Do expert patients get better treatment than others? Agency discrimination and statistical discrimination in obstetrics

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Do expert patients get better treatment than others? Agency discrimination and statistical discrimination in obstetrics

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Abstract

We address models that can explain why expert patients (obstetricians, midwives and doctors) are treated better than non-experts (mainly non-medical training). Models of statistical discrimination show that benevolent doctors treat expert patients better, since experts are better at communicating with the doctor. Agency theory suggests that doctors have an incentive to limit hospital costs by distorting information to non-expert patients, but not to expert patients.

The hypotheses were tested on a large set of data, which contained information about the highest education of the parents, and detailed medical information about all births in Norway during the period 1967 to 2005 (Medical Birth Registry). The empirical analyses show that expert parents have a higher rate of Caesarean section than non-expert parents. The educational disparities were considerable 40 years ago, but have become markedly less over time. The analyses provide support for statistical discrimination theory, though agency theory cannot be totally excluded.

Key words: statistical discrimination; agency theory; Caesarean section; expert patients; disparities

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1. Introduction

A typical patient has neither adequate information about his or her medical situation nor about the effectiveness of alternative treatment. Most patients are non-experts, and have little choice but to rely on the advice and recommendations provided by doctors. In contrast, the expert patient knows as much about medical diagnosis and treatment as the physician. The nearest one comes to an expert patient is a doctor who is sick, and who needs to be examined and treated. Our research question is whether expert patients are treated in the same way as non-expert patients, and whether diagnostic technology can reduce potential differences between the two groups.

We tested our research question using a large and unique set of data, which contains information about the highest education of the parents, and detailed medical information about all births in Norway during the period 1967 to 2005. Our main finding is that expert parents (i.e. parents who have medical training: obstetricians, midwives and doctors) have a higher rate of Caesarean section than non-expert parents (mainly non-medical training). These educational disparities[3] were considerable 40 years ago, but have become markedly less over time.

We suggest two alternative explanations for the observed disparities in rate of Caesarean section. The first explanation addresses mothers' ability to communicate their symptoms and preferences to the obstetrician ("statistical discrimination"). If complications arise, the expert mother is in a better position to communicate her symptoms and which method of delivery she prefers to the obstetrician. The benevolent obstetrician takes her assessment into account, which implies that the mother is more likely to have a Caesarean section than a non-expert mother. The second explanation is that the mother who gives birth and the obstetrician have conflicting interests. Obstetricians want to minimize the number of Caesarean sections, while mothers do not ("agency discrimination"). Due to asymmetric information, non-expert mothers can be persuaded to have vaginal deliveries rather than Caesarean sections.

Below we briefly outline the theories of statistical discrimination and agency discrimination as they apply to obstetric services. The most relevant empirical studies are

[3] Throughout the paper we use the term "disparities" to describe variation based on whether parents have medical training or not.

reviewed, before the data and the analyses are described. Finally, the results are reported and discussed.

2. Theory and background: statistical discrimination versus agency discrimination

The two theoretical models can be used to understand the interaction between obstetricians and the mothers who give birth. Both models underscore the role of information, but in completely different ways.

2.1 Statistical discrimination and obstetric services

The statistical discrimination model assumes that patients send noisy signals to the doctor, which lead to “statistical discrimination”. Imprecise signals make it difficult for physicians to match treatment with patients’ actual health conditions and health care needs. Information flows from the patient to the physician. The doctor receives a signal from the patient, and uses the signal to update his or her prior estimate of the severity of the patient’s condition. Some patients give more ambiguous signals than others. Patients who send a precise signal will receive the most appropriate treatment. Clinical uncertainty about diagnosis and treatment favours expert patients because they are more able to interpret and communicate their symptoms to the doctor, that is they send more precise signals than non-expert patients.

Balsa and McGuire (2001, 2003) have made the central *theoretical* contribution to how statistical discrimination theory applies to health services. Their contribution is based on labour market modelling (Aigner and Cain, 1977). There are few studies where statistical discrimination theory have been tested empirically, but the studies that exist support the theory (Balsa et al., 2005; Lutfey and Ketcham, 2005; McGuire et al., 2008). For example, Balsa et al. (2005) and McGuire et al. (2008) found that ethnic minority patients are less likely than whites to be diagnosed with depression. This is partly because whites communicate their symptoms better to the doctor than minorities.

An underlying assumption of their model is that doctors are altruistic agents for their patients. In addition, the model assumes that patients with the same diagnosis are equally likely to benefit from the same type of treatment. Further assumptions are that expert patients send more precise signals than non-expert patients, and that the average patient does not benefit from a particular type of treatment or type of service. Only when the level of severity of the condition is high (above a certain threshold) can treatment be expected to be effective. Most patients are expected to be below the threshold level.

To a large extent the above conditions are fulfilled for mothers who give birth. Most births run a normal course, and the mother and child are well after the birth. For example, in Norway more than 80 per cent of mothers have uncomplicated deliveries, that is they are below the threshold level (Norwegian Institute of Public Health, 2008). But in some cases there are complications, and it can be appropriate to deliver the child by Caesarean section (Kolås et al., 2003). When complications occur, there will often be uncertainty about the seriousness of the situation, and therefore it may not always be clear which method of delivery should be chosen (Fuglenes et al., 2009; Ecker and Frigoletto, 2007; O'Leary et al., 2007). Obstetricians do not observe the medical condition directly (for example the health of the foetus), but only the symptoms of the condition.

However, the obstetrician's decision is not only based on objective observation of symptoms, but also on the mother's subjective interpretation and assessment of the situation (Habiba et al., 2006). Here, the expert patient has an advantage. She will be more able to register and assess the implications of symptoms for her health and her child's health than the non-expert patient, and will probably also be more able to communicate her assessment to the obstetrician. Further, we expect that the well-informed mother is more able to respond to the information she receives from the obstetrician, and to participate in the decision process about choice of method of delivery than a mother who is not so well informed. This means that the expert patient is probably more able to communicate which method of delivery she prefers. The research question is thus whether this is actually reflected in the method of delivery that is offered.

2.2 Agency discrimination and obstetric services

The agency model assumes that there is a conflict of interest between the doctor and the patient. Because the patient is poorly informed, the doctor has the possibility to influence both the diagnosis and the type of services that are provided. The model assumes that information flows from the doctor to the patient, and that the doctor can exploit the information advantage.

In several studies on maternity care, agency theory is the point of departure. One issue that has been raised is whether obstetricians take their own private economic interests into account when deciding on type of delivery (for example see: Gruber and Owings, 1996; Tussing and Wojtowycz, 1992; Keeler and Brodie, 1993; Grant, 2009). Most of the studies are from the United States, Brazil, Chile, Taiwan and Korea (Henderson et al., 2001). The rate of Caesarean section is high in all these countries, and many maternity services are privately funded and organized (Henderson et al., 2001; Stephenson et al., 1993; Leone et al., 2008).

The main idea behind the principal agent model is illustrated in the much cited study by Gruber and Owings (1996). During the period 1970 to 1982, the birth rate in the USA fell by 13.5 per cent. In order to prevent a fall in revenue, obstetricians compensated by carrying out more Caesarean sections, which generate more income than vaginal deliveries. In a similar study, Gruber et al. found a positive and significant relationship between fees for Caesarean section and the number of Caesarean sections that were carried out (Gruber et al., 1999). Several other studies from the 1980s and the 1990s also found that the rate of Caesarean section was influenced by how doctors were remunerated or how hospitals were funded (Tussing and Wojtowycz, 1992; Stafford, 1990; Ransom et al., 1996).

The organization of maternity care in Norway is quite different from in the USA. In Norway, women give birth in publically-owned and publically-funded hospitals (Ministry of Health, 2002)[4]. Doctors receive a fixed salary and have no personal economic advantage by carrying out a Caesarean section rather than a normal delivery. There is little competition between hospitals for women giving birth. The country is divided into hospital areas in which the capacity of maternity units is planned according to the expected number of births within the catchment area. Mothers pay no fee, irrespective of the type of delivery.

Due to strict budget control, hospitals have incentives to keep costs down (Hagen, 1997; Dalen et al., 2002). Both international and national studies show that the cost of a Caesarean section is about twice the cost of an ordinary delivery (Gazmarian and Koplan, 1998; Mathisen et al., 2002). Therefore, one way to keep costs down is to keep the rate of Caesarean section low. This is also the case in Norway, where the rate of Caesarean

[4] During the period 1967 to 2001 hospitals were owned by the counties and financed by county government grants (Nerland, 2001). There are 19 counties in Norway. Before 1980 the counties financed the hospitals on a per diem basis, from 1980 a block grant system was introduced. From 2001 hospitals have been owned and financed by the State.

section is low compared to in many other countries (Tollånes, 2009). If the obstetrician takes the interests of the hospital into account, he or she may persuade mothers to have vaginal deliveries rather than Caesarean sections[5]. The obstetrician then acts more as an agent for the hospital than the mother. Different strategies can be used. For example, the obstetrician may overstate the probability of medical complications of Caesarean section (Jackson and Paterson-Brown, 2001; Häger et al., 2004; Wagner, 2000; Deneux-Tharaux et al., 2006; Hall and Bewley, 1999). Often mothers are anxious about giving birth. Then the obstetrician may try to calm down a nervous mother by understating the risk of complications with an ordinary delivery.

The obstetrician's possibility to persuade mothers to have vaginal deliveries rather than Caesarean sections is likely to depend on the mothers' level of education. When the mother has compulsory school education, the obstetrician can be more persuasive than for example when parents have university education. Expert mothers are likely to be difficult to persuade[6]. The implication is the same as from statistical discrimination theory: we expect expert parents to have a higher rate of Caesarean section than non-expert parents.

2.3 Diagnostic technology and reduction in clinical uncertainty

To distinguish between "statistical discrimination" and "agency discrimination", we investigated the influence of new diagnostic technology. There has been a rapid development in diagnostic technology in maternity care during the last decades. These advances have improved foetal monitoring both before and during delivery (for an overview of different technologies see: Norwegian Society for Gynaecology and Obstetrics, 2008). We focussed on four diagnostic tools that we assessed to be important in obstetrics, and that have been introduced at different times in maternity units during the 39 years that we have data for (Norwegian Society for Gynaecology and Obstetrics, 2008; Norwegian Institute of Public Health, 2007). 2-dimensional ultrasound was introduced early in the period, and is used to check foetal circulation and anatomy, both before and during the delivery. Cardiotocography, ST waveform analysis (STAN) and foetal blood analyses were introduced later in the period. These technologies are used to

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[5] For example, The Norwegian System of Compensation to Patients has documented cases where a Caesarean section should have been done rather than an ordinary delivery (The Norwegian System of Compensation to Patients, 2008).

[6] This also applies when mothers do not want to have a Caesarean section. For example, some mothers wish to be in control of their birth, or they wish to avoid a medical procedures. In these cases it may be difficult to persuade a mother to have a Caesarean section even though it is indicated on the basis of risk factors.

register foetal distress, a condition that can lead to lack of oxygen, and for which Caesarean section may be indicated.

Use of diagnostic technology has reduced clinical uncertainty, so that the obstetrician is less dependent on judgment and interpretation of information from the mother for assessing whether the delivery is progressing without complications. According to statistical discrimination theory, better diagnostic technology should lead to smaller differences in Caesarean section rates between experts and non-experts.

According to agency theory, obstetricians have to take the interests of the hospital into account and keep the rate of Caesarean section low. In principle, new information could enhance patients’ control over their physician. We believe that this is not very likely. The reason is that interpretation of test results requires a great deal of medical competence and experience. The results may be difficult to interpret, conflicting test results must often be assessed in relation to each other, and there may be little time to loose from when test results are available to when the obstetrician has to decide which type of delivery is most appropriate (Rosén et al., 2004; Williams and Arulkumaran, 2004).

A woman who is about to give birth has neither the mental state (she may be in pain, or may have been given a general anaesthetic), nor the medical knowledge to interpret her test results. For example, an understanding of the anatomy and physiology of the heart is needed in order to interpret the results of cardiography. Signs that something is wrong are based on a deviation from “a baseline fetal heart rate frequency between 110-150 beats per minute, presence of periodic accelerations, a normal heart rate variability between 5-25 beats per minute and the absence of decelerations” (Rooth et al., 1987; Van Geijn, 1998). The interpretation of foetal blood analyses is based on the physiology of the blood and respiration. A pH value greater than 7.25 indicates that the birth is proceeding normally (National Collaborating Centre for Women’s and Children’s Health, 2007). A pH value under 7.20 is a sign of acidosis, which is an indication to speed up the birth. ST waveform analysis is used in the case of high-risk births. Deviation from normal progression is assessed, among other things, on the basis of T/QRS gradient in the electrocardiogram of the foetus. This is complicated technology that requires advanced skills (Amer-Wahlin et al., 2007; Luzietti et al., 1999).

Internationally, regular training of personnel who use cardiotocography is recommended to prevent incorrect interpretation (Williams and Arulkumaran, 2004). In Norway, authorized education and certification, and continual follow up and training are required for people who use ST waveform analysis (Eikeland et al., 2008). Therefore, in our opinion, new technology is of no or limited help to the non-expert parent to control the advice or decisions of the obstetrician. New diagnostic technology is not likely to hinder obstetricians if they need to persuade non-expert parents. Therefore, if the data show that educational disparities persist after the introduction of new technology, we have empirical support for the agency theory. If the data show that differences in Caesarean section rates decrease over time, this supports statistical discrimination theory.

3. Materials and methods

3.1 The source of the data and the variables

The analyses were carried out on data from the Medical Birth Registry of Norway (MFR) for the period 1967 to 2005, for approximately 2.25 million births (www.fhi.no). Since 1967, all maternity units have had a duty to report all births to MFR (Irgens, 2000). On the registration form, the personal identification numbers of the child and the parents are recorded. This made it possible to merge the data from MFR with three data registers in Statistics Norway. The first register, the Norwegian Standard Classification of Education (Statistics Norway, 2000), contains information about the highest education for all Norwegians from 1967. The second register, the Health Personnel Register, contains data about medical specialty (Köber, 2004). Data from this register were used to identify obstetricians. The third register contains information about immigrant background for all first generation immigrants (Statistics Norway, 2009).

Information about use of diagnostic technology was collected by using a questionnaire that was sent to all senior consultants in every maternity unit in all the hospitals in the country[7]. The senior consultants were asked to record the year in which the unit began to use the following different types of technology regularly: 2-dimensional ultrasound, cardiotocography, ST waveform analysis (STAN) and foetal blood analyses. The response rate was high. 44 of 46 senior consultants replied. During the 39 years covered by our study, some maternity units have been closed down[8], so that it was not possible to send a questionnaire to them. Therefore, analyses with the technology variables could

[7] The survey was carried out by the Norwegian Medical Association's Research Institute.
[8] This corresponds well with the number of hospitals that have been closed down, since most hospitals have a maternity unit. From 1970 to 2000 the number of maternity units was reduced from 150 to 57 (Nilsen et al., 2001). The greatest reduction has been for units with less than 500 deliveries per year.

only be done for maternity units that have existed for the whole period 1967-2005. We have data for approximately 1.5 million births distributed among 44 maternity units.

3.2 The model specification

The data were analysed using binary logistic regression. A simplified way of writing the basic regression equation is:

$$\begin{aligned} \text{Log}[p_{imt}/(1- p_{imt})] = {} & \alpha_0 + \alpha_1 \text{ obstetrician}_{imt} + \alpha_2 \text{ midwife}_{imt} + \alpha_3 \text{ doctor}_{imt} \\ & + \alpha_4 \text{ university/college}_{imt} + \alpha_5 \text{ upper secondary school}_{imt} \\ & + \beta \text{ medical control variables}_{imt} \\ & + \lambda \text{ maternity unit control variables}_{mt} + \gamma \text{ year}_t + \varepsilon_{im} \qquad (1) \end{aligned}$$

where the subscript i denotes the mother, m denotes the maternity unit and t denotes year, and p_{imt} denotes the probability that the mother will give birth by means of a Caesarean section. Year is a continuous variable starting in 1967 ($\text{Year}_{1967}=0$) and ending in 2005 ($\text{Year}_{2005}=38$). In some specifications, we used fixed effects for individual years. All models are estimated by multilevel logistic regression to take into account the clustering of births into maternity unit years. The estimation procedure allows for non-zero error term correlations within individual maternity unit years.

We included five dummy variables for education in the regression. They measure educational level for the parent that has the highest education. The highest educational level is when one or both parents are obstetricians. They are regarded as super experts. The other variables that measure medical training, are whether one or both parents are midwives, or whether one or both parents are doctors. Whether one or both parents have university/college or upper secondary education is a measure of non-medical training. The lowest educational level is when the mother and father have only compulsory school education (= the reference category). They are non-experts, and are expected to have the lowest probability to have a Caesarean section. The probability for mothers in the other educational levels to have a Caesarean section is expected to fall as educational level falls.

Important control variables are characteristics of the health status of the mother and child[9] (Table 1) (Epstein and Nicholson, 2009; Gregory et al., 2002; Henry et al., 1995; Kolås et al., 2003; Norwegian Institute of Public Health, 2008). Older mothers have a Caesarean section more often than younger mothers, and small and large babies are more often delivered by Caesarean section than babies of average weight. Measures of health status of the mother which are likely to increase the probability for a Caesarean section are: whether the mother has asthma, diabetes, epilepsy, heart disease, chronic hypertension, chronic kidney failure, rheumatoid arthritis, if preeclampsia is a complication and bleeding during pregnancy. The probability for a Caesarean section also increases if the foetus has an abnormal presentation, if the birth is a multiple birth, and if the mother has previously had a Caesarean section. Non-western immigrants often come from countries where it is more common to have a Caesarean section than in Norway. These mothers can therefore have a higher rate of Caesarean section than Norwegian mothers (Vangen et al., 2000).

In all the estimations in Tables 3 and 5, we include all the educational variables and control variables. In addition, we present several other specifications of Equation 1. There are two main differences between them[10].

The first main difference is whether the maternity units are included as fixed effects or not. In Table 3 Columns I, II and III, two variables are included that reflect the obstetric competence of the maternity unit directly in the regression: the number of births in total per year, and the number of Caesarean sections per year. A large maternity unit will have more experience and competence to deal with complicated deliveries than a small unit. This has two effects. On the one hand, units with a high level of competence can carry out more complicated deliveries as normal deliveries instead of by Caesarean section. The result can be that there are relatively fewer Caesarean sections in large units than in small units (Lin et al., 2004; Lin and Xirasagar, 2004). This is measured by the variable number of births, which is therefore expected to be negative. But on the other hand, large units will have more referrals for complicated deliveries, which can lead to relatively more Caesarean sections (Liu et al., 2007). This is measured by the variable number of Caesarean sections which is therefore expected to be positive. In Table 3, Columns IV and V, the effects of the competence and experience of the maternity unit are not estimated directly. Here, the maternity units are included as fixed effects to control for unobserved heterogeneity between the maternity units.

[9] Several of the medical conditions mentioned below are correlated with slow or no progress in labour or signs of foetal distress. A Caesarean section can then be indicated to prevent damage to the child.
[10] Some other minor differences in the specifications are described in the results section.

The second main difference is whether an additive model is specified or not. In Table 3, Columns I, II and IV, and in Table 5 Columns I-III, we have estimated additive models. Here, the regression coefficients for the educational level variables show the mean effects for the whole period 1967-2005. However, we also wished to study how the effects of educational level changed over time, and the effect of introducing the use of new technology in the maternity units. Therefore, we specified two new regressions, one of them with an interaction term between each educational level variable and year (linear) (Equation 2), the other with an interaction term between each educational level variable and technology (Equation 3).

$$\begin{aligned} \text{Log}[p_{imt}/(1-p_{imt})] = {} & \alpha_0 + \alpha_1 \text{ obstetrician}_{imt} + \alpha_2 \text{ midwife}_{imt} + \alpha_3 \text{doctor}_{imt} \\ & + \alpha_4 \text{ university/college}_{imt} + \alpha_5 \text{ upper secondary school}_{imt} \\ & + \beta \text{ medical control variables}_{imt} \\ & + \lambda \text{ maternity unit control variables}_{mt} + \gamma \text{ year}_t \\ & + \alpha_6 \text{ obstetrician}_{imt} \cdot \text{year}_t + \alpha_7 \text{ midwife}_{imt} \cdot \text{year}_t \\ & + \alpha_8 \text{ doctor}_{imt} \cdot \text{year}_t + \alpha_9 \text{ university/college}_{imt} \cdot \text{year}_t \\ & + \alpha_{10} \text{ upper secondary school}_{imt} \cdot \text{year}_t + \varepsilon_{imt} \end{aligned} \tag{2}$$

$$\begin{aligned} \text{Log}[p_{imt}/(1-p_{imt})]) = {} & \alpha_0 + \alpha_1 \text{ obstetrician}_{imt} + \alpha_2 \text{ midwife}_{imt} + \alpha_3 \text{ doctor}_{imt} \\ & + \alpha_4 \text{ university/college}_{imt} + \alpha_5 \text{ upper secondary school}_{imt} \\ & + \beta \text{ medical control variables}_{imt} \\ & + \lambda \text{ maternity unit control variables}_{mt} + \gamma \text{ year}_t + \tau \text{ technology}_{mt} \\ & + \alpha_6 \text{ obstetrician}_{imt} \cdot \text{technolgy}_{mt} + \alpha_7 \text{ midwife}_{imt} \cdot \text{technology}_{mt} \\ & + \alpha_8 \text{ doctor}_{imt} \cdot \text{technology}_{mt} \\ & + \alpha_9 \text{ university/college}_{imt} \cdot \text{technology}_{mt} \\ & + \alpha_{10} \text{ upper secondary school}_{imt} \cdot \text{technology}_{mt} \end{aligned} \tag{3}$$

For the latter specification, we used an additive index, which was constructed from each of the four technology variables[11]. The index has values from 0 (no technology is used)

[11] We also estimated an interaction model between the five educational level variables and the four technology variables, which resulted in 15 regression coefficients for all the interaction terms. We have chosen to present the results from the estimation of the technology index, since the result is then easier to present and to interpret. The signs of the 15 regression coefficients mainly correspond with the signs of the interaction terms in Equation 3.

to 4 (all four types of technology are used). If diagnostic technology reduces clinical uncertainty, we would expect the effects of the interaction terms to be negative.

3.3 The agency model – an additional test with data over a limited period of time

A direct measure of the pressure obstetricians experience to ration the number of Caesarean deliveries is the hospital's financial status. For each hospital, information is available for hospital revenue per bed, for a limited period (1976-1999) [12]. We have used this information to carry out an alternative test of the agency model. According to the theory, we expect that low revenue per bed for a hospital means that the obstetricians carry out fewer Caesarean sections for non-expert mothers than for expert mothers. The reason for this is the same as previously: non-expert mothers are likely to be easier to persuade than expert mothers. This can be tested using the following regression model:

$$\begin{aligned} \text{Log}[p_{imt}/(1-p_{imt})] = {} & \alpha_0 + \alpha_1 \text{ medical}_{imt} + \alpha_2 \text{ university/college}_{imt} \\ & + \alpha_3 \text{ upper secondary school}_{imt} + \beta \text{ medical control variables}_{imt} \\ & + \lambda_{mt} + \gamma \text{ year}_t + \delta \text{ hospital revenue per bed}_{mt} \\ & + \alpha_4 \text{ medical}_{imt} \cdot \text{hospital revenue per bed}_{mt} \\ & + \alpha_5 \text{ university/college}_{imt} \cdot \text{hospital revenue per bed}_{mt} \\ & + \alpha_6 \text{ upper secondary school}_{imt} \cdot \text{hospital revenue per bed}_{mt} + \varepsilon_{imt} \end{aligned} \quad (4)$$

The variable *medical* includes the parent whose highest qualification is either obstetrician, doctor or midwife[13]. The variable that measures hospital revenue per bed was transformed into natural logarithms, as this gives the elasticity of the odds of having a Caesarean section with respect to hospital revenue per bed. The model was estimated with fixed effects for hospital and year. If the regression coefficients α_4 to α_6 are almost equal to 0, the agency model is weakened. Variation in the rate of Caesarean section between educational groups is then not influenced by the hospitals' financial situation.

[12] We do not have corresponding data for the years before 1976. Data for the years after 1999 are not comparable with data for previous years because of a hospital reform, which involved changes to the accounting system.

[13] We constructed this variable because the number of observations for each educational group was too small for reliable statistical testing over the relatively short period of time.

4. Results

4.1 Descriptive statistics

The percentage of Caesarean sections increased from 1.8 per cent in 1967 to 16.5 per cent in 2005 (Table 1). There has also been a marked increase in parents' educational level. The percentage of parents where either the mother or the father or both have a university/college education increased from 17.4 per cent in 1967 to 55.6 per cent in 2005. This was followed by a corresponding decrease in the percentage where both of the parents have compulsory school education only. The percentage of parents where one or both parents had a medical training also increased quite a lot during the study period. For example, the percentage of parents where either the mother or the father or both had medical training was only 0.52 per cent (n=346) in 1967. The corresponding figure in 2005 was 1.90 per cent (n=1072). The odds for Caesarean section have increased for all educational groups from 1967 to 2005 (Figure 1). The increase was greatest before 1988. After this the increase tailed off. For all years the odds for Caesarean section are highest for midwives and doctors. The differences between those with upper secondary school and compulsory school education are small[14].

There has been a clear increase in several of the risk factors for Caesarean section (Table 1). In particular, the age of the mother has increased. For example, the proportion of women aged 31-40 years of age increased from 20.5 per cent in 1967 to 43.2 per cent in 2005. Also, the weight of babies has increased. The percentage of babies weighing 4 kilograms or more increased from 16.5 per cent in 1967 to 19.7 per cent in 2005. There has also been an increase in the proportion of foetuses with an abnormal presentation, and the proportion of mothers with preeclampsia.

In 1967, only 0.2 per cent of mothers were non-western immigrants, but this increased to 12.7 per cent in 2005. The proportion of births during weekends has decreased slightly. Both the number of births and the number of Caesarean deliveries has increased per maternity unit from 1967 to 2005. This has occurred because some small hospitals, and thus some maternity units, have been amalgamated to form larger units (Nilsen et al., 2001).

[14] The odds varied a lot from one year to the next for obstetricians. This variation is likely to reflect random fluctuations rather than any systematic differences in the rate of Caesarean section from one year to the other. The reason is the low number of obstetricians who have Caesarean sections during a year. We therefore decided not to include obstetricians in Figure 1.

The use of diagnostic technology has increased considerably from 1967 to 2005. By the end of the study period 2-dimensional ultrasound and cardiotocography were in use in all maternity units. Foetal blood analyses was the type of technology that was used the least in 2005. About 70 per cent of the maternity units had this type of technology.

In Table 2 we present the distribution of some important explanatory variables according to the educational status of the mother. In particular, there are large variations according to the age of the mother, and whether the mother has a western background or not. Mothers with high education are older than those with low education when they give birth. For example, 34 percent of obstetricians are over 35 years old, but the proportion is only 6.9 percent for those with compulsory school education. 5.2 percent of those who have compulsory school education are non-western immigrants. The corresponding proportion for those with university/college education is 2.5 percent. For western immigrants, the pattern is the opposite. The proportion for those with high education is higher than for those with low education.

Birthweight is also unevenly distributed according to the educational status of the mother (Table 2). 5.4 percent of mothers with compulsory school education give birth to children with low birthweight (< 2500 g). The corresponding proportion for mothers with university/college education is 3.8 percent. The pattern for large babies (> 3500 g) is the opposite. Mothers with high education give birth to the largest babies. In Table 2 we have also included some health variables for the mother. The proportion of mothers with epilepsy is higher for mothers with compulsory school education than for mothers with university/college education. This pattern is the opposite for mothers with chronic hypertension and chronic kidney failure. There are small differences between educational groups for diabetes.

4.2 Do expert parents have more Caesarean sections than others?

In Table 3, Columns I, II and IV, we present the results for the additive effects of education. Parents with compulsory school education only (the reference group) have the lowest rate of Caesarean section. Parents with upper secondary school education and with university/college education have a higher rate, doctors and midwives have even higher rates, and obstetricians have the highest rate of Caesarean section. For example, the odds ratio for having a Caesarean section is 1.64[15] for obstetricians and 1.09 for parents with upper secondary school education.

All the additive effects for each of the educational groups are statistically significantly different from the reference group (compulsory school education) at conventional levels ($p<0.05$). In Table 4, we also present significance tests for pairwise comparisons of the educational groups. Midwives and doctors do not differ significantly ($p=0.68$). Otherwise, the tests demonstrate that the educational groups have different rates of Caesarean section. These results support the hypothesis that the probability for Caesarean section falls as medical competence falls. Patients who can be regarded as super experts are more likely to have a Caesarean section.

In Model I, *year* is assumed to have a linear effect on Caesarean sections, while Model II allows for non-linear year effects. The effects of education are only marginally lower in the latter specification. Model IV differs from Models I and II, as it includes fixed effects for hospitals. Again, model specifications appear to have little bearing on the estimates of the educational variables.

4.3 Do disparities between expert and non-expert parents in rates of Caesarean section decrease over time?

In Table 3, Columns III and V we present the results where we have included interaction terms for *education* and *year*. While the regressions in Columns I, II and IV give mean effects for the whole period, in the interaction models we can study developments over time. *Year* is coded as zero for the first year. This implies that we can assess disparities in 1967 by ignoring the interaction terms, and study the direct effects of the education variables in Models III and V. Since these estimates are much higher than the mean effects obtained in Models I, II and IV, we see that the disparities were highest in 1967. For example, in 1967 obstetricians were 2.3 times more likely to have a Caesarean section than mothers with compulsory school education only.

The interaction terms are negative, which means that the educational disparities in the rates for Caesarean section decline over time. Note however that the sizes of the interaction terms for obstetricians are relatively low and not statistically significant at conventional levels, both in Model III and Model V. The speed of convergence is highest

[15] This follows from exponentiatin 0.494.

for midwives and doctors, and lowest for parents with upper secondary school education (Table 3, Columns III and V and Table 4[16])

To illustrate the development over time, we compared the odds ratios for 1967 and 2005 (Figure 2). The odds ratios are: for obstetricians 2.28 (1967) and 1.21 (2005); for midwives 2.48 (1967) and 0.85 (2005); for doctors 2.23 (1967) and 0.85 (2005); for people with university/college education 1.75 (1967) and 0.79 (2005); for people with upper secondary school education 1.20 (1967) and 0.98 (2005). With the possible exception of mothers who are obstetricians, these numbers indicate that disparities have been eliminated during the 39-year period (Figure 2)[17].

4.4 Does more advanced diagnostic technology lead to more Caesarean sections?

We then went on to examine the impact of improved diagnostic technology. The analyses shown in Table 3, Columns I-V were carried out on the whole population of mothers for the period 1967-2005. The analyses with the technology variables had to be carried out on a sample with fewer observations (see the explanation given in Section 3.1). In order to check whether the sample with the technology variable differed from the whole population, we re-estimated the regression models in Table 3, Columns I and III using the smaller sample. These results are presented in Table 3, Columns VI and VII. The results are very similar to the results based on the complete set of observations (Columns I and III), which indicates that the sample is not biased. This is also supported by the descriptive results in Table 1, which show that both the percentage distribution and the mean values for the variables in the sub-sample and in the main sample are almost identical.

In Table 5, Columns I and II, we assess the impact of the technology variables. In particular, use of 2-dimensional ultrasound and cardiotocography increase the probability for Caesarean section. The odds ratio for 2-dimensional ultrasound is 1.73 and for cardiotocography 1.75. The additive technology index also has a statistically significant positive effect on the probability (Column III).

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[16] In Table 4, we present significance tests for pairwise comparisons of the regression coefficients for the interaction terms. The coefficients for midwife · year and doctor · year were not statistically significantly different from each other at conventional levels. However, each of these two coefficients were statistically significantly different from the interaction terms for upper secondary school · year.

[17] An odds ratio of 1 signifies that there is no educational disparity, and an odds ratio of less than 1 implies that parents with compulsory school education have a higher probability of having a Caesarean section.

In Table 5, Model I we include a linear time trend. The regression coefficient for year is small in absolute value, and it is not statistically significant at conventional levels. This result suggests that the introduction of new technologies captures much of the effect that we ascribed to year in Table 3. This shows that new technology is part of the explanation for the increasing rate of Caesarean section in Norway over time. The size of the regression coefficients for the educational variables in Table 5 Columns I and II are similar to those in Table 3 Columns I, II and IV. Also the results from the significance tests for pairwise comparisons of the educational groups in Table 6 show very much the same pattern as those in Table 4. When the technology variables are included in the regression equations as additive factors, the educational disparities persist.

4.5 Does more advanced diagnostic technology lead to fewer disparities in rates of Caesarean section between expert and non-expert parents?

In Table 5, Column IV we present the results where we have included interaction terms for education and technology. The mean value of the technology index for 1967 is zero (Table 1). This implies that we can assess disparities in 1967 by ignoring the interaction terms, and inspect the direct effects of the education variables in Model IV. With the exception of obstetricians, we observe that these estimates are much higher than the mean effects obtained in Models I-III. Accordingly, the disparities were highest in 1967, a finding that is consistent with the results from the previous analyses (Table 3, Columns III and V).

The mean value of the technology index for 2005 is 3.45 (Table 1). By inserting this mean value into Model IV, we can calculate the disparities at the end of the period. We get the following odds ratios: obstetricians 1.73; midwives 1.06; doctors 1.01; university/college 0.92; upper secondary school 1.01. Similar to the results in Table 3, Columns III and V, we find that the educational disparities have been reduced from 1967 to 2005 (Figure 3). The speed of convergence is highest for midwives and doctors, and lowest for parents with upper secondary school education (Table 5, Column IV and Table 6[18]).

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[18] In Table 6, we present significance tests for pairwise comparisons of the regression coefficients for the interaction terms. The coefficients for midwife · technology and doctor · technology were not statistically significantly different from each other at conventional levels. However, each of these two coefficients were statistically significantly different from the interaction terms for upper secondary school · technology.

4.6 Does our additional test support the agency model?

In Table 7 we present the results from our additional test of the agency model. The elasticity for the odds of having a Caesarean section with respect to hospital revenue per bed was 0.24. This is as expected - more Caesarean sections are carried out when hospital revenue per bed increases (Column I). This effect is also fairly constant over time. From 1988 and later, when the Caesarean rate levelled out, the elasticity of the odds of having a Caesarean section with respect to hospital revenue per bed is 0.24 (Table 7 Column IV). The corresponding elasticity for the period before 1988 is 0.29 (Column III). None of the interaction terms between educational groups and hospital revenue per bed were significant at conventional levels ($p<0.05$) (Column II). The logit coefficients were also small. This weakens the agency model. Variation in the Caesarean rate between educational groups is not influenced by the financial situation of the hospital.

4.7 Effects of the control variables

The estimates for the control variables are similar in Tables 3 and 5. The likelihood of a Caesarean section increases with mothers' age. Weight of the child has a non-linear impact. Caesarean delivery is most prevalent when the baby is large (more than 4.5 kilograms) and small (less than 2.5 kilograms). Previous Caesarean section, preeclampsia and abnormal presentation increase the likelihood of Caesarean section, while single baby birth decreases the likelihood of Caesarean section. Since many Caesarean sections can be planned ahead, surgical births are less likely to take place during weekends. Both non-western and western immigrants are more likely to have a Caesarean section than native Norwegian mothers. Large maternity units, ie. units with a large number of births, have a lower proportion of Caesarean section.

5. Discussion

5.1 Interpretation and alternative explanations

The focus of this study was to examine whether a publicly financed health care system discriminates against people with low education. We compare services provided to expert and non-expert patients to get a better grasp of the information problem involved. The statistical discrimination hypothesis suggests that patients with high education communicate better with their doctor, and therefore they are likely to receive better treatment, than patients with low education. The hypothesis of agency discrimination suggests that doctors ration health care services, and more so when they treat patients with low education.

Few studies have tested the statistical discrimination hypothesis (Balsa et al., 2005; Lutfey and Ketcham, 2005; McGuire et al., 2008). We believe that the current test is a strong one. First, we tested the statistical discrimination hypothesis against a competing hypothesis derived from agency theory. Second, knowledge and information were measured directly by distinguishing between super-expert parents (obstetricians), expert parents (doctors and midwives) and non-expert parents. Third, we explicitly tested whether disparities are reduced as a consequence of better diagnostic tests. Fourth, our dataset is sufficiently large to perform the statistical testing. Data covers the entire population of mothers who gave birth over a 39-year period. Hospitals started to use different technologies at different times, and this provides sufficient variation for empirical testing.

It is also necessary to discuss alternative explanations for our findings. One factor to consider is the impact that mother's preferences may have on Caesarean section rates. It may be that the preferences for Caesarean section of mothers with low education gradually get stronger over time. In that way educational disparities in Caesarean section rates decrease – similar to what we observe in our data. Such a possibility cannot be excluded, but is not very likely for the following reasons. First, the available evidence shows that the proportion of Caesarean sections that are carried out as a result of pressure from mothers, even if a Caesarean delivery is not medically indicated, is low. Extensive literature reviews conclude that the proportion of Caesarean sections that are carried out on the basis of the mother's request is well under five percent in several studies (McCourt et al., 2007; Gamble et al., 2007; Lavender et al., 2006; Hildingsson et al., 2002). Second, if preferences are met, this is a phenomenon found particularly among resourceful women. Women with high education are more able to promote their wishes about their preferred method of delivery than women with low education (for a review of the relevant literature see: Bailit et al., 2004; Marx et al., 2001; Young, 2006; Weaver et al., 2007). In this way, educational disparities in Caesarean section rates would be maintained, and would not decrease over time. To our knowledge, existing studies do not display a convergence of preferences among mothers with high and low education.

One exception that can probably be explained on the basis preferences, is the pattern of delivery for obstetricians. They are super experts and continue to have higher rates of Caesarean section than midwives, doctors and mothers in other educational groups throughout the whole period (Tables 3, 5)[19]. This may reflect the obstetrician's own personal preferences for Caesarean section. This is supported by studies that show that obstetricians would favour a Caesarean section for themselves or for their partners even in an uncomplicated pregnancy (for a review see: Habiba et al., 2006). They prefer Caesarean section because of convenience, or because they are frightened of an ordinary delivery (Land et al., 2001; Savage and Francome, 2007). They also believe that Caesarean section is safer for both the mother and the child, even in cases for which the scientific evidence is weak. Unlike other mothers, obstetricians are in a much stronger position to have their preferences met, i.e. to get the type of delivery they desire. This will be the case even if the results from diagnostic tests show that a Caesarean section is not medically indicated. That obstetricians have more Caesarean sections than is medically indicated results in little extra cost for the hospital. Therefore, obstetricians who carry out Caesarean sections for this group of mothers have no reason to behave as the hospital's agent for their own colleagues. Since the high Caesarean rate for obstetricians is governed more by preferences than by medical indications, there is therefore no basis for claiming that the service for mothers in all other educational groups is rationed.

Another explanation, which is also relevant to discuss, is defensive medicine. It is possible that obstetricians carry out more Caesarean sections than there are medical indications for because of concern about malpractice liability. This issue has been studied particularly in the USA. Most of the studies from the USA have found a positive relationship between malpractice claims risk and the rate of Caesarean delivery (for a review of the literature see: Tussing and Wojtowycz, 1997; Symon, 2000; Brown, 2007). However, this issue is less relevant in Norway. We do not believe that our results have been influenced by defensive medicine. There are three reasons for this.

First, the parents who have the most resources to complain and to take care of their interests are those with high education. If obstetricians practised defensive medicine, we would expect the Caesarean rate to be higher for those with high education than for those with low education. However, at the end of the period there was no difference between

[19] This is in accordance with studies from other countries. For example, in one survey from the USA, 46 percent of obstetricians reported that they would prefer a Caesarean section when they gave birth (Al-Mufti et al., 1997). The corresponding figure in a survey among female obstetricians in London was 31 percent (Gabbe and Holzman, 2001). These figures are well above the national figures for rates of Caesarean section in both the USA and Great Britain.

the education groups (with the exception of for obstetricians). We would not have expected this if doctors took account of which patient groups were most likely to complain.

Second, obstetricians have no personal responsibility for compensation, either for the mother or the hospital, if something goes wrong with the delivery (Jørstad et al., 2007). In Norway, there is a public body (the Norwegian System of Compensation to Patients), which is responsible for compensation for all types of incorrect medical treatment (http://www.npe.no/). Therefore, obstetricians can recommend the type of delivery on the basis of medical criteria, without taking account of the risk of claims for compensation against themselves in the case of an adverse event.

Third, in Norway, the risk for a doctor or a maternity unit to be involved in a case of complaint is low. This reduces the need for defensive medicine. For example, during the period 1988-2006, the Norwegian System of Compensation to Patients paid compensation for only 374 cases involving mothers or babies during delivery (Jørstad et al., 2007). This represents about 20 cases per year, which is a small number, taking into consideration the fact that about 60 000 babies are born in Norway each year. The Norwegian System of Compensation to Patients assesses the case for compensation and the amount of compensation. The Norwegian Board of Health Supervision assesses the consequences of the event for the professional practice of the doctor. During the period 1993-2000, the Norwegian Board of Health Supervision withdrew the authorization of two obstetricians, and 37 doctors were given a warning for having acted in a way that was not in accordance with sound practice (Holmboe and Molne, 2001). These figures are also small. It may be that the amount of unsound treatment in maternity care is greater than the figures indicate. But underreporting reduces the risk of doctors and maternity units being involved in a case of complaint.

5.2 Sufficient number of control variables

One of the strengths of our data set is that it contains many relevant medical control variables, both for the mother and the child, and these variables are available at the individual level as far back as 1967. The effects of all the medical control variables are also as expected, and similar to the effects that have been found in other studies from Norway (Kolås et al., 2003; Tollånes et al., 2007). The effects are also similar to those that have been found in comparable international studies (for example see: Notzon et al., 1994; Leitch and Walker, 1998; Odlind et al., 2003).

We cannot exclude the possibility that unobserved conditions associated with the mother’s health can have biased our results. However, we have data for several relevant variables for mother’s health status. An important control variable in our analysis is the baby’s birthweight. Epidemiological studies have shown that birthweight is strongly correlated with the health status of the mother (Emanuel et al., 1992; Kramer, 1987). If there is still unobserved heterogeneity in our data associated with the health of the mother, our dummy variables for birthweight will probably catch some of this. This will help to reduce any bias of our coefficients.

Another factor to consider is the lack of information about access to prenatal care. Several studies have shown that good access to prenatal care prevents complications during delivery and helps to improve infant health (Arima et al., 2009; Currie and Gruber, 1996; Olds et al., 1986). This is also highlighted in WHO’s guidelines and recommendations for maternal care (Carroli et al., 2001; Villar et al., 1998). Since the 1960s, all pregnant women in Norway have been offered free prenatal check-ups, and nearly all women have taken advantage of this offer (Blondel et al., 1985; Miller, 1993). For example, in the middle of the 1990s, only 0.1% of pregnant women in Norway had not attended prenatal check-ups (Backe, 2001, Delvaux et al., 1999). We believe that, since access to prenatal care is so universal, also for mothers with low education, it is unlikely that the lack of information about prenatal visits has lead to any significant bias in the results.

Another issue is that we lack control variables for the mental health status of the mother. The most relevant psychological factor is fear of childbirth (Saisto and Halmesmäki, 2003). Serious fear of childbirth occurs in 6-10 % of pregnant women. The most important reason is a negative experience (pain) during a previous birth. Fear of childbirth is treated in several different ways: cognitive therapy and psychotherapy are used most often (Saisto and Halmesmäki, 2003; Nerum et al., 2006). A Caesarean delivery is an alternative in some cases, but is seldom used (Gamble and Creedy, 2000; Heimstad et al., 2006). This means that it is unlikely that lack of control for fear of childhood has lead to significant bias of our results.

The non-medical control variables also have the expected effects. For example, most Caesarean sections are done on weekdays, which is more convenient for the staff and cost saving for the maternity unit. Our results also give support to the fact that larger maternity units have more complicated deliveries which lead to more Caesarean sections (Liu et al., 2007). Our results are also consistent with another Norwegian study, which has found that midwives and doctors have a higher rate of Caesarean section than the rest of the population (Lehmann et al., 2007). One interesting finding is that non-western immigrant mothers are more likely to have a Caesarean section than Norwegian mothers. Two explanations have been suggested (Vangen et al., 2000; Kramer et al., 2000; Leone et al., 2008): First, several of the medical risk factors for a Caesarean section are more prevalent among immigrant mothers and their children than among Norwegian mothers and their children. For example, one risk factor – feto-pelvic disproportion – is 3-6 times higher among immigrants from south-east Asia than among Norwegian women (Vangen et al., 2000). Second, there are non-medical differences in opinions and cultures between immigrant mothers and Norwegian mothers about when a Caesarean section is necessary. Most of the immigrants come from countries where the rate of Caesarean section is higher than in Norway, and where mothers are more used to having a Caesarean section on request. Our results show that even after we have taken medical risk factors into account, immigrant mothers have a higher probability of having a Caesarean section than Norwegian mothers. This indicates that Norwegian obstetricians accept the wishes of immigrant mothers, and take their wishes into account when deciding on type of delivery.

5.3 Implications

Based on our empirical analyses and the above discussion, we believe that we have reason to claim that our findings support statistical discrimination theory, and not agency theory. However, we have two reservations. First, we assume that parents do not have the ability to interpret new diagnostic tests, so the obstetrician’s ability to exert influence remains stable in the presence of new technology. If this is not the case, the arguments in favour of statistical discrimination theory are weakened. Second, when more objective tests are available, colleagues are in a better position to assess the reasons for the decisions made by the individual obstetrician. Peer pressure could make it harder for obstetricians to keep hospital costs low by keeping the rate of Caesarean section low. Such an interpretation is probably more in line with agency theory than statistical discrimination theory.

However, if we accept that our analyses provide more support to statistical discrimination theory than to agency theory, an important implication of our findings is that communication between the doctor and the patient should be improved (Balsa et al., 2005). Doctors are encouraged to listen more to their patients, in particular those from lower educational groups (Stewart 1995). The current study suggests that better diagnostic technology reduces the importance of patient-physician communication. The obstetrician is less dependent on interpreting the mother's subjective assessment of how the birth is progressing. Since non-expert parents communicate less effectively than expert parents, they benefit the most from new technology. The proportion of the population with a high education has increased dramatically during the last 2-3 decades, particularly among young people (Lappegård, 1999). From a health policy point of view this is encouraging. More educated patients communicate better with the doctor than less educated patients. This improves the interaction between the patient and the doctor, which further leads to a more precise diagnosis and therefore better treatment.

The increase in the Caesarean rate slowed down from about 1988 and later (Figure 1). This is a trend that has been reported in all the Nordic countries, and from Great Britain and the USA (Bergsjø, 2007; Mayor, 2002; MacDorman et al., 2008). There is no satisfactory explanation for this trend. One possibility is that the authorities in these countries have become more aware of the cost to the health services and that hospital funding has been reduced with a consequent reduction in activity, including Caesarean sections. However, the trend in hospital budgets in Norway during the period of the study does not support this explanation. From 1980 until the mid 1990s, hospital revenue increased evenly by 1 percent per year. In other words, there was no indication of cost containment (Ministry of Health, 2002). From the mid 1990s, the increase was 3-4 percent per year. Therefore, the levelling off of the Caesarean rate from 1988 and later occurred despite the fact that hospital revenue increased. So other explanations must be sought. Since this trend is seen in several countries, explanatory mechanisms that are relevant for different countries must be sought.

This study was carried out in an homogenous population in which obstetricians have no private economic incentives to carry out more Caesarean sections than necessary. Caution must be used in generalizing the findings to other countries where maternity care is organized differently. This applies particularly to countries where many births take place in private clinics, in which the physicians/hospitals are reimbursed from private and public insurance for each delivery. Here, obstetricians will also often be remunerated in other ways than a fixed salary. For example, if obstetricians are remunerated on a fee-for-service basis, there can be an incentive to carry out a Caesarean section rather than a vaginal delivery (for a review see: Keeler and Brodie, 1993). This is supported by studies that have shown that doctors carry out more Caesarean sections when they generate more income per delivery than a vaginal delivery (Gruber et al., 1999; Stafford, 1990). Gruber and Owings (1996) have also shown that doctors can maintain their income by carrying out more Caesarean sections, which generate more income than a vaginal delivery, when the fertility rate decreases. Therefore, we cannot exclude the possibility that agency discrimination may play a greater role in countries with more privatized maternity care, for example the USA.

In conclusion, we find that expert parents have a higher rate of Caesarean section than non-expert parents. In the case of complications, the expert mother is in a better position to communicate her symptoms and her preferences for type of delivery than the non-expert mother. The introduction of new diagnostic technology reduces clinical uncertainty about diagnosis and which type of delivery to choose. Since non-expert parents communicate less effectively than expert parents, they benefit the most from the new technology.

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Table 1
Descriptive statistics

Variables	1967 (n)	1967 Percent/ Mean [1]	Whole material (n)	Whole material Percent/ Mean [1]	2005 (n)	2005 Percent/ Mean [1]	Material with technology data (n)	Material with technology data Percent/ Mean [1]
Parents' highest education:								
obstetrician	66 323	0.01	2 249 602	0.03	56 421	0.03	1 575 764	0,03
midwife	66 323	0.12	2 249 602	0.16	56 421	0.21	1 575 764	0,16
doctor (excluding obstetricians)	66 323	0.39	2 249 602	0.92	56 421	1.66	1 575 764	0,91
university/college education [2]	61 254	17.37	2 116 503	36.57	48 163	55.56	1 489 226	37,51
upper secondary school education	61 254	58.33	2 116 503	50.82	48 163	35.82	1 489 226	50,73
compulsory school education	61 254	23.74	2 116 503	11.43	48 163	6.39	1 489 226	10,60
Mother's age:								
< 20 years	66 323	9.22	2 249 598	6.08	56 421	2.07	1 575 764	5,83
20-30 years	66 323	68.28	2 249 598	67.51	56 421	53.16	1 575 764	67,27
31-35 years	66 323	13.27	2 249 598	19.16	56 421	31.84	1 575 764	19,69
36-40 years	66 323	7.22	2 249 598	6.30	56 421	11.39	1 575 764	6,31
> 40 years	66 323	2.00	2 249 598	0.95	56 421	1.53	1 575 764	0,90
Birth weight:								
< 1000 g	66 134	0.20	2 244 993	0.27	56 302	0.37	1 574 343	0,26
1000-1499 g	66 134	0.45	2 244 993	0.48	56 302	0.51	1 574 343	0,46
1500-1999 g	66 134	0.95	2 244 993	0.98	56 302	1.16	1 574 343	0,97
2000-2499 g	66 134	2.84	2 244 993	2.76	56 302	2.82	1 574 343	2,78
2500-2999 g	66 134	11.77	2 244 993	10.85	56 302	10.71	1 574 343	10,75
3000-3499 g	66 134	32.91	2 244 993	31.19	56 302	30.12	1 574 343	30,78
3500-3999 g	66 134	34.34	2 244 993	34.73	56 302	34.56	1 574 343	34,75
4000-4499 g	66 134	13.50	2 244 993	15.17	56 302	15.84	1 574 343	15,50
>= 4500 g	66 134	3.04	2 244 993	3.58	56 302	3.91	1 574 343	3,74
Characteristics of the birth:								
Caesarean section	66 323	1.78	2 249 602	9.59	56 421	16.53	1 575 764	10,34
Caesarean section previously	-	-	2 249 602	4.62	56 421	8.44	1 575 764	5,19
abnormal presentation [3]	66 323	3.44	2 243 867	5.63	56 035	9.82	1 575 764	6,02
single baby birth	66 323	98.07	2 249 602	97.50	56 421	96.15	1 575 764	97,40
weekend [4]	66 323	26.96	2 249 602	25.01	56 421	25.52	1 575 764	24,87
Predisposing factors - mother:								
asthma	66 323	0.16	2 249 602	1.95	56 421	3.99	1 575 764	2,20
diabetes	66 323	0.11	2 249 602	0.31	56 421	0.75	1 575 764	0,30
epilepsy	66 323	0.22	2 249 602	0.55	56 421	0.74	1 575 764	0,57

Table 1 (continued)

Variables	1967 (n)	1967 Percent/ Mean [1]	Whole material (n)	Whole material Percent/ Mean [1]	2005 (n)	2005 Percent/ Mean [1]	Material with technology data (n)	Material with technology data Percent/ Mean [1]
heart disease	66 323	0.06	2 249 602	0.19	56 421	0.57	1 575 764	0,20
chronic hypertension	66 323	0.03	2 249 602	0.26	56 421	0.44	1 575 764	0,28
chronic kidney failure	66 323	0.03	2 249 602	0.13	56 421	0.35	1 575 764	0,14
rheumatoid arthritis	66 323	0.05	2 249 602	0.25	56 421	0.23	1 575 764	0,27
preeclampsia [5]	66 323	2.13	2 249 602	3.01	56 421	3.98	1 575 764	3,20
bleeding during pregnancy	66 323	1.63	2 249 602	2.29	56 421	4.20	1 575 764	2,47
Mother's immigrant background:								
non-western immigrant	66 323	0.21	2 249 602	4.08	56 421	12.69	1 575 764	4,02
western immigrant	66 323	2.05	2 249 602	2.30	56 421	2.89	1 575 764	2,15
Maternity unit - production:								
number of births	66 323	1314.75	2 233 880	1814.75	52 796	2513.26	1 575 764	2043,37
		(1096.75)		(1335.88)		(1716.12)		(1360.97)
number of Caesarean sections	66 323	21.27	2 233 880	181.42	52 796	387.67	1 575 764	206,70
		(23.85)		(189.38)		(255.71)		(191.48)
Maternity unit - technology:								
ultrasound	30 184	0	1 575 764	77.51	46 391	100.00	1 575 764	77.51
cardiotocography	30 184	0	1 575 764	80.05	46 391	100.00	1 575 764	80.05
ST waveform analysis	30 184	0	1 575 764	19.59	46 391	75.54	1 575 764	19.59
foetal blood analyses	30 184	0	1 575 764	32.51	46 391	70.29	1 575 764	32.51
technology index (0-4)	30 184	0	1 575 764	2.09	46 391	3.45	1 575 764	2.09
				(1.24)		(0.64)	1 575 764	(1.24)

[1] Mean value and standard deviation in brackets are given for: number of births, number of Caesarean sections and technology index
[2] Excluding obstetricians, midwives and doctors
[3] Including breech presentation, transverse presentation, abnormal cephalic presentation and other
[4] The birth was on a Saturday or a Sunday
[5] Including unspecified, mild and severe preeclampsia

Table 2

Distribution of selected independent variables according to mother's level of education[1]. Percent

		Mother's age	Immigrant background		Birth weight		Predisposing factors - mother			
Mother's highest education:	**n**	> 35 years	Non-western	Western	< 2500 g	>= 3500 g	Epilepsy	Chronic hypertension	Rheumatoid arthritis	Chronic kidney failure
Obstetrician	265	34,0		10,2		54,7	0		0	0
Midwife	3 695	21,6	1,4	5,1	4,6	58,2				
Doctor (excluding obstetricians)	7 260	19,4	4,5	8,9	4,2	57,8	0,4			
University/college education [2]	589 785	9,4	2,5	3,2	3,8	58,0	0,4	0,3	0,3	0,2
Upper secondary school education	985 350	6,0	1,9	1,4	4,3	54,2	0,5	0,2	0,2	0,1
Compulsory school education	592 645	6,9	5,2	1,1	5,4	48,8	0,7	0,2	0,3	0,1

[1] Empty cells: figures are not reported due to low number of individuals in these groups

[2] Excluding obstetricians, midwives and doctors

Diabetes
0,5
0,3
0,3
0,3

Table 3

Effects of parents' highest level of education on Caesarean sections in Norway 1967-2005.

Data from the Medical Birth Registry. Logistic regressions with random effects. Multilevel analysis. T-values in parentheses

	Without fixed effects for maternity unit			With fixed effects for maternity unit		Without fixed effects for maternity unit [3]	
	Regression coefficients [1] I	Regression coefficients [2] II	Regression coefficients [1] III	Regression coefficients [1] IV	Regression coefficients [1] V	Regression coefficients [1] VI	Regression coefficients [1] VII
Intercept	-2.671 *	-4.291 *	-2.806 *	-5.119	-5.313	1.700 *	1.425 *
	(11.5)	(21.1)	(12.3)	(2.82)	(2.95)	(11.6)	(9.78)
Time variable:							
year	0.019 *		0.029 *	0.029 *	0.039 *	0.020 *	0.029 *
	(52.8)		(36.1)	(106.9)	(51.4)	(47.7)	(31.3)
Parents' highest education: [4]							
obstetrician	0.494 *	0.381 *	0.823 *	0.517 *	0.803 *	0.536 *	0.994 *
	(4.01)	(3.03)	(2.85)	(4.22)	(2.81)	(3.61)	(2.86)
midwife	0.297 *	0.238 *	0.907 *	0.292 *	0.873 *	0.343 *	0.905 *
	(5.37)	(4.21)	(6.98)	(5.28)	(6.77)	(5.29)	(5.67)
doctor (excluding obstetricians)	0.226 *	0.182 *	0.801 *	0.237 *	0.757 *	0.201 *	0.875 *
	(9.09)	(7.19)	(12.5)	(9.53)	(11.8)	(6.72)	(11.05)
university/college education [5]	0.089 *	0.043 *	0.558 *	0.092 *	0.533 *	0.079 *	0.573 *
	(9.22)	(4.38)	(26.4)	(9.51)	(25.3)	(7.00)	(22.4)
upper secondary school education	0.086 *	0.053 *	0.178 *	0.085 *	0.183 *	0.070 *	0.153 *
	(9.21)	(5.59)	(9.08)	(9.10)	(9.40)	(6.45)	(6.45)
Interaction terms:							
obstetrician · year			-0.016		-0.014		-0.022
			(1.28)		(1.14)		(1.43)
midwife · year			-0.028 *		-0.026 *		-0.025 *
			(5.32)		(5.14)		(3.97)
doctor · year			-0.025 *		-0.023 *		-0.028 *
			(10.3)		(9.47)		(9.53)
university/college · year			-0.020 *		-0.019 *		-0.021 *
			(23.6)		(22.5)		(20.4)
upper secondary school · year			-0.005 *		-0.005 *		-0.004 *
			(6.04)		(6.44)		(4.50)
Mother's age: [6]							
< 20 years	-0.072 *	-0.047 *	-0.050 *	-0.065 *	-0.045 *	-0.070 *	-0.047 *
	(5.29)	(3.39)	(3.67)	(4.82)	(3.31)	(4.41)	(2.95)
31-35 years	0.153 *	0.182 *	0.160 *	0.154 *	0.162 *	0.135 *	0.142 *
	(23.4)	(27.3)	(24.5)	(23.7)	(24.8)	(17.8)	(18.8)
36-40 years	0.471 *	0.528 *	0.484 *	0.471 *	0.484 *	0.450 *	0.464 *
	(50.3)	(55.1)	(51.6)	(50.4)	(51.6)	(41.2)	(42.3)
> 40 years	0.959 *	1.060 *	0.980 *	0.958 *	0.978 *	0.953 *	0.975 *
	(45.4)	(48.9)	(46.3)	(45.4)	(46.3)	(38.2)	(39.0)
Birth weight: [7]							
< 1000 g	1.435 *	1.430 *	1.434 *	1.444 *	1.444 *	1.539 *	1.541 *
	(42.0)	(41.0)	(41.9)	(42.4)	(42.2)	(36.9)	(36.9)
1000-1499 g	2.309 *	2.334 *	2.313 *	2.304 *	2.309 *	2.380 *	2.386 *
	(96.1)	(94.1)	(96.0)	(96.0)	(95.9)	(82.4)	(82.4)

Table 3 (continued)

	Without fixed effects for maternity unit			With fixed effects for maternity unit		Without fixed effects for maternity unit [3]	
	Regression coefficients [1] I	Regression coefficients [2] II	Regression coefficients [1] III	Regression coefficients [1] IV	Regression coefficients [1] V	Regression coefficients [1] VI	Regression coefficients [1] VII
1500-1999 g	2.040 *	2.070 *	2.044 *	2.032 *	2.036 *	2.048 *	2.054 *
	(117.4)	(115.6)	(117.3)	(117.0)	(117.0)	(99.5)	(99.5)
2000-2499 g	1.192 *	1.207 *	1.195 *	1.190 *	1.192 *	1.168 *	1.171 *
	(96.1)	(94.9)	(96.1)	(96.0)	(96.0)	(80.4)	(80.4)
2500-2999 g	0.431 *	0.432 *	0.432 *	0.431 *	0.432 *	0.425 *	0.426 *
	(49.8)	(48.8)	(49.8)	(49.8)	(49.8)	(42.3)	(42.2)
3500-3999 g	-0.159 *	-0.154 *	-0.159 *	-0.159 *	-0.159 *	-0.160 *	-0.159 *
	(22.8)	(21.7)	(22.8)	(22.8)	(22.8)	(19.8)	(19.7)
4000-4499 g	-0.046 *	-0.038 *	-0.046 *	-0.048 *	-0.048 *	-0.053 *	-0.053 *
	(5.46)	(4.35)	(5.41)	(5.64)	(5.59)	(5.43)	(5.39)
>= 4500 g	0.402 *	0.419 *	0.403 *	0.399 *	0.400 *	0.042 *	0.425 *
	(30.8)	(31.5)	(30.9)	(30.5)	(30.6)	(28.4)	(28.5)
Characteristics of the birth:							
Caesarean section previously	2.47 *	2.440 *	2.470 *	2.472 *	2.466 *	2.497 *	2.492 *
	(329.8)	(318.9)	(328.6)	(329.2)	(328.2)	(292.2)	(291.2)
abnormal presentation [8]	2.267 *	2.303 *	2.270 *	2.258 *	2.261 *	2.294 *	2.298 *
	(314.1)	(310.4)	(314.06)	(313.3)	(313.3)	(276.0)	(276.0)
single baby birth	-0.271 *	-0.288 *	-0.272 *	-0.272 *	-0.273 *	-0.309 *	-0.309 *
	(21.7)	(22.6)	(21.8)	(21.8)	(21.9)	(21.2)	(21.3)
weekend [9]	-0.497 *	-0.489 *	-0.49.7 *	-0.498 *	-0.497 *	-0.496 *	-0.495 *
	(73.3)	(70.7)	(73.1)	(73.4)	(73.2)	(63.0)	(62.9)
Predisposing factors - mother:							
asthma	0.200 *	0.231 *	0.194 *	0.186 *	0.180 *	0.192 *	0.187 *
	(12.42)	(14.0)	(12.0)	(11.5)	(11.1)	(10.5)	(10.2)
diabetes	1.748 *	1.800 *	1.748 *	1.758 *	1.759 *	1.631 *	1.632 *
	(59.9)	(60.5)	(59.8)	(60.4)	(60.4)	(45.5)	(45.4)
epilepsy	0.372 *	0.376 *	0.371 *	0.369 *	0.367 *	0.410 *	0.408 *
	(12.5)	(12.4)	(12.4)	(12.4)	(12.3)	(11.9)	(11.8)
heart disease	0.257 *	0.357 *	0.266 *	0.251 *	0.259 *	0.192 *	0.199 *
	(5.26)	(7.16)	(5.44)	(5.14)	(5.29)	(3.28)	(3.40)
chronic hypertension	0.375 *	0.364 *	0.373 *	0.371 *	0.368 *	0.392 *	0.390 *
	(10.2)	(9.81)	(10.1)	(10.1)	(10.0)	(9.13)	(9.08)
chronic kidney failure	0.213 *	0.333 *	0.211 *	0.208 *	0.207 *	0.194 *	0.191 *
	(3.59)	(5.50)	(3.55)	(3.51)	(3.48)	(2.80)	(2.76)
rheumatoid arthritis	0.452 *	0.375 *	0.443 *	0.447 *	0.438 *	0.426 *	0.418 *
	(10.9)	(8.90)	(10.6)	(10.7)	(10.5)	(8.78)	(8.60)
preeclampsia [10]	1.301 *	1.312 *	1.301 *	1.305 *	1.306 *	1.286 *	1.287 *
	(125.3)	(123.6)	(125.1)	(125.7)	(125.6)	(106.2)	(106.1)
bleeding during pregnancy	0.192 *	0.243 *	0.193 *	0.190 *	0.190 *	0.184 *	0.186 *
	(12.5)	(15.4)	(12.5)	(12.3)	(12.3)	(10.4)	(10.5)

Table 3 (continued)

	Without fixed effects for maternity unit			With fixed effects for maternity unit		Without fixed effects for maternity unit [3]	
	Regression coefficients [1]	Regression coefficients [2]	Regression coefficients [1]	Regression coefficients [1]	Regression coefficients [1]	Regression coefficients [1]	Regression coefficients [1]
	I	II	III	IV	V	VI	VII
Immigrant background:							
non-western immigrant	0.215 *	0.221 *	0.194 *	0.233 *	0.214 *	0.268 *	0.247 *
	(15.7)	(15.8)	(14.0)	(17.0)	(15.6)	(16.5)	(15.2)
western immigrant	0.079 *	0.084 *	0.074 *	0.080 *	0.075 *	0.096 *	0.091 *
	(4.32)	(4.47)	(4.04)	(4.38)	(4.11)	(4.32)	(4.09)
Maternity unit - production:							
number of births (log)	-0.655 *	-0.356 *	-0.651 *			-0.748 *	-0.737 *
	(43.5)	(20.3)	(43.1)			(38.6)	(38.0)
number of Caesarean sections	0.001 *	0.001 *	0.001 *			0.001 *	0.001 *
	(52.8)	(33.9)	(54.5)			(45.3)	(46.7)
Concordant value	0.825	0,829	0,826	0,832	0,833	0,819	0,819
N	2 082 763	2 082 763	2 082 763	2 082 763	2 082 763	1 483 735	1 483 735

[1] Year continuous
[2] Year dummies
[3] Here the number of observations are the same as the number of observations we have when the technology variable is used instead of the year (see Table 5).
[4] Reference category: compulsory school
[5] Excluding obstetricians, midwives and doctors
[6] Reference category: 20 - 30 years
[7] Reference category: 3000 - 3499 g
[8] Including breech presentation, transverse presentation, abnormal cephalic presentation and other
[9] The birth was on a Saturday or a Sunday
[10] Including unspecified, mild and severe preeclampsia

* p<0.05

Table 4

Significance test for pairwise comparisons of the different educational groups[1] and of the different interaction terms for education and year[2]
Wald Chi-Square test. p-values in brackets

	Additive model				Model with interaction terms			
Education with and without year	obstetrician	midwife	doctor (excluding obstetricians)	university/college[3]	obstetrician · year	midwife · year	doctor · year	university/college · year
Education:								
midwife	4.43 (0.03)							
doctor (excluding obstetricians)	6.05 (0.01)	0.16 (0.68)						
university/college education[3]	14.41 (<0.01)	11.12 (<0.01)	45.04 (<0.01)					
upper secondary school education	15.46 (<0.01)	13.24 (<0.01)	54.75 (<0.01)	8.25 (<0.01)				
Education with year:								
midwife · year					0.38 (0.53)			
doctor · year					0.35 (0.55)	0.02 (0.88)		
university/college · year					0.02 (0.87)	1.58 (0.20)	5.86 (0.01)	
upper secondary school · year					1.36 (0.24)	20.68 (<0.01)	94.62 (<0.01)	943.56 (<0.01)

[1] Estimated on the basis of the regression coefficients in Table 3, column I.
[2] Estimated on the basis of the regression coefficients in Table 3, column III.
[3] Excluding obstetricians, midwives and doctors

Table 5

Effects of parents' highest level of education on Caesarean sections in Norway 1967-2005. Technology variables included.
Data from the Medical Birth Registry. Multilevel analysis. T-values in parentheses.
Maternity units for which we have information about medical technology

	Regression coefficients [1] I	Regression coefficients II	Regression coefficients [1] III	Regression coefficients [1] IV
Intercept	0.958 *	0.948 *	1.994 *	1.779 *
	(6.49)	(6.42)	(13.8)	(12.2)
Time variable:				
year	-0.001		-0.0002	-0.0004
	(1.69)		(0.36)	(0.69)
Parents' highest education: [2]				
obstetrician	0.453 *	0.454 *	0.514 *	0.407
	(3.01)	(3.02)	(3.44)	(1.10)
midwife	0.286 *	0.286 *	0.326 *	0.849 *
	(4.36)	(4.36)	(5.02)	(5.44)
doctor (excluding obstetricians)	0.162 *	0.161 *	0.190 *	0.600 *
	(5.37)	(5.35)	(6.34)	(7.70)
university/college education [3]	0.041 *	0.040 *	0.070 *	0.422 *
	(3.63)	(3.55)	(6.22)	(17.6)
upper secondary school education	0.043 *	0.042 *	0.064 *	0.141 *
	(3.89)	(3.86)	(5.92)	(6.42)
Maternity unit - technology:				
ultrasound	0.548 *	0.537 *		
	(34.8)	(37.1)		
cardiotocography	0.562 *	0.555 *		
	(35.5)	(36.1)		
ST waveform analysis	-0.069 *	-0.079 *		
	(5.99)	(7.90)		
foetal blood analyses	-0.059 *	-0.066 *		
	(5.21)	(6.17)		
technology index (0-4)			0.249 *	0.317 *
			(38.9)	(32.4)
Interaction terms:				
obstetrician · technology				0.040
				(0.28)
midwife · technology				-0.228 *
				(3.71)
doctor · technology				-0.171 *
				(5.99)
university/college · technology				-0.148 *
				(16.0)
upper secondary school · technology				-0.038 *
				(4.35)
Mother's age: [4]				
< 20 years	-0.048 *	-0.047 *	-0.064 *	-0.050 *
	(3.02)	(2.97)	(4.06)	(3.19)
31-35 years	0.155 *	0.154 *	0.139 *	0.144 *
	(20.3)	(20.2)	(18.4)	(19.0)
36-40 years	0.489 *	0.488 *	0.460 *	0.468 *
	(44.1)	(44.1)	(42.0)	(42.6)

Table 5 (continued)

	Regression coefficients [1] I	Regression coefficients II	Regression coefficients [1] III	Regression coefficients [1] IV
> 40 years	1.022 *	1.022 *	0.971 *	0.984 *
	(40.3)	(40.3)	(38.8)	(39.3)
Birth weight: [5]				
< 1000 g	1.560 *	1.560 *	1.541 *	1.542 *
	(37.0)	(37.0)	(36.9)	(36.9)
1000-1499 g	2.425 *	2.425 *	2.393 *	2.395 *
	(82.3)	(82.3)	(82.5)	(82.4)
1500-1999 g	2.078 *	2.078 *	2.059 *	2.060 *
	(99.1)	(99.1)	(99.7)	(99.6)
2000-2499 g	1.184 *	1.184 *	1.174 *	1.175 *
	(80.2)	(80.3)	(80.6)	(80.5)
2500-2999 g	0.425 *	0.425 *	0.426 *	0.426 *
	(41.7)	(41.7)	(42.2)	(42.2)
3500-3999 g	-0.157 *	-0.157 *	-0.159 *	-0.159 *
	(19.2)	(19.25)	(19.7)	(19.7)
4000-4499 g	-0.047 *	-0.048 *	-0.052 *	-0.052 *
	(4.77)	(4.81)	(5.27)	(5.25)
>= 4500 g	0.435 *	0.434 *	0.427 *	0.427 *
	(28.8)	(28.8)	(28.6)	(28.6)
Characteristics of the birth:				
Caesarean section previously	2.471 *	2.470 *	2.492 *	2.489 *
	(286.0)	(286.3)	(291.6)	(290.7)
abnormal presentation [6]	2.312 *	2.311 *	2.298 *	2.300 *
	(273.8)	(273.9)	(275.7)	(275.7)
single baby birth	-0.325 *	-0.325 *	-0.310 *	-0.311 *
	(22.1)	(22.1)	(21.3)	(21.4)
weekend [7]	-0.490 *	-0.490 *	-0.495 *	-0.494 *
	(61.6)	(61.6)	(62.8)	(62.7)
Predisposing factors - mother:				
asthma	0.215 *	0.213 *	0.198 *	0.196 *
	(11.7)	(11.6)	(10.9)	(10.7)
diabetes	1.682 *	1.681 *	1.646 *	1.645 *
	(46.3)	(46.3)	(45.8)	(45.7)
epilepsy	0.408 *	0.408 *	0.409 *	0.407 *
	(11.7)	(11.7)	(11.8)	(11.8)
heart disease	0.245 *	0.244 *	0.204 *	0.208 *
	(4.15)	(4.12)	(3.48)	(3.56)
chronic hypertension	0.375 *	0.374 *	0.389 *	0.388 *
	(8.67)	(8.65)	(9.06)	(9.03)
chronic kidney failure	0.255 *	0.254 *	0.210 *	0.209 *
	(3.65)	(3.63)	(3.03)	(3.01)
rheumatoid arthritis	0.374 *	0.374 *	0.417 *	0.415 *
	(7.64)	(7.64)	(8.60)	(8.54)
preeclampsia [8]	1.291 *	1.290 *	1.287 *	1.287 *
	(105.1)	(105.1)	(106.1)	(106.0)
bleeding during pregnancy	0.211 *	0.211 *	0.192 *	0.193 *
	(11.9)	(11.8)	(10.9)	(10.9)

Table 5 (continued)

	Regression coefficients [1] I		Regression coefficients II		Regression coefficients [1] III		Regression coefficients [1] IV	
Immigrant background:								
non-western immigrant	0.273	*	0.272	*	0.272	*	0.261	*
	(16.7)		(16.6)		(16.8)		(16.1)	
western immigrant	0.095	*	0.095	*	0.096	*	0.096	*
	(4.21)		(4.21)		(4.33)		(4.30)	
Maternity unit - production:								
number of births (log)	-0.700	*	-0.699	*	-0.799	*	-0.789	*
	(34.0)		(34.0)		(40.6)		(40.1)	
number of Caesarean sections	0.001	*	0.001	*	0.001	*	0.001	*
	(46.4)		(49.5)		(47.5)		(48.0)	
Concordant value	0,821		0.821		0.819		0.820	
N	1 483 735		1 483 735		1 483 735		1 483 735	

[1] Year continuous
[2] Reference category: compulsory school
[3] Excluding obstetricians, midwives and doctors
[4] Reference category: 20 - 30 years
[5] Reference category: 3000 - 3499 g
[6] Including breech presentation, transverse presentation, abnormal cephalic presentation and other
[7] The birth was on a Saturday or a Sunday
[8] Including unspecified, mild and severe preeclampsia

* p<0.05

Table 6

Significance test for pairwise comparisons of the different educational groups[1] and of the different interaction terms for education and technology index[2]. Wald Chi-Square test. p-values in brackets

Education with and without technology index	Additive model: obstetrician	Additive model: midwife	Additive model: doctor (excluding obstetricians)	Additive model: university/college[3]	Model with interaction terms: obstetrician · technology	Model with interaction terms: midwife · technology	Model with interaction terms: doctor · technology	Model with interaction terms: university/college · technology
Education:								
midwife	1.80 (0.17)							
doctor (excluding obstetricians)	4.92 (0.02)	2.85 (0.09)						
university/college education[3]	9.54 (<0.01)	14.10 (<0.01)	18.84 (<0.01)					
upper secondary school education	9.86 (<0.01)	15.00 (<0.01)	21.19 (<0.01)	1.31 (0.25)				
Education with technology index								
midwife · technology					2.54 (0.11)			
doctor · technology					1.80 (0.17)	0.62 (0.43)		
university/college · technology					1.60 (0.20)	1.20 (0.27)	0.26 (0.60)	
upper secondary school · technology					0.21 (0.64)	8.99 (<0.01)	22.17 (<0.01)	370.17 (<0.01)

[1] Estimated on the basis of the regression coefficients in Table 5, column III.

[2] Estimated on the basis of the regression coefficients in Table 5, column IV.

[3] Excluding obstetricians, midwives and doctors

Table 7
Effects of hospital revenue per bed on Caesarean sections in Norway 1976-1999.
Data from the Medical Birth Registry. Logistic regressions with fixed effect for hospital and year. Multilevel analysis. T-values in parentheses

	Whole material		Material with subsamples	
	Additive model	Interactions between education and hospital revenue per bed	Sample with data 1976-1987	Sample with data 1988-1999
	I	II	III	IV
Intercept	1.164	2.789	-0.987	-2.118 *
	(0.00)	(0.00)	-	(49.1)
Revenue variable:				
hospital revenue per bed (log)	0.245 *	0.182 *	0.297 *	0.240 *
	(8.37)	(3.70)	(5.39)	(5.40)
Parents' highest education: [1]				
medical education	0.234 *	0.310 *	0.257 *	0.224 *
	(8.05)	(4.41)	(5.63)	(5.88)
university/college education [2]	0.052 *	0.027	0.069 *	0.043 *
	(4.25)	(0.99)	(3.60)	(2.68)
upper secondary school education	0.053 *	0.005	0.051 *	0.055 *
	(4.45)	(0.22)	(2.76)	(3.51)
Interaction terms:				
medical education · hospital revenue per bed		-0.128		
		(1.11)		
university/college · hospital revenue per bed		0.049		
		(1.05)		
upper secondary school · hospital revenue per bed		0.092		
		(1.96)		
Mother's age: [3]				
< 20 years	0.012	0.012	0.078 *	-0.033
	(0.71)	(0.73)	(3.45)	(1.27)
31-35 years	0.177 *	0.177 *	0.195 *	0.170 *
	(21.3)	(21.3)	(13.7)	(16.5)
36-40 years	0.568 *	0.569 *	0.771 *	0.488 *
	(46.4)	(46.5)	(36.1)	(32.4)
> 40 years	1.129 *	1.129 *	1.489 *	0.963 *
	(39.0)	(39.0)	(30.7)	(26.6)
Birth weight: [4]				
< 1000 g	1.566 *	1.566 *	0.775 *	1.900 *
	(37.1)	(37.1)	(9.39)	(37.1)
1000-1499 g	2.638 *	2.638 *	2.047 *	3.094 *
	(83.7)	(83.7)	(41.0)	(71.1)
1500-1999 g	2.280 *	2.280 *	2.033 *	2.474 *
	(101.4)	(101.3)	(57.4)	(82.9)
2000-2499 g	1.295 *	1.295 *	1.305 *	1.305 *
	(82.6)	(82.6)	(53.0)	(63.6)
2500-2999 g	0.447 *	0.447 *	0.455 *	0.447 *
	(41.3)	(41.3)	(26.8)	(31.5)
3500-3999 g	-0.180 *	-0.180 *	-0.200 *	-0.164 *
	(20.5)	(20.5)	(14.4)	(14.4)
4000-4499 g	-0.081 *	-0.081 *	-0.145 *	-0.036 *
	(7.49)	(7.49)	(8.14)	(2.62)

Table 7 (continued)

	Whole material		Material with subsamples	
	Additive model	Interactions between education and hospital revenue per bed	Sample with data 1976-1987	Sample with data 1988-1999
>= 4500 g	0.380 *	0.380 *	0.222 *	0.473
	(22.6)	(22.6)	(7.58)	(22.8) *
Characteristics of the birth:				
Caesarean section previously	2.505 *	2.505 *	2.897 *	2.352 *
	(268.7)	(268.7)	(173.2)	(206.6)
abnormal presentation [5]	2.423 *	2.423 *	2.321 *	2.536 *
	(254.8)	(254.8)	(156.7)	(201.3)
single baby birth	-0.418 *	-0.418 *	0.143 *	-0.689 *
	(26.1)	(26.1)	(5.01)	(34.5)
weekend [6]	-0.487 *	-0.487 *	-0.483 *	-0.488
	(56.7)	(56.7)	(34.8)	(44.2)
Predisposing factors - mother:				
asthma	0.209 *	0.209 *	0.190 *	0.220 *
	(9.63)	(9.63)	(4.47)	(8.63)
diabetes	1.871 *	1.871 *	2.473 *	1.600 *
	(46.8)	(46.8)	(35.7)	(32.3)
epilepsy	0.398 *	0.399 *	0.362 *	0.429 *
	(10.37)	(10.3)	(5.73)	(8.74)
heart disease	0.412 *	0.413 *	0.592 *	0.339 *
	(5.55)	(5.56)	(4.24)	(3.84)
chronic hypertension	0.425 *	0.425 *	0.615 *	0.344 *
	(8.92)	(8.92)	(7.66)	(5.80)
chronic kidney failure	0.423 *	0.422 *	0.459 *	0.401 *
	(4.36)	(4.35)	(2.69)	(3.36)
rheumatoid arthritis	0.377 *	0.377 *	0.317 *	0.412 *
	(7.78)	(7.78)	(3.38)	(7.22)
preeclampsia [7]	1.369 *	1.369 *	1.443 *	1.325 *
	(103.5)	(103.5)	(69.1)	(76.6)
bleeding during pregnancy	0.226 *	0.225 *	0.238 *	0.252 *
	(10.5)	(10.5)	(8.15)	(8.02)
Immigrant background:				
non-western immigrant	0.293 *	0.294 *	0.243 *	0.312 *
	(17.3)	(17.4)	(6.29)	(16.4)
western immigrant	0.086 *	0.086 *	0.121 *	0.057
	(3.72)	(3.72)	(3.12)	(1.95)
Concordant value	0.813	0,813	0.807	0.818
N	1 167 334	1 167 334	515 580	651 754

[1] Reference category: compulsory school
[2] Excluding medical education
[3] Reference category: 20 - 30 years
[4] Reference category: 3000 - 3499 g
[5] Including breech presentation, transverse presentation, abnormal cephalic presentation and other
[6] The birth was on a Saturday or a Sunday
[7] Including unspecified, mild and severe preeclampsia
* $p<0.05$

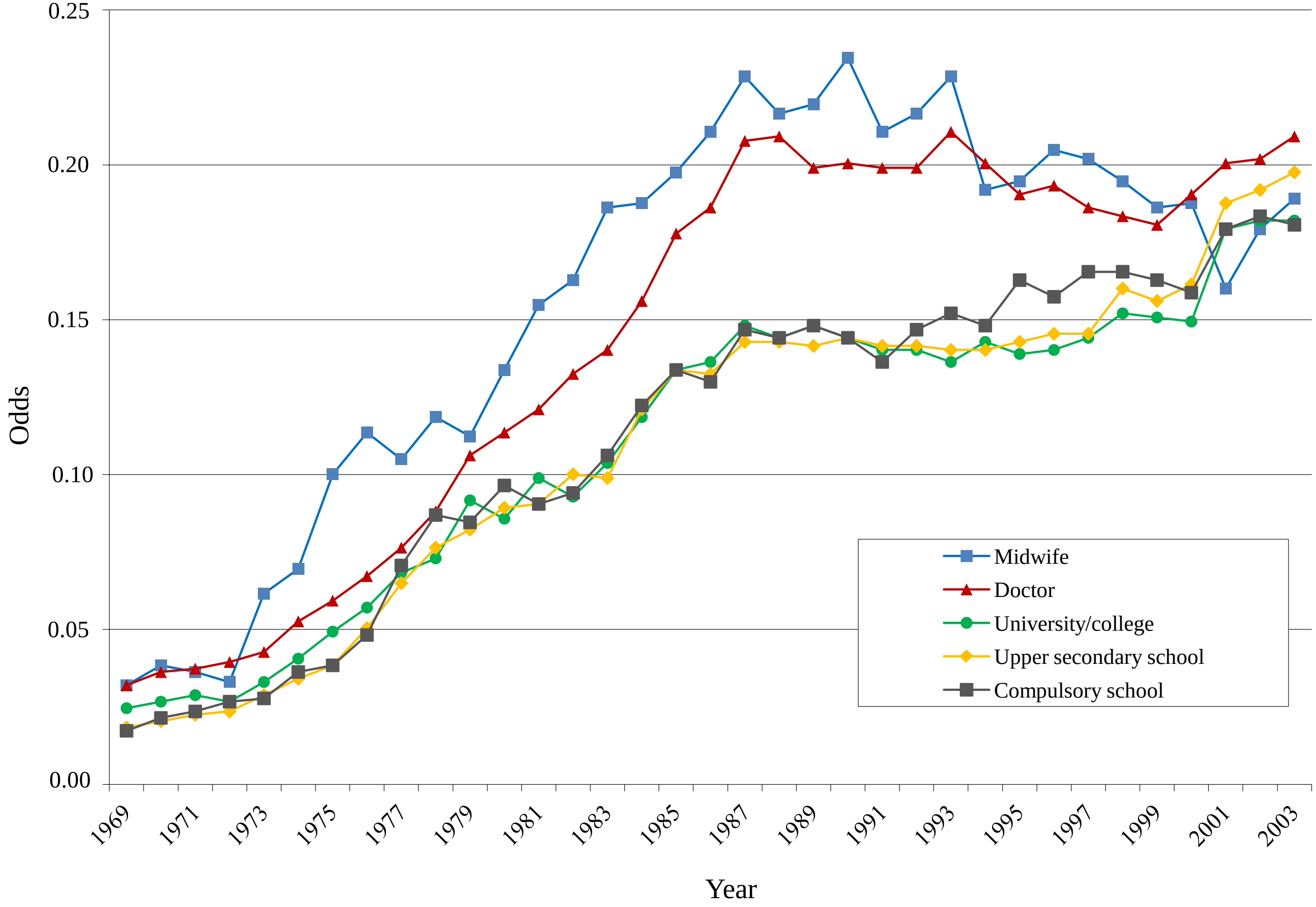

Fig.1. Odds for Caesarean section for different educational groups by year

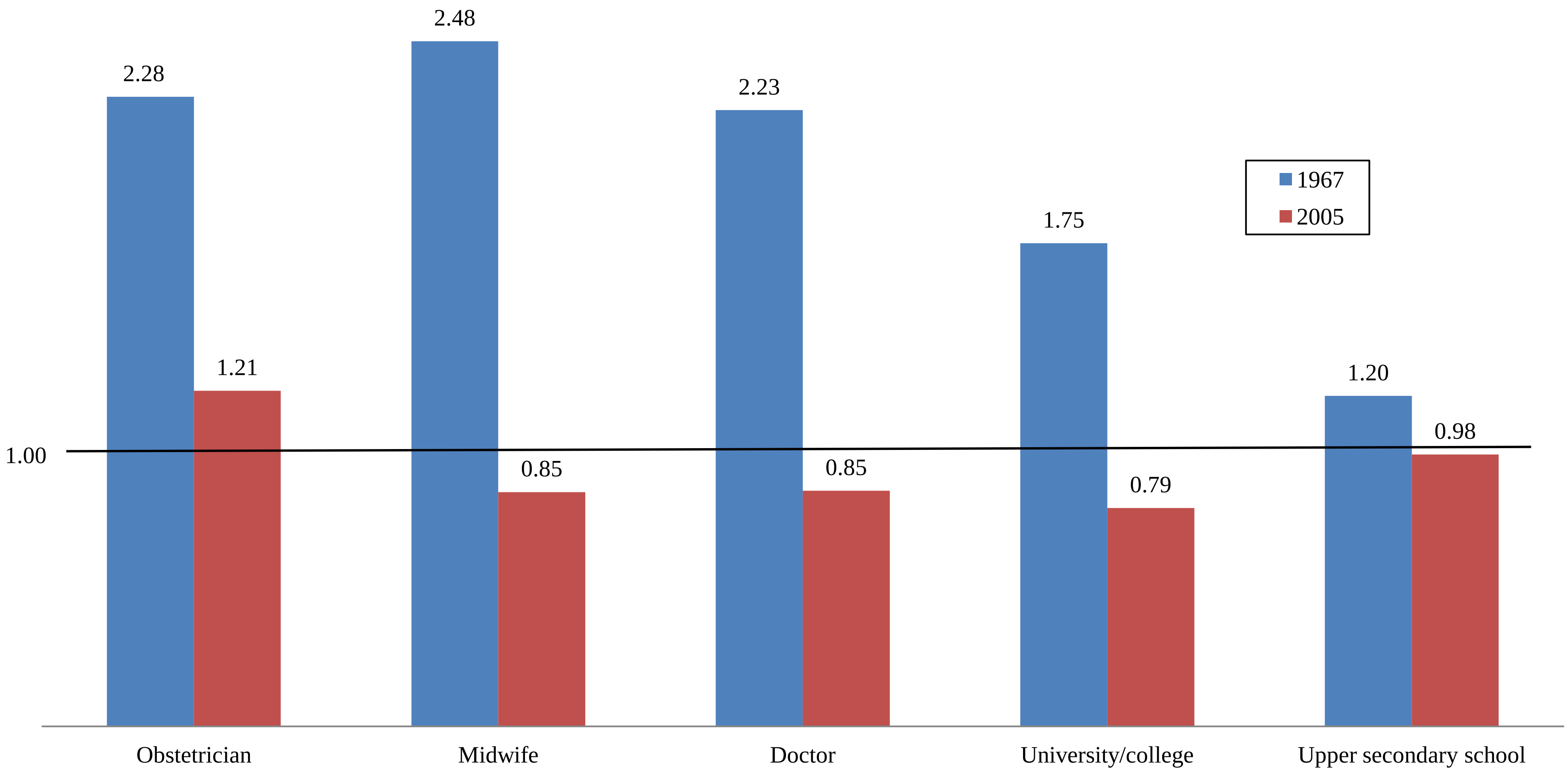

Fig. 2. Odds ratio for Caesarean section for different educational groups relative to the reference category (compulsory school), 1967 and 2005

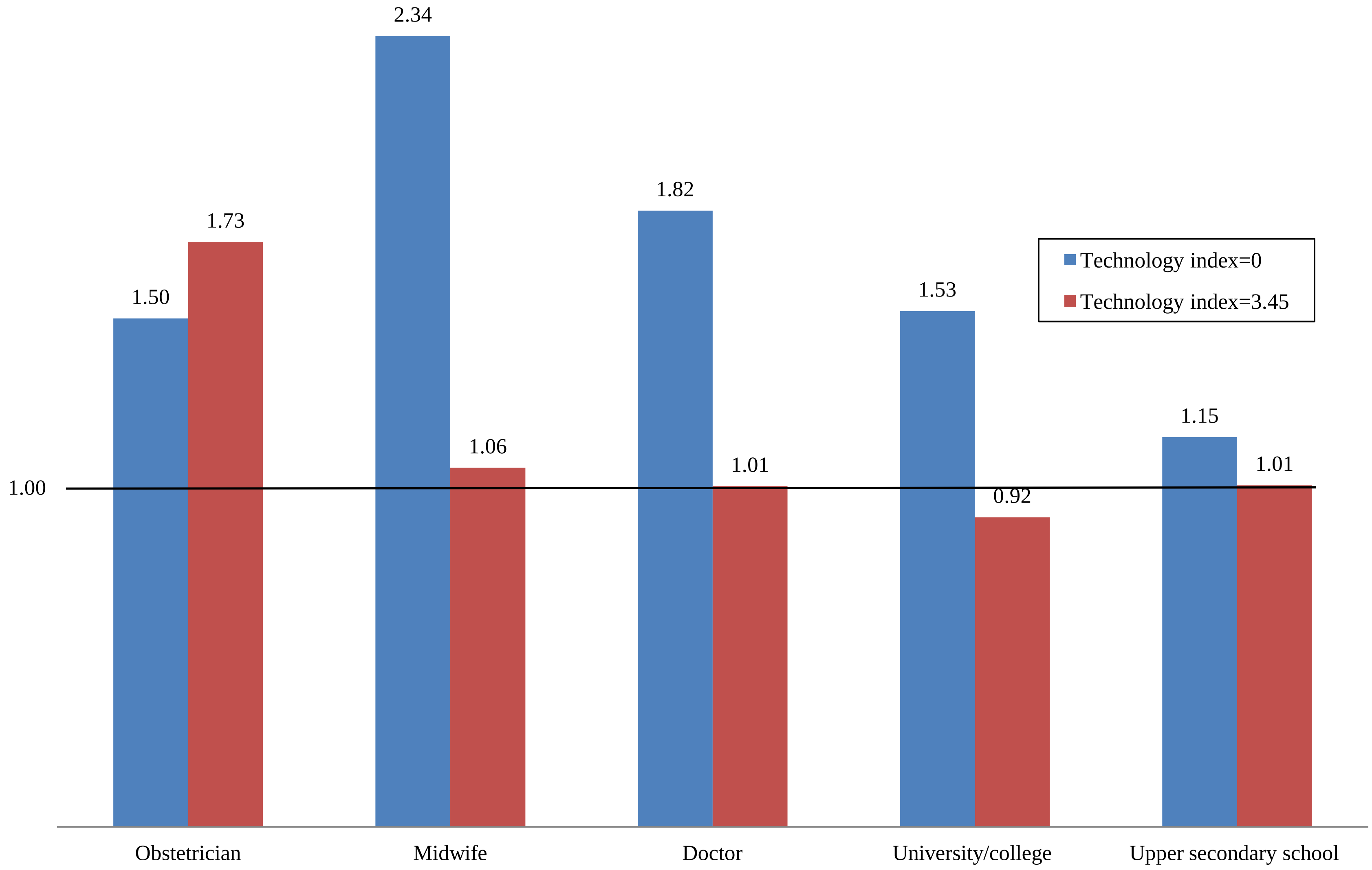

Fig. 3. Odds ratio for Caesarean section for different education groups relative to the reference category (compulsory school), according to technology