages 50–64						
post X new MW catchment area 5.5 km	-0.007***	-0.008***	-0.008***	-0.008***	-0.006**	-0.007**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
linear distance to the closest MW	0.007***	0.008***	0.008***	0.007***	0.008***	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
access to MW (gravity)	-0.004***	-0.005***	-0.005***	-0.005***	-0.004	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Mean of dep. variable	0.067	0.067	0.067	0.067	0.067	0.069
Individuals	480,807	480,807	480,807	480,807	480,807	136,859
Birth year FEs	yes	yes	yes	yes	yes	yes
Birth parish FEs	yes	yes	yes	yes	yes	yes
Region-specific linear birth year trends		yes				
Region controls 1930 x linear birth year trends			yes			
Birth parish controls 1930 linear birth year trends				yes		
Birth parish-specific linear birth year trends					yes	

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. All models include parish-of-birth fixed effects (2,274 for the Models 1–5 and 205 for the Model 6) and year-of-birth fixed effects. All models are estimated according to Eq.1–3 plus additional controls. Models 2 additionally include region-of-birth-specific linear birth year trends (49 regions, county urban/rural and Stockholm). Models 3 additionally include interactions between region-of-birth characteristics in 1930 and linear birth year trends. Models 4 additionally include interactions between parish-of-birth characteristics in 1930 and linear birth year trends. For the region- and parish-of-birth characteristics see *IV. Data. A. Historical Data on Reform and Regional Characteristics.* Models 5 additionally include parish-of-birth-specific linear birth year trends. Models 6 are estimated according to Eq. 1–3 for the sample of ever-implementers.
*** p<0.01, ** p<0.05, * p<0.1.

Table 5 – The long-term effects of the openings of MWs on health and education, Sweden cohorts born in 1931–1946

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Average length of stay in hospital, nights per year in ages 37–64						
post X new MW catchment area 5.5 km	-0.052*	-0.048	-0.054*	-0.047	-0.054	-0.056
	(0.030)	(0.030)	(0.031)	(0.031)	(0.045)	(0.036)
linear distance to the closest MW	0.053*	0.042	0.049	0.045	0.062	0.053
	(0.032)	(0.029)	(0.030)	(0.032)	(0.038)	(0.035)
access to MW (gravity)	-0.039*	-0.034*	-0.039**	-0.037*	-0.056*	-0.034
	(0.021)	(0.019)	(0.020)	(0.020)	(0.031)	(0.023)
Mean of dependent variable	0.730	0.730	0.730	0.730	0.730	0.704
Individuals	491,025	491,025	491,025	491,025	491,025	139,810
Years of schooling						
post X new MW catchment area 5.5 km	0.090**	0.077**	0.057*	0.065*	0.072*	0.117**
	(0.039)	(0.031)	(0.034)	(0.038)	(0.043)	(0.057)
linear distance to the closest MW	-0.096***	-0.065**	-0.053*	-0.066*	-0.055	-0.105**
	(0.034)	(0.031)	(0.030)	(0.035)	(0.040)	(0.047)
access to MW (gravity)	0.069**	0.044	0.047*	0.056**	0.030	0.085**
	(0.027)	(0.027)	(0.028)	(0.028)	(0.028)	(0.037)
Mean of dependent variable	8.985	8.985	8.985	8.985	8.985	9.293
Individuals	487,162	487,162	487,162	487,162	487,162	139,135
High school graduate						
post X new MW catchment area 5.5 km	0.007	0.007*	0.004	0.005	0.008*	0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)
linear distance to the closest MW	-0.010***	-0.008**	-0.007*	-0.008**	-0.010**	-0.010**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
access to MW (gravity)	0.008***	0.006**	-0.001**	0.008**	0.005	0.009**
	(0.003)	(0.003)	(0.000)	(0.003)	(0.003)	(0.004)
Mean of dependent variable	0.107	0.107	0.107	0.107	0.107	0.130
Individuals	487,162	487,162	487,162	487,162	487,162	139,135
Birth year FEs	yes	yes	yes	yes	yes	yes
Birth parish FEs	yes	yes	yes	yes	yes	yes
Region-specific linear birth year trends		yes				
Region controls 1930 x linear birth year trends			yes			
Birth parish controls 1930 linear birth year trends				yes		
Birth parish-specific linear birth year trends					yes	

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. All models include parish-of-birth fixed effects (2,274 for the Models 1–5 and 205 for the Model 6) and year-of-birth fixed effects. All models are estimated according to Eq.1–3 plus additional controls. Models 2 additionally include region-of-birth-specific linear birth year trends (49 regions, county urban/rural and Stockholm). Models 3 additionally include interactions between region-of-birth characteristics in 1930 and linear birth year trends. Models 4 additionally include interactions between parish-of-birth characteristics in 1930 and linear birth year trends. For the region- and parish-of-birth characteristics see *IV. Data. A. Historical Data on Reform and Regional Characteristics.* Models 5 additionally include parish-of-birth-specific linear birth year trends. Models 6 are estimated according to Eq. 1–3 for the sample of ever-implementers.
*** p<0.01, ** p<0.05, * p<0.1.

Table 6 – The short- and long-term effects of the openings of MWs by type and arrival of sulphonamides (against puerperal fever), Sweden cohorts born in 1931–1946

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
	Short-term		*Long-term*							
	Neonatal mortality		Ln labour income		On disability pension		Length of stay in hospital		Years of schooling	
post X new MW *Type I* ≤5.5 km	-21.219***	-20.694***	0.041*	0.038*	-0.005	-0.004	-0.011	0.026	0.116**	0.097**
	(7.424)	(7.404)	(0.023)	(0.022)	(0.003)	(0.003)	(0.041)	(0.042)	(0.047)	(0.046)
post X new MW *Type II* ≤5.5 km	-23.352***	-22.897***	0.046**	0.044**	-0.009***	-0.009***	-0.110*	-0.090	0.069	0.057
	(4.857)	(4.876)	(0.020)	(0.019)	(0.003)	(0.003)	(0.064)	(0.058)	(0.051)	(0.047)
pre-puerperal fever X post1938		-6.458*		0.036		-0.009***		-0.108***		0.214***
		(3.723)		(0.022)		(0.003)		(0.038)		(0.052)
Mean of dependent variable	35.240	35.240	7.900	7.900	0.067	0.067	0.730	0.730	8.985	8.985
Birth parish x birth years	30,379	30,379								
Individuals			484,523	484,523	480,807	480,807	491,025	491,025	487,162	487,162
Birth year FEs	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Birth parish FEs	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. *MW type I* denotes maternity units in large-scale lying-in and cottage hospitals. *MW type II* denotes small-scale maternity wards (cottage hospitals, nursing and charity maternity wards). Pre-puerperal fever denotes normalized (divided by it range between 95th and 5th percentiles) puerperal fever per 1000 women in 1931–1937. All models include parish-of-birth fixed effects (2,274 for the Models 1–5 and 205 for the Model 6) and year-of-birth fixed effects. All models are estimated according to Eq.1–3 plus additional controls. Models 2 additionally include region-of-birth-specific linear birth year trends (49 regions, county urban/rural and Stockholm). Models 3 additionally include interactions between region-of-birth characteristics in 1930 and linear birth year trends. Models 4 additionally include interactions between parish-of-birth characteristics in 1930 and linear birth year trends. For the region- and parish-of-birth characteristics see *IV. Data. A. Historical Data on Reform and Regional Characteristics.* Models 5 additionally include parish-of-birth-specific linear birth year trends. Models 6 are estimated according to Eq. 1–3 for the sample of ever-implementers.
*** p<0.01, ** p<0.05, * p<0.1.

Table 7 – The short- and long-term effects of being born in a MW, Southern Sweden, cohorts born in 1920–1946

	(1)	(2)
Short-term		
Mortality <28 days, per 1000		
post1931 x born in MW *Specialized clinics and Type I*	-46.549**	-45.875**
	(18.965)	(19.019)
Mean of dependent variable	34.506	34.506
Individuals	2,927	2,927
R-sq	0.012	0.013
Long-term		
Ln average real labour income in ages 47–64		
post1931 x born in MW *Specialized clinics and Type I*	0.232*	0.252*
	(0.137)	(0.136)
Mean of dependent variable	8.215	8.215
Individuals	1,597	1,597
R-sq	0.181	0.193
On disability pension, permanent status in ages 50–64		
post1931 x born in MW *Specialized clinics and Type I*	-0.063*	-0.060*
	(0.033)	(0.033)
Mean of dependent variable	0.044	0.044
Individuals	1,582	1,582
R-sq	0.067	0.070

Note: estimations from the SEDD. Standard errors are in parentheses. The term *post1931 x born in MW Specialized clinics* denotes individuals born during and after 1931 in the maternity hospital (specialized clinics in Helsingborg and Lund, and Type I MWs in Landskrona, Malmö, and Ängelholm). In addition to it, Model 1 controls for whether *born in a maternity hospital*, *parish of birth* fixed effects, *year of birth fixed effects*, and *sex*. Model 2, in addition to these controls, includes *SES of the family head* (based on HISCLASS classification that distinguishes SES and sector of employment), and whether the *mother was present* in early childhood.
*** p<0.01, ** p<0.05, * p<0.1

Table 8 – Social rate of return to investments in maternity wards of different types, Sweden 1931–2012

	(1) *Type I MW*	*(2)* *Type II MW*	*(3)* *Total*
Long-term increase in labour income	42,089,828	80,662,452	122,752,280
Total value of saved maternal lives	–	2,786,102	2,786,102
Total value of saved neonatal lives	22,752,727	45,024,279	67,777,006
Costs per birth	37.9	40.7	39.3
Total costs	2,279,059	4,154,814	6,433,873
Social rate of return, long-term returns	18.5	19.4	19.1
Social rate of return, inc. saved maternal lives	18.5	20.1	19.5
Social rate of return, inc. saved neonatal lives	28.5	30.9	30.0

Note: Values in constant 1931 SEK. Increase in labour income is discounted with the real long-term government bond yields in 1931–1946, ranging from 2.46 to 4.80 (Waldenström 2014), for the age at observation (age 47). Long-term increase in labour income is calculated based on estimates from Table 6 (column 3). Value of a statistical life from Hultkrantz and Svensson (2012) adjusted for growth rate in GDP per capita between 1931–2012. *Source*: estimations based on SIP (2012); Riksarkivet (2018c); Socialstyrelsen (1931–1946).

Table 9 – Robustness Analysis. Confounding changes and plausible measurement error, Sweden cohorts born in 1931–1946

	(1) *Ln labour income*	*(2)* *On disability*	*(3)* *Length of stay in hospital*	*(4)* *Years of schooling*	*(5)* *High school graduate*
			I – Compositional changes and coincidental reforms		
			(A) Parental SES characteristics		
post X new MW ≤5.5 km	0.043***	-0.007***	-0.048	0.106***	0.009**
	(0.018)	(0.002)	(0.030)	(0.040)	(0.004)
Mean of dep variable	7.900	0.067	0.730	8.985	0.107
Individuals	484,523	480,807	491,025	487,162	487,162
			(B) Mother Fixed Effects		
post X new MW ≤5.5 km	0.040	-0.006	-0.071	0.077**	0.005
	(0.027)	(0.004)	(0.050)	(0.035)	(0.005)
Mean of dep variable	7.953	0.068	0.598	9.141	0.117
Individuals	386,120	384,521	388,695	383,796	383,796
Mothers	249,386	248,743	250,510	248,500	248,500
			(C) Overlapping Reforms		
post X new MW ≤5.5 km	0.040**	-0.006***	-0.047	0.067*	0.005
	(0.017)	(0.002)	(0.030)	(0.037)	(0.004)
sulphapyridine	0.032*	-0.015***	-0.038	0.114***	0.009**
	(0.018)	(0.003)	(0.031)	(0.035)	(0.004)
infant care	0.010	0.000	-0.035	0.116***	0.009
	(0.021)	(0.004)	(0.041)	(0.044)	(0.007)
school 9 years	0.044***	-0.004	-0.019	0.282***	0.015***
	(0.016)	(0.004)	(0.034)	(0.053)	(0.005)
food during WWII	0.027	-0.004	-0.009	-0.031	-0.002
	(0.017)	(0.003)	(0.032)	(0.036)	(0.005)
Mean of dep variable	7.900	0.067	0.730	8.985	0.107
Individuals	484,523	480,807	491,025	487,162	487,162
			II – Plausible measurement error		
			(D) Nearest hospital not registering		
post X new MW ≤5.5 km	0.056**	-0.010***	-0.105**	0.087	0.008
	(0.022)	(0.003)	(0.044)	(0.057)	(0.006)
Mean of dep variable	7.921	0.067	0.944	9.075	0.114
Individuals	286,475	284,266	290,440	288,332	288,332
			(E) Early non-accessibility of MW		
post X new MW ≤5.5 km	0.037**	-0.006***	-0.038	0.085**	0.010***
	(0.016)	(0.002)	(0.028)	(0.039)	(0.003)
Mean of dep variable	7.912	0.069	0.713	9.057	0.112
Individuals	298,019	295,688	302,038	299,954	299,954
			(F) Maternal parish of residence		
post X new MW ≤5.5 km	0.038**	0.006**	-0.050*	0.094***	0.008
	(0.015)	(0.003)	(0.025)	(0.034)	(0.005)
Mean of dep variable	8.009	0.065	0.561	9.393	0.137
Individuals	669,775	666,726	675,054	667,700	667,700
Birth year FEs	yes	yes	yes	yes	yes
Birth parish FEs	yes	yes	yes	yes	yes

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. All models include parish-of-birth fixed effects (2,274 for the Models 1–5 and 205 for the Model 6) and year-of-birth fixed effects. For the description, see *VII. Robustness Analyses*.
*** p<0.01, ** p<0.05, * p<0.1

Appendix A

Gravity-Based Measure of Hospital Accessibility

Potential geographical access to the maternity hospital depends on distance to nearby maternity hospitals as well as their availability to the demand from the surrounding population. Least cost path analysis ignores supply and demand of maternity hospital services and hence arrives at using the shortest distance (that costs least) between the population and locations of services. Gravity (potential) modelling takes them into account. Gravity model used in this study to construct the potential access A_i at parish i is the following (Crooks and Schuurman 2012):

$$A_i = \sum_j \frac{S_j}{D_j f(t_{ij})} \quad (1)$$

where S_j – supply at maternity hospital j (number of childbirth beds), $f(t_{ij})$ – travel time impedance function, t_{ij} – travel time from parish i to maternity hospital j (based on the closest distance, km), D_j – demand at maternity hospital j.

Demand is as following:

$$D_j = \sum_k \frac{P_k}{f(t_{kj})} \quad (2)$$

where P_k – population size in parish k (total population in 1000s in 1930), $f(t_{kj})$ – travel time impedance function for travel from parish k to maternity hospital location j.

The demand is adjusted with a decay coefficient following the rationale that women are attracted to larger services (in this case also to those of presumably better quality) and this attraction diminishes with distance and costs. For walking times less than or equal to 60 minutes, I do not apply any decay; for 60 to 180 minutes, I use a $\frac{1}{10}$ implying that the travel impedance increases linearly; for walking time more than 180 minutes, a maternity hospital is considered as not accessible.

Appendix B

Analysis of changes in composition of cohorts due to the reform

Table B.1 – Changes in composition of the cohorts due to the openings of maternity hospitals, cohorts 1931–1946, Sweden

	(1) Maternal years of schooling	(2) Paternal SES high	(3) Paternal sector of employment agriculture	(4) Paternal sector of employment industry	(5) Paternal sector of employment services
post X new MW catchment area 5.5 km	-0.019	0.004	0.014**	0.005	0.001
	(0.018)	(0.005)	(0.007)	(0.008)	(0.006)
R-sq	0.009	0.012	0.011	0.029	0.017
linear distance to the closest MW	0.015	0.002	-0.016***	0.001	-0.002
	(0.014)	(0.004)	(0.005)	(0.006)	(0.005)
R-sq	0.009	0.012	0.011	0.029	0.017
access to MW (gravity)	-0.003	0.004	0.010***	0.001	-0.001
	(0.009)	(0.003)	(0.003)	(0.004)	(0.003)
R-sq	0.009	0.012	0.011	0.029	0.017
Mean of dep. variable	7.187	0.121	0.105	0.226	0.113
Individuals	383,245	383,245	383,245	383,245	383,245
Parishes of birth	2,254	2,254	2,254	2,254	2,254

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. All models include parish-of-birth fixed effects and year-of-birth fixed effects. All models are estimated according to Eq.1–3.
*** p<0.01, ** p<0.05, * p<0.1

Table B.2 – Changes in maternal completed family size in total and by subgroups due to the openings of new maternity hospitals, cohorts 1931–1946, Sweden

	(1) Family size	(2) Maternal < primary schooling	(3) Maternal ≥ primary schooling	(4) Maternal schooling unknown	(5) Paternal SES low	(6) Paternal SES high	(7) Paternal SES unknown	(8) Paternal sector of employment agriculture	(9) Paternal sector of employment industry	(10) Paternal sector of employment services	(11) Paternal sector of employment unknown
postXnew MW catchment area 5.5 km	-0.126***	-0.224***	-0.230	-0.069**	-0.138***	-0.210**	-0.082**	-0.194**	-0.174***	-0.067	-0.082**
	(0.024)	(0.077)	(0.159)	(0.031)	(0.045)	(0.105)	(0.034)	(0.092)	(0.049)	(0.064)	(0.034)
R-sq	0.034	0.002	0.002	0.039	0.007	0.009	0.046	0.008	0.008	0.007	0.045
linear distance to the closest MW	0.124***	0.224***	0.191	0.063***	0.151***	0.197*	0.092***	0.182**	0.173***	0.083	0.092***
	(0.020)	(0.066)	(0.193)	(0.024)	(0.043)	(0.106)	(0.026)	(0.077)	(0.049)	(0.057)	(0.026)
R-sq	0.034	0.002	0.002	0.039	0.007	0.009	0.046	0.008	0.008	0.007	0.045
access to MW (gravity)	-0.069**	-0.150**	-0.144	-0.035	-0.121***	-0.062	-0.032	-0.138**	-0.124***	-0.035	-0.032
	(0.028)	(0.073)	(0.107)	(0.023)	(0.027)	(0.081)	(0.028)	(0.060)	(0.030)	(0.031)	(0.029)
R-sq	0.028	0.002	0.003	0.034	0.005	0.008	0.039	0.007	0.006	0.008	0.039
Mean of dep	3.065	3.507	2.916	2.773	3.199	3.394	2.916	3.639	3.199	2.998	2.917
Individuals	383,245	148,878	16,472	217,895	123,768	46,398	213,079	40,103	86,584	43,248	213,310
Parishes of birth	2,254	2,198	1,311	2,252	2,186	2,063	2,252	2,063	2,133	1,954	2,252

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. All models include parish-of-birth fixed effects and year-of-birth fixed effects. All models are estimated according to Eq.1–3.
*** p<0.01, ** p<0.05, * p<0.1

Table B.3 – Changes in maternal county of residence in total and by subgroups due to the openings of new maternity hospitals, cohorts 1931–1946, Sweden

	(1) Family size	(2) Maternal < primary schooling	(3) Maternal ≥ primary schooling	(4) Maternal schooling unknown	(5) Paternal SES low	(6) Paternal SES high	(7) Paternal SES unknown	(8) Paternal sector of employment agriculture	(9) Paternal sector of employment industry	(10) Paternal sector of employment services	(11) Paternal sector of employment unknown
postXnew MW catchment	0.002	0.000	-0.021	0.012	0.007	0.003	0.006	0.006	0.005	-0.007	0.006
area 5.5 km	(0.003)	(0.004)	(0.016)	(0.008)	(0.007)	(0.004)	(0.006)	(0.008)	(0.005)	(0.008)	(0.006)
R-sq	0.001	0.001	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
linear distance to	-0.001	-0.003	0.024*	-0.005	-0.005	-0.002	-0.002	-0.004	-0.005	0.007	-0.002
the closest MW	(0.002)	(0.003)	(0.013)	(0.004)	(0.005)	(0.003)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)
R-sq	0.001	0.001	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
access to MW	0.001	0.004**	-0.003	0.002	0.007**	0.002	0.001	0.004	0.003	0.004	0.001
(gravity)	(0.001)	(0.002)	(0.007)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)
R-sq	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mean of dep	0.040	0.045	0.039	0.037	0.039	0.046	0.037	0.042	0.044	0.047	0.037
Individuals	234,511	96,242	11,150	127,119	29,829	78,728	125,954	25,683	54,530	28,178	126,120
Parishes of birth	2,254	2,198	1,311	2,252	2,063	2,186	2,252	2,063	2,133	1,954	2,252

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. All models include parish-of-birth fixed effects and year-of-birth fixed effects. All models are estimated according to Eq.1–3.
*** p<0.01, ** p<0.05, * p<0.1

Appendix C

Sources of the Regional-Level Data

Variable	Source	Comments
Trafficked road length, km per 1000	constructed based on SCB Sveriges officiella statistik. Statistik Årsbok för Sverige [Statistics Sweden. Statistics Yearbook]	yearly and county level, 24 counties and Stockholm
Length of railways, km	constructed based on SCB Sveriges officiella statistik. Statistik Årsbok för Sverige [Statistics Sweden. Statistics Yearbook]	yearly and county level, 24 counties and Stockholm
Municipal income	constructed based on SCB Sveriges officiella statistik. Statistik Årsbok för Sverige [Statistics Sweden. Statistics Yearbook]	yearly and county urban-rural level, 49 regions
Share employed in agriculture	constructed based on SCB Sveriges officiella statistik. Folkräkningen [Statistics Sweden. Population Census] (number employed in agriculture, industry and services) 1930, 1940, 1950	decadal and county level, 24 counties and Stockholm
Share employed in industry	constructed based on SCB Sveriges officiella statistik. Folkräkningen (number employed in agriculture, industry and services) 1930, 1940, 1950	decadal and county level, 24 counties and Stockholm
Real regional GDP per capita	Enflo, Henning & Schön (2015)	decadal and county level, 24 counties
Medical personnel, per 1000 mid-year population	constructed based on SCB Sveriges officiella statistik. Allmän om Hålso och sjukvård [Statistics Sweden. Health and Health Care] (number of legitimate doctors, midwives, and medical nurses); SCB Sveriges officiella statistik. Befolkningsrörelsen (mid-year population)	yearly and county urban-rural level, 49 regions
Real hospital spending, per 1000 mid-year population	constructed based on SCB Sveriges officiella statistik. Allmän om Hålso och sjukvård (hospitals' receipts); SCB Sveriges officiella statistik. Befolkningsrörelsen (mid-year population); Edvinsson & Söderberg (2011) (national CPI)	yearly and county urban-rural level (24 counties and 3 urban regions: Stockholm, Malmo and Gothenborg), 27 regions
Share females in total population	constructed based on SCB Sveriges officiella statistik. Befolkningsrörelsen (female and male mid-year population)	yearly and county urban-rural level, 49 regions
Share under age 15 in total population	constructed based on SCB Sveriges officiella statistik. Statistik Årsbok för Sverige [Statistics Sweden. Statistics Yearbook] (population under age 15); SCB Sveriges officiella statistik. Befolkningsrörelsen (mid-year population)	5-year and county level, 24 counties and Stockholm
Share above age 65 in total population	constructed based on SCB Sveriges officiella statistik. Statistik Årsbok för Sverige (population above age 65); SCB Sveriges officiella statistik. Befolkningsrörelsen (mid-year population)	5-year and county level, 24 counties and Stockholm
Cause-specific mortality rates, per 1000 mid-year population	constructed based on Dödsorsaker: SCB Sveriges officiella statistik. Befolkningsrörelsen (mid-year population)	yearly and county urban-rural level, 49 regions, 1920–1950
Infant mortality rate, per 1000 live births	constructed based on SCB Sveriges officiella statistik. Befolkningsrörelsen (infant deaths and live births)	yearly and county urban-rural level, 49 regions
Crude death rate, per 1000 mid-year population	constructed based on SCB Sveriges officiella statistik. Befolkningsrörelsen (total deaths and mid-year population)	yearly and county urban-rural level, 49 regions
Stillbirth rate, per 1000 total births	constructed based on SCB Sveriges officiella statistik. Befolkningsrörelsen (stillbirths and live births)	yearly and county urban-rural level, 49 regions
Crude birth rate, per 1000 mid-year population	constructed based on SCB Sveriges officiella statistik. Befolkningsrörelsen (live births and mid-year population)	yearly and county urban-rural level, 49 regions

Marital fertility rate, per 1000	constructed based on SCB Sveriges officiella statistik. Befolkningsrörelsen (yearly legitimate total births and 5-mid-year married women 15-45 ages)	yearly and county urban-rural level, 49 regions
Number of school-rooms, per 1000 primary-school pupils	constructed based on SCB Sveriges officiella statistik. Statistik Årsbok för Sverige (number of school-rooms and number of pupils in primary schools)	yearly and county level, 24 counties and Stockholm
Number of teachers, per 1000 primary-school pupils	constructed based on SCB Sveriges officiella statistik. Statistik Årsbok för Sverige (number of teachers and number of pupils in primary schools)	yearly and county level, 24 counties and Stockholm
Sulphonamide availability, per 1000 mid-year population;	constructed based on Riksarkivet. Medicinalstyrelsens apoteksbyrå [National Archive. National Health Board's Pharmacy Agency], aggregated from pharmacy level, pharmacy-city locations from SCB. Recalculated into adult doses to treat pneumonia episode per 1000 population (1 adult dose = 22 grams of sulphonamides). Sveriges kommuner åren 1952-1986	parish level
Health care investment	Constructed based on Kommunernas Finanser 1930 [Commune Finances 1930]	parish level
Investments into primary schooling, church, infrastructure and poor relief	Constructed based on Kommunernas Finanser 1930 [Commune Finances 1930]	parish level
Population, mid-year	*Folknet*, 1930; cross-checked with SCB Sveriges officiella statistik. Befolkningsrörelsen for the regional-level data	parish level and county urban-rural level, 49 regions

Appendix D

Survivors of Cohorts under Analysis

The cohorts born between 1931 and 1946 appear in the SIP dataset from 1968. I therefore do not observe individuals that died or migrated from Sweden prior to age 37. I gathered information on one-year survivors (live births minus infant deaths) of the cohorts born 1920–1950 from Statistics Sweden (Statistiska Centralbyrån, 1920c–1950). In Figure below, I plot them against counts of individuals with places of birth available in SIP by cohort and those who have valid information on the county and parish of birth. A relatively stable fraction of individuals observed in the SIP dataset compared to number of one-year survivors indicates that the individuals born 1931–1946 were dying at a constant rate between the ages 1 and 36. Among the first-year survivors of these cohorts, 96.4 percent were observed in the dataset. The selection to survival to adulthood should not therefore violate the results in the paper.

Starting from cohorts 1932 and born later, individuals are linked to their parents through the multigenerational register (*Flergenerationsregistret*) thereby giving a unique family identifier. This information is available for all individuals in our sample conditional on their survival or presence in Sweden to the year 1991. Due to the availability of family links (across different outcome samples, 80.9–82.1 percent are linked to mothers), I was able to merge socio-economic and demographic information of the family to the individual data. The parental background characteristics included the following information: education of the mother, socio-economic status and sector of employment of the father obtained from population and housing census 1970 (*Folk- och Bostadsräkningen 1970*). Socio-economic status has been originally constructed by Statistics Sweden (Statistiska Centralbyrån 1975) based on occupation and occupational status, which I further grouped into high (farmers, business owners in different sectors of economy, higher professionals, and higher managers) and low (workers in different sectors of economy, military, lower professionals and managers, and clerical and sales personnel). This information was available only for the post-treatment child's ages, in parents' late adulthood (mean age 64 and 99.8 percent are employed), although for paternal cohorts education should have been completed, and socio-economic status and branch of work had to stabilise.

Table analyses the differences between parishes with different MW accessibility across demographic and socio-economic characteristics: parishes that appear to be treated already in 1931 and do not enter the estimation sample and parishes subject to reform in 1931–1946. As it is evident, parishes subject to the openings of new MWs are more rural that is in line with the passage of the reform. I further adjust the estimation sample for the differences in registration of the birth location across the period and hospitals: exclude the parishes that were closely located (5.5 km) to the new maternity hospitals that registered births in the location of the hospital not in the parish of maternal residence (0.7 percent of parish-years and 7.6 percent of individuals). The original sample of implementing parishes and an adjusted are similar across the observed demographic and socio-economic characteristics. The main results should therefore be externally valid with regard to all reforming parishes in Sweden and in addition are corrected for the plausible measurement error to yield internal validity.

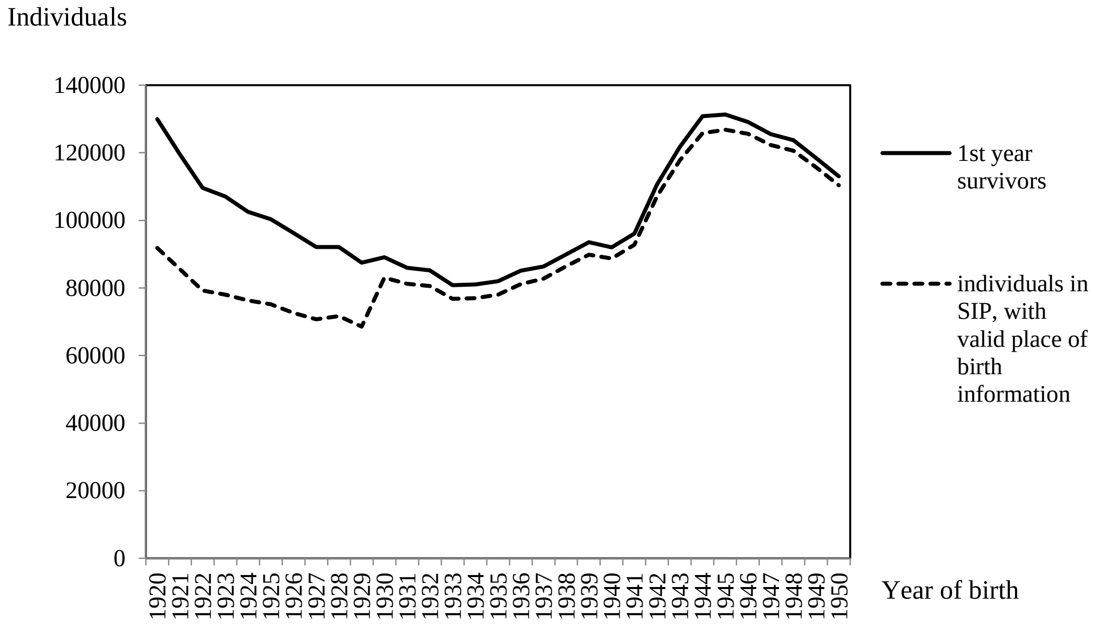


Figure – First-year survivors and estimation sample for the cohorts 1920–1950

Sources: own calculations based on SIP and Statistiska Centralbyrån (1920c,d-1950).

Table – Differences between parishes with varying MW accessibility across demographic and socio-economic characteristics, 1931–1946

	Total parishes	Parishes subject to reform	*Parishes subject to reform with correct parish of birth information*	P-value (2 versus 1)	P-value (3 versus 2)
	1	2	3	4	5
Urban	0.0605	0.0222	0.0205	(0.000)	(0.741)
North	0.113	0.107	0.107	(0.032)	(1.000)
Centre	0.234	0.230	0.229	(0.441)	(1.000)
South	0.654	0.663	0.665	(0.009)	(1.000)
Ln trafficked road length	1.814	1.827	1.827	(0.000)	(1.000)
Ln length of railways	6.510	6.514	6.514	(0.819)	(1.000)
Ln real regional income	17.70	17.68	17.68	(0.000)	(1.000)
Share employed in agriculture	0.448	0.466	0.466	(0.000)	(1.000)
Share employed in industry	0.341	0.335	0.334	(0.000)	(1.000)
Regional GDP per capita, relative to the national	0.925	0.916	0.916	(0.000)	(1.000)
Ln doctors	3.256	3.209	3.207	(0.000)	(1.000)
Ln midwives	4.405	4.448	4.450	(0.000)	(1.000)
Ln medical nurses	3.470	3.464	3.464	(1.000)	(1.000)
Ln hospitals	1.190	1.181	1.180	(0.054)	(1.000)
Ln real hospital expenditures	13.39	13.38	13.38	(0.001)	(1.000)
Share females	0.497	0.495	0.495	(0.000)	(1.000)
Share under age 15	0.270	0.269	0.269	(0.007)	(1.000)
Ln crude death rate per 1000	2.492	2.496	2.496	(0.000)	(1.000)
Share disabled	0.00959	0.00884	0.00880	(0.000)	(1.000)
Ln primary schools	6.271	6.276	6.275	(1.000)	(1.000)
Ln live births	7.869	7.897	7.899	(0.000)	(1.000)
Ln pharmacies per 100,000	2.281	2.212	2.208	(0.000)	(1.000)
Ln mid-year population	12.01	12.03	12.04	(0.000)	(1.000)
Ln infant mortality rate per 1000 live births	3.934	3.931	3.931	(0.061)	(1.000)
Ln maternal mortality rate per 1000	-3.407	-3.420	-3.422	(0.388)	(1.000)
Ln pneumonia mortality per 1000	-0.420	-0.409	-0.408	(0.000)	(1.000)
Sulphonamides, grams per 1000	31.44	25.94	25.76	(0.000)	(1.000)
Ln healthcare investments, parish	6.945	6.920	6.914	(0.007)	(1.000)
Ln other investment, parish	11.09	11.04	11.04	(0.000)	(1.000)
Ln population, parish	7.288	7.148	7.141	(0.000)	(0.892)
Parish-years	34885	30580	30379		
Parishes	2529	2275	2274		

Note: OLS regression estimates. The significance of the differences in means is adjusted with the Bonferroni multiple-comparison test.

Appendix E

Table – The effects of the openings of MWs on mortality until the age of 37 (cohort mortality), Sweden cohorts 1931–1946

	(1)	(2)	(3)	(4)	(5)	(6)
Postneonatal mortality (≥28 days and <1 age)						
post X new MW catchment area 5.5 km	-7.243*	-6.798*	-6.983*	-9.703**	-9.088*	-2.691
	(3.823)	(4.057)	(4.008)	(3.920)	(4.836)	(4.292)
Rsq	0.172	0.174	0.174	0.173	0.255	0.223
linear distance to the closest MW	5.158***	5.567***	5.908***	7.678***	3.718*	1.660
	(1.707)	(2.021)	(1.968)	(1.841)	(2.259)	(1.915)
Rsq	0.172	0.174	0.174	0.173	0.255	0.222
access to MW (gravity)	-0.955	-1.206	-1.237	-1.393	-1.537	-0.423
	(0.935)	(0.977)	(0.984)	(0.957)	(1.225)	(0.843)
Rsq	0.172	0.174	0.173	0.173	0.255	0.222
Mean of dep. variable	27.721	27.721	27.721	27.721	27.721	20.235
Birth parish x birth years	30,379	30,379	30,379	30,379	30,379	2,626
Child mortality (≥1 age and <15 age)						
post X new MW catchment area 5.5 km	-1.033	-0.767	-0.343	-1.982	5.403	1.130
	(2.888)	(2.981)	(2.929)	(2.930)	(5.327)	(3.617)
Rsq	0.173	0.174	0.174	0.174	0.253	0.195
linear distance to the closest MW	2.593	3.014	2.449	3.373*	-4.642	1.931
	(1.778)	(1.939)	(1.847)	(1.820)	(3.412)	(2.636)
Rsq	0.173	0.174	0.174	0.174	0.253	0.195
access to MW (gravity)	0.118	-0.009	0.108	-0.014	2.203	0.201
	(0.899)	(0.941)	(0.918)	(0.906)	(1.410)	(0.930)
Rsq	0.173	0.174	0.174	0.174	0.253	0.195
Mean of dep. variable	21.989	21.989	21.989	21.989	21.989	20.394
Birth parish x birth years	30,379	30,379	30,379	30,379	30,379	2,626
Adult mortality (≥15 age and <37 age)						
post X new MW catchment area 5.5 km	2.995	4.103	4.532	2.179	-3.226	2.324
	(3.804)	(3.681)	(3.727)	(3.831)	(5.986)	(4.257)
Rsq	0.253	0.254	0.253	0.253	0.341	0.177
linear distance to the closest MW	-2.016	-2.051	-2.864	-1.028	1.375	-1.403
	(2.199)	(2.194)	(2.153)	(2.203)	(3.134)	(2.662)
Rsq	0.253	0.254	0.253	0.253	0.341	0.176
access to MW (gravity)	0.469	0.583	0.668	0.294	-2.093	-0.589
	(1.578)	(1.441)	(1.556)	(1.566)	(2.060)	(1.779)
Rsq	0.253	0.254	0.253	0.253	0.341	0.176
Mean of dep. variable	19.453	19.453	19.453	19.453	19.453	21.029
Birth parish x birth years	30,379	30,379	30,379	30,379	30,379	2,626
Birth year FEs	yes	yes	yes	yes	yes	yes
Birth parish FEs	yes	yes	yes	yes	yes	yes
Region-specific linear birth year trends		yes				
Region controls 1930 x linear birth year trends			yes			
Birth parish controls 1930 linear birth year trends				yes		
Birth parish-specific linear birth year trends					yes	

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. All models include parish-of-birth fixed effects (2,274 for the Models 1–5 and 205 for the Model 6) and year-of-birth fixed effects. All models are estimated according to Eq.1–3 plus additional controls. Models 2 additionally include region-of-birth-specific linear birth year trends (49 regions, county urban/rural and Stockholm). Models 3 additionally include interactions between region-of-birth characteristics in 1930 and linear birth year trends. Models 4 additionally include interactions between parish-of-birth characteristics in 1930 and linear birth year trends. For the region- and parish-of-birth characteristics see *IV. Data. A. Historical Data on Reform and Regional Characteristics.* Models 5 additionally include parish-of-birth-specific linear birth year trends. Models 6 are estimated according to Eq. 1–3 for the sample of ever-implementers.
*** p<0.01, ** p<0.05, * p<0.1.

Appendix F

Table – The long-term effects of the openings of MWs on economic, educational and health outcomes with a natural logarithm of distance as a treatment variable, Sweden cohorts born in 1931–1946

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Ln average real labour income, ages 47–64						
ln linear distance to the closest MW	-0.033**	-0.035**	-0.035**	-0.036**	-0.027*	-0.034**
	(0.014)	(0.015)	(0.014)	(0.015)	(0.016)	(0.016)
Mean of dep. variable	7.900	7.900	7.900	7.900	7.900	7.957
Individuals	484,523	484,523	484,523	484,523	484,523	137,938
On disability pension, permanent status in ages 50–64						
ln linear distance to the closest MW	0.006***	0.006***	0.007***	0.007***	0.006**	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Mean of dep. variable	0.067	0.067	0.067	0.067	0.067	0.069
Individuals	480,807	480,807	480,807	480,807	480,807	136,859
Average length of stay in hospital, nights per year in ages 37–64						
ln linear distance to the closest MW	0.045*	0.040	0.046*	0.040	0.045	0.050*
	(0.025)	(0.024)	(0.025)	(0.025)	(0.037)	(0.029)
Mean of dependent variable	0.730	0.730	0.730	0.730	0.730	0.704
Individuals	491,025	491,025	491,025	491,025	491,025	139,810
Years of schooling						
ln linear distance to the closest MW	-0.076**	-0.064**	-0.047*	-0.053*	-0.061*	-0.097**
	(0.032)	(0.025)	(0.027)	(0.031)	(0.036)	(0.045)
Mean of dependent variable	8.985	8.985	8.985	8.985	8.985	9.293
Individuals	487,162	487,162	487,162	487,162	487,162	139,135
High school graduate						
ln linear distance to the closest MW	-0.006*	-0.006*	-0.004	-0.005	-0.008**	-0.006
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Mean of dependent variable	0.107	0.107	0.107	0.107	0.107	0.130
Individuals	487,162	487,162	487,162	487,162	487,162	139,135
Birth year FEs	yes	yes	yes	yes	yes	yes
Birth parish FEs	yes	yes	yes	yes	yes	yes
Region-specific linear birth year trends		yes				
Region controls 1930 x linear birth year trends			yes			
Birth parish controls 1930 linear birth year trends				yes		
Birth parish-specific linear birth year trends					yes	

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. The estimate for the natural logarithm of distance is presented as a 10-percentage change in a distance. All models include parish-of-birth fixed effects (2,274 for the Models 1–5 and 205 for the Model 6) and year-of-birth fixed effects. All models are estimated according to Eq.1–3 plus additional controls. Models 2 additionally include region-of-birth-specific linear birth year trends (49 regions, county urban/rural and Stockholm). Models 3 additionally include interactions between region-of-birth characteristics in 1930 and linear birth year trends. Models 4 additionally include interactions between parish-of-birth characteristics in 1930 and linear birth year trends. For the region- and parish-of-birth characteristics see *IV. Data. A. Historical Data on Reform and Regional Characteristics.* Models 5 additionally include parish-of-birth-specific linear birth year trends. Models 6 are estimated according to Eq. 1–3 for the sample of ever-implementers.
*** p<0.01, ** p<0.05, * p<0.1.

Appendix G

Analysis of the Later-Life Morbidity by Cause

The cause of admission to the hospital is obtained from the Swedish national inpatient register 1987–2012. It adopted two revisions of the international classifications of the causes of morbidity, such as revision 9 for 1987–1996, and revision 10 for 1997–2012. Following the previous literature (Kuh and Ben-Shlomo 2007), I classified all causes of admissions into six groups, including infectious/respiratory diseases, cardiovascular diseases, diabetes, cancer, degenerative diseases of tissues and organs, and mental diseases and calculated the respective average length of stay in hospital. The same classification is used for cause-specific mortality. The group of degenerative diseases of tissues and organs is dominant with symptoms of respiratory diseases, arthritis and gastro-enteric diseases. In order to measure pathology in health exclusively, I excluded hospital admissions due to violent/accidental causes (2 percent of person-years) and observations with no need for further treatment (0.01 percent of person-years). The exact codes used for these groupings are provided in Table E.1 below.

Additionally, I perform the analysis of the effects on length of stay in hospital by the cause of admission (see Table E.2). The strongest and statistically significant results are depicted for morbidity due to cardiovascular disease: the related stays in the hospital reduced by 0.052–0.115 days or 4.4–9.7 percent of the mean due to the reform. Also, results for morbidity due to degenerative disease, primarily arthritis, suggest statistically significant reductions at 0.072–0.153 days or 2.9–6.4 percent of the mean due to the reform. Rather counter-intuitively, there are positive effects of the reform on morbidity due to cancer. In interpreting, one can follow Ludvigsson et al (2011) who in the validation of the inpatient hospital register conclude that long follow-ups are valid for all but not cancer morbidity.

Table G.1 – Diagnoses groups across two revisions of the ICD, 1987–2012

	ICD-9	ICD-10
Infectious/Respiratory	001-139; 320-324; 460-519	A00-B99; G00-G09; J00-J99
Cardiovascular	390-459	I00-I99
Diabetes	250	E10-E14
Cancer	140-239	C00-D48
Degenerative	240-246; 251-289; 325-330; 332-389; 520-796	D50-E07; E15-E90; F10-F99; G10-G26; G31-H95; K00-R94
Mental diseases	290-319; 331	F00-F09; G30

Table G.2 – The long-term effects of the openings of MWs on length of stay in hospital by cause, Sweden cohorts born in 1931–1946

	(1)	(2)	(3)	(4)	(5)	(6)
Infectious and Respiratory						
post X new MW catchment area 5.5 km	0.031	0.032	0.010	0.038	0.001	-0.014
	(0.040)	(0.041)	(0.041)	(0.040)	(0.049)	(0.042)
linear distance to the closest MW	-0.007	-0.009	0.011	-0.013	0.024	0.029
	(0.030)	(0.032)	(0.030)	(0.031)	(0.033)	(0.029)
access to MW (gravity)	0.024	0.014	0.007	0.028	0.017	0.005
	(0.021)	(0.021)	(0.022)	(0.021)	(0.041)	(0.022)
Mean of dep. variable	0.708	0.708	0.708	0.708	0.708	0.692
Individuals	491,025	491,025	491,025	491,025	491,025	139,810
Cardiovascular disease						
post X new MW catchment area 5.5 km	-0.084	-0.088*	-0.104*	-0.079	-0.126	-0.076
	(0.052)	(0.052)	(0.054)	(0.054)	(0.086)	(0.061)
linear distance to the closest MW	0.092*	0.095*	0.115**	0.087*	0.115*	0.087
	(0.050)	(0.052)	(0.053)	(0.052)	(0.066)	(0.058)
access to MW (gravity)	-0.052*	-0.060**	-0.066**	-0.052*	-0.069	-0.043
	(0.030)	(0.030)	(0.032)	(0.030)	(0.050)	(0.033)
Mean of dep. variable	1.185	1.185	1.185	1.185	1.185	1.172
Individuals	491,025	491,025	491,025	491,025	491,025	139,810
Diabetes						
post X new MW catchment area 5.5 km	0.011	0.007	0.008	0.011	0.025	0.018
	(0.020)	(0.019)	(0.020)	(0.019)	(0.025)	(0.023)
linear distance to the closest MW	-0.012	-0.006	-0.008	-0.012	-0.012	-0.015
	(0.015)	(0.015)	(0.015)	(0.015)	(0.019)	(0.016)
access to MW (gravity)	-0.002	-0.006	-0.005	-0.002	0.007	-0.003
	(0.011)	(0.010)	(0.011)	(0.011)	(0.017)	(0.012)
Mean of dep. variable	0.166	0.166	0.166	0.166	0.166	0.161
Individuals	491,025	491,025	491,025	491,025	491,025	139,810
Cancer						
post X new MW catchment area 5.5 km	0.141***	0.116***	0.098**	0.139***	0.132*	0.148***
	(0.040)	(0.040)	(0.038)	(0.041)	(0.069)	(0.051)
linear distance to the closest MW	-0.093**	-0.064	-0.052	-0.089*	-0.035	-0.073
	(0.046)	(0.044)	(0.041)	(0.047)	(0.063)	(0.051)
access to MW (gravity)	0.075***	0.048**	0.041*	0.073***	0.104**	0.068***
	(0.024)	(0.023)	(0.022)	(0.025)	(0.040)	(0.026)
Mean of dep. variable	1.167	1.167	1.167	1.167	1.167	1.125
Individuals	491,025	491,025	491,025	491,025	491,025	139,810
Degenerative diseases						
post X new MW catchment area 5.5 km	-0.062	-0.098	-0.127**	-0.071	-0.096	-0.153**
	(0.060)	(0.062)	(0.062)	(0.060)	(0.091)	(0.070)
linear distance to the closest MW	0.095*	0.116**	0.144***	0.103*	0.081	0.170***
	(0.056)	(0.056)	(0.056)	(0.054)	(0.076)	(0.054)

access to MW (gravity)	-0.023	-0.062	-0.072*	-0.027	-0.051	-0.069
	(0.042)	(0.041)	(0.041)	(0.041)	(0.061)	(0.046)
Mean of dep. variable	2.508	2.508	2.508	2.508	2.508	2.409
Individuals	491,025	491,025	491,025	491,025	491,025	139,810
Mental disease						
post X new MW catchment area 5.5 km	-0.069	-0.096	-0.145	-0.093	-0.117	-0.035
	(0.108)	(0.104)	(0.102)	(0.109)	(0.131)	(0.130)
linear distance to the closest MW	0.032	0.070	0.096	0.054	0.138	0.011
	(0.081)	(0.084)	(0.083)	(0.081)	(0.101)	(0.089)
access to MW (gravity)	0.013	-0.013	-0.033	-0.002	-0.043	0.051
	(0.063)	(0.063)	(0.067)	(0.061)	(0.101)	(0.066)
Mean of dep. variable	1.398	1.398	1.398	1.398	1.398	1.357
Individuals	491,025	491,025	491,025	491,025	491,025	139,810
Birth year FEs	yes	yes	yes	yes	Yes	yes
Birth parish FEs	yes	yes	yes	yes	Yes	yes
Region-specific linear birth year trends		yes				
Region controls 1930 x linear birth year trends			yes			
Birth parish controls 1930 linear birth year trends				yes		
Birth parish-specific linear birth year trends					Yes	

Note: estimations from the *SIP*. Standard errors (in parentheses) are clustered at a parish-of-birth level. All models include parish-of-birth fixed effects (2,274 for the Models 1–5 and 205 for the Model 6) and year-of-birth fixed effects. All models are estimated according to Eq.1–3 plus additional controls. Models 2 additionally include region-of-birth-specific linear birth year trends (49 regions, county urban/rural and Stockholm). Models 3 additionally include interactions between region-of-birth characteristics in 1930 and linear birth year trends. Models 4 additionally include interactions between parish-of-birth characteristics in 1930 and linear birth year trends. For the region- and parish-of-birth characteristics see *IV. Data. A. Historical Data on Reform and Regional Characteristics.* Models 5 additionally include parish-of-birth-specific linear birth year trends. Models 6 are estimated according to Eq. 1–3 for the sample of ever-implementers.
*** p<0.01, ** p<0.05, * p<0.1

Appendix H

Analysis of the Contemporaneous Effects of Sulphonamides on Mortality from Puerperal Fever, 1931–1946

In this paper, I use the plausibly exogenous reductions in mortality due to puerperal fever resulting from the arrival of sulphonamides as a shock to maternal health (and early-life health technology). The analysis below demonstrates that mortality due to puerperal fever declined sharply and converged across regions during and after 1938, precisely when sulphonamides arrived to Sweden. Figure F.1 displays the average mortality due to puerperal fever per 1000 mid-year population of women. In 1931–1937, mortality due to puerperal fever was small: it varied between 0 and 0.324 across regions with the mean at 0.044 deaths per 1000. However, beginning from 1938, it exhibits a sharp reduction by more than two thirds: puerperal fever mortality amounts 0.013 death at the mean. Figure F.2 plots puerperal fever mortality in 1931–1937 (prior to antibiotics) against absolute decline in puerperal fever mortality for the period until 1947. The results indicate strong convergence, almost 1 to 1, in aggregate mortality rates due to puerperal fever after arrival of sulpha antibiotics. More specifically, a one-unit higher pneumonia mortality rate in 1931–1937 is associated with 0.957 unit reduction in puerperal fever mortality afterwards.

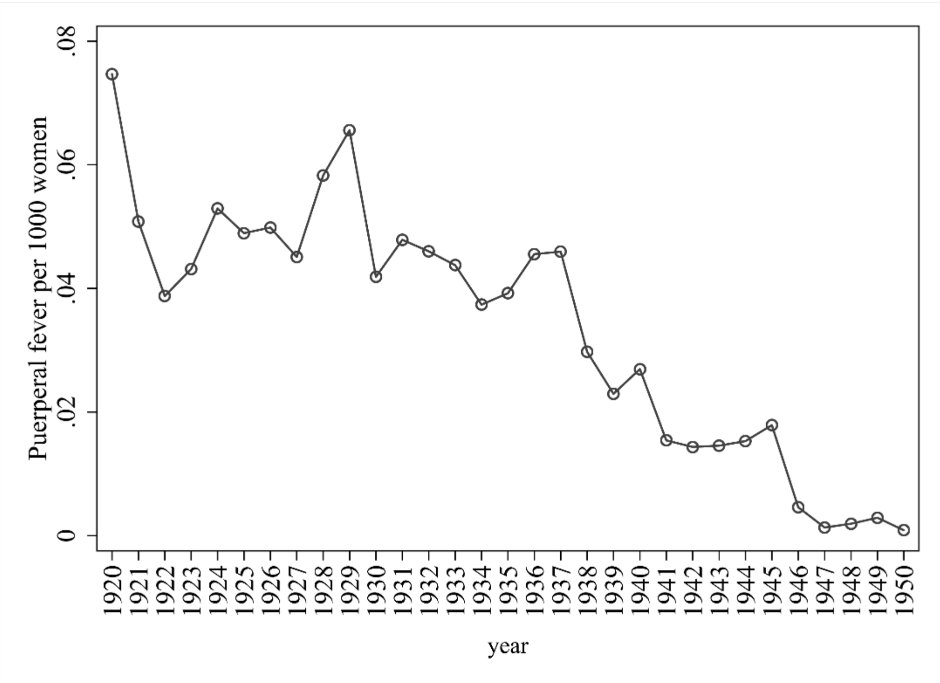


Figure H.1 – Puerperal fever mortality in Sweden in 1920–1950, deaths per 1000 women

Sources: own calculations based on Statistiska Centralbyrån (1920c,d-1950).

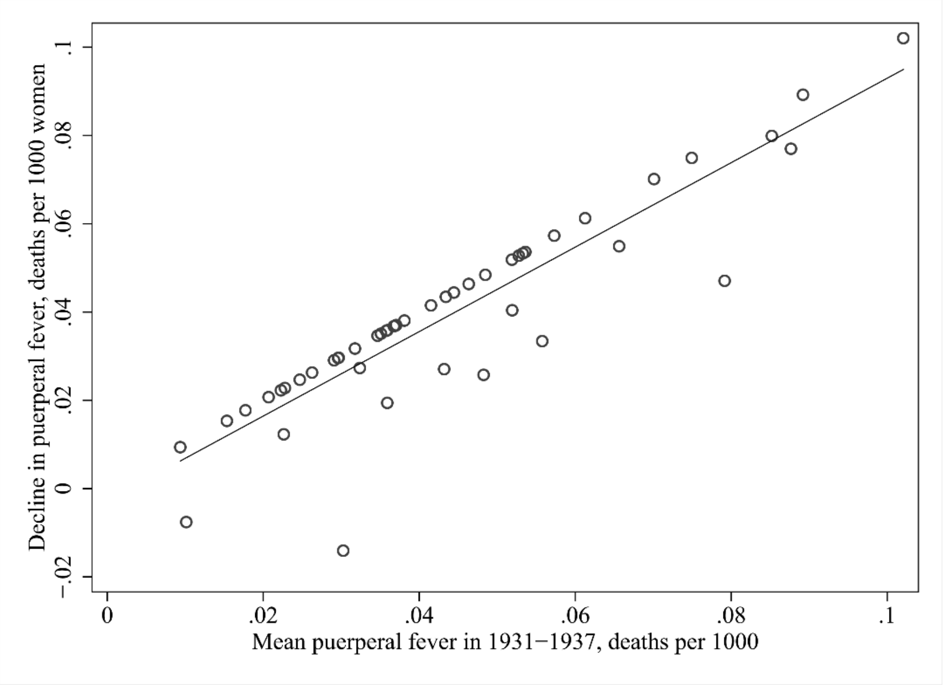


Figure H.2 – Convergence in puerperal fever mortality in Sweden during and after 1938, deaths per 1000 women

Sources: own calculations based on Statistiska Centralbyrån (1920c,d-1950).