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- Causes and Economic Consequences

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by

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ABSTRACT

The average cesarean section rate in Sweden more than doubled during the 1970´s, and amounted to 12.3 percent in 1983. After that, there was a steady-state for a couple of years and towards the end of the 80´s even a small decrease, to 10.9 percent in 1990. In the early 90´s, there was a slight tendency towards an increase. Continuously, however, there has been a considerable variation in cesarean section rates among obstetrical departments. The objective of the study was to explain the interdepartmental variation, and to discuss its potential economic consequences.

Using data from The Swedish Medical Birth Registry 1991, we made a cross-sectional study of the cesarean section rate at the departmental level. We identified some 20 determinants, demand-related as well as supply-related, including practice style. A general model including all regressors was specified. After reducing this model, we were able to explain about one third of the variation.

We conclude that the large variation in cesarean section rates implies inefficiency, mainly due to overutilization, but perhaps also underutilization. It is difficult to calculate the resulting welfare loss to society, but we made some rough estimations, indicating an additional cost for ”unnecessary” cesarean sections of 12-14 million SEK per year.

Keywords: Cesarean section, practice variation, economic consequences, regression analysis.

1. INTRODUCTION

Deliveries may be performed in one of two ways - *vaginally* (if necessary aided by forceps or vacuum extraction), or abdominally by *cesarean section*. Before 1950 cesarean section was an uncommon procedure in Sweden. Less than one percent of the deliveries were cesareans, at that time a risky intervention, not least for the mother. Even in the late 50´s the average cesarean section rate was only two percent, ranging from 0.5-4.5 percent among obstetrical departments.

Since then, however, cesarean sections have become more common, in Sweden like in most other comparable countries. International comparisons of cesarean section rates indicate a general increase since the 70´s, as well as large variations among (and within) different countries. In the United States, for example, permanently among the high-rate countries, the cesarean section rate increased from 5.5 percent in 1970 to 20.3 percent in 1983 and 23.5 percent in 1991. Even in low-rate countries, e.g. Czecho-Slovakia, the cesarean section rate has increased rapidly, from 2.3 percent in 1970 to 6.0 percent in 1983 and 7.7 percent in 1988 (32, 37).

In Sweden, the average cesarean section rate more than doubled during the 70´s and amounted to a maximum of 12.3 percent in 1983. Figure 1 shows the range of variation, and the quartiles, in cesarean section rates among obstetrical departments 1973-1992. Obviously, the variation has been considerable and persisting, even if it has shown a downward trend. The coefficient of variation decreased from 0.39 in 1973, to 0.24 in 1983 and 0.19 in 1991.

(FIGURE 1)

The reasons for this development has been thoroughly dicussed in medical journals (2, 27, 28, 29). Expanded indications, laws and rules concerning medical liability and the development of new medical technology are examples of factors believed to explain the rapid increase in the 70´s.

Physicians´ practice style and personal attitudes to cesarean section are also supposed to be important explanatory factors. It should be noted that the decrease during the 80´s has been accompanied by a continuous improvement (decrease) in outcome measures like perinatal mortality and prevalence of asphyxia.

The objective of this study was to explain the variation in cesarean section rate among obstetrical departments in Sweden, and to discuss its potential economic consequences. We first briefly review the literature (section 2). After a theoretical discussion about what governs the choice of mode of delivery, we formulate some hypotheses (section 3), and present a cross-sectional study of cesarean section rates in 1991 (section 4). The paper ends with some concluding remarks and ideas for future research (section 5).

2. PREVIOUS STUDIES

Causes

Lomas&Enkin (20) divide the factors explaining the choice of mode of delivery into three cathegories: obstetrical indications, non-medical patient-related determinants and non-medical professional-related determinants. The major obstetrical indications are: previous cesarean, breech presentation, dystocia and fetal distress. The non-medical patient-related determinants are: socioeconomic status, influence of malpractice litigation and women´s expectations. Non-medical professional-related determinants are: financial incentives, convenience, professional discipline and availability of technology. Even if some of these factors are less relevant for Sweden, e.g. those concerning malpractice litigation and financial incentives, most of them are applicable.

Maternal age seems to have a strong influence. *McCloskey et al* (22) found that maternal age is a dominating factor independently of clinical risk and type of organization. *Zahniser et al* (43) found that women over 35 years had 30 percent higher probability to deliver by cesarean section. According to *Adashek et al* (1) maternal age, birth weight, need for oxytocin and spinal anaestesia each showed a positive correlation with cesarean section rate.

Anderson&Lomas (2) compared cesarean section rates by indication at university hospitals and community hospitals. They found that the variation was as large within as between the two types of hospitals. Some studies demonstrate the importance of ”the physician factor”. *Tussing&Wojtowycz* (39) found that female doctors usually performed a somewhat lower cesarean section rate, but higher on the dystocia indication. In a study of deliveries performed by eleven physicians in a single community hospital in Detroit, *Goyert et al* (12) found that only nulliparity had a greater influence than the identity of the physician on the rate of cesarean section.

Lomas&Enkin (20), concluded that the cesarean section rate probably is as much affected by non-medical factors as by medical factors.

Consequences

Cesarean sections have no doubt contributed to the improvements of perinatal morbidity and mortality in this century. Due to improved medical technology, such as anesthetic techniques, pharmacotherapy, etc, even maternal morbidity and mortality rates have decreased significantly in abdominal deliveries. Consequently, the indications for cesarean section have been widened in recent decades, in the best interest of all concerned, and certainly with better outcome for the newborns. However, abdominal delivery is associated with significantly higher morbidity and mortality for the mother than vaginal delivery. Even if a cesarean section today is regarded as a, by and large, riskless routine procedure, the intervention may cause great discomfort for the woman as well as complications during the operation and afterwards. The frequency of maternal mortality and complications, e.g. in terms of infertility, is higher mainly for women undergoing acute cesarean section. Furthermore, infants born by cesarean section are at higher risk of developing respiratory distress syndrome (26).

Obviously, variations in cesarean section rates may have medical as well as economic consequences (6, 31). Regarding economic consequences, it should be noticed that a delivery by cesarean section is more resource demanding than a normal vaginal delivery. The direct costs differ, partly due to difference in care intensity and partly due to difference in length of stay. Even indirect costs, e.g. in terms of convalescence, are higher after a cesarean section as compared to a vaginal delivery. Based on British experience, *Clark et al* (5) have made some cost calculations for different modes of delivery, showing that the hospital cost of a cesarean section without complications is three times that of a normal vaginal delivery. According to U.S. Diagnosis Related Groups (DRG)-payments the additional cost for a cesarean section was 85 percent. Based on a study by Health Insurance Association of America, *Keeler&Brodie* (17) found that a cesarean section is 66 percent more expensive than a normal delivery. Corresponding Swedish DRG-data (1993) shows that the cost of a cesarean section was SEK 36 000 (with complications, DRG 370), and SEK 26 500 (without complications, DRG 371). The cost of a vaginal delivery was SEK 12 500 (with complications, DRG 372) and SEK 10 000 (without complications, DRG 373).

In the light of these figures it seems quite obvious that a higher cesarean section rate implies higher costs for obstetric care. However, *Finkler&Wirtschafter* (9) found in a cost-effectiveness study of obstetric care at eight hospitals in an American HMO that the cesarean section rate does not play an important role for the level of costs. Their conclusion was that cost management should focus on staff levels and mix more than on practice patterns, and that care mangement should focus on practice patterns in relation to their influences on outcomes.

3. THEORETICAL FRAMEWORK

To understand medical practice variations better it is important to understand medical decision-making, i.e. the physicians´ practice behaviour. Different theories have been launched in the literature concerning the major determinants for medical decision-making. *Eisenberg* (7) describe three groups of factors, related to *the self-fulfilling physician*, the physicians role as *the patient´s agent*, and the phycisian´s desire to *maximize the social benefit* of medical care. The first group relates to the physician´s economic self-interest, personal style, and practice environement. The second group of factors relate to the physician´s desire to act on behalf of the patient´s physical or economic health and the patient´s preferences. The third group, finally, is based on the idea that the physician is guided by a desire to provide the most good to the most people.

Ellis&McGuire (8) proposed a model for analyzing the physician´s reactions on different payment systems - *cost based*, *prospective*, and *mixed*. The model includes three actors: the patient, the physician and the hospital. The patient is assumed to be fully insured and to accept the care prescribed. The physician is assumed to be the key decision-maker, with a utility function including the patient´s utility (a function of the quantity of care), as well as the hospital´s utility (net profit). The physician´s own interest is, however, not included. The Swedish payment system is not identical to any of the three systems analyzed by Ellis&McGuire, but our traditional system with a fixed budget - without any direct link to work done - is probably moving towards something similar to the ”mixed” alternative.

Folland&Stano (10) have developed an econometric model of physicians´ resource utilization, including uncertainty and practice style as explanatory factors behind existing variations in utilization of medical and surgical procedures. Practice style is regarded as reflecting the physician´s beliefs concerning the correlation between the care provided and its benefit to the patient. The fact that physicians´ beliefs differ is assumed to be due to professional uncertainty. An empirical test of the model indicated that practice style does not seem to explain variations in resource utilization at an aggregated level, but probably do so for single procedures.

Applying some of these ideas to the Swedish setting, one may identify three main actors: *the patient*, *the physician/department* and *the County Council/Community*. The patient is assumed to ask for the best possible care without any regard to cost, since she pays only a small part out of pocket. The Swedish healthcare system, with hospital-employed physicians and specially appointed chief physicians responsible for all healthcare at their departments, makes it reasonable to assume a consistent practice style within the single department. This in turn means that the relevant study unit is the clinical department rather than the single physician.

The medical decisions made by the physicians/department are assumed to be governed mainly by a desire to do what is best for the patients. Direct economic considerations are not very prominent, e.g. in deciding whether or not to carry out a certain diagnostic procedure. The decisive argument is the physician´s judgement of the patient´s ”need”. This implies a risk for inefficiency in terms of overutilization, beyond the point where marginal utility is offset by marginal cost. We should also take into consideration the physician´s and the department´s self-interest. Ambitions concerning for example the number of beds and the technical equipment in the department, might influence decision-making. The system underway in Swedish healthcare, including DRG-based payment and freedom of choice for the patient, probably will stimulate competition among hospitals, and make them act as ”revenue-seekers”. Until recently, however, most departments had a fixed budget. The ever increasing demand for savings and enhanced efficiency may also turn the focus to the social benefit of health care, meaning that the interests of different patient groups - or potential patients -

have to be balanced against each other. The County Councils/Community, finally, probably want to minimize the cost for a - more or less clearly specified - high-quality healthcare.

Applied to the case of cesarean sections, we assume that the obstetrician/department - in consultation with the woman - choose the mode of delivery. Decision-making is primarily guided by *demand-related factors*, like age, morbidity, expectations, etc. The physician/department may, however, also want to fulfill his/its own interests, and act as an agent for the employer, the hospital and the County Council/Community, who may be assumed to demand the cheapest, medically defensible, method to be used. This implies that also resource capacity and factors related to clinical judgement and practice style - what we call *supply-related factors* - influence the decisions.

The decision can be described as an optimization problem under uncertainty. The physicians/ departments are assumed to maximize a utility function, including their own utility as well as the patients´ utility and the social good. The utility maximization is constrained by a variety of restrictions - medical, organizational, technological, economic, etc. Using terminology from contract theory, the decision-making physician/department can be regarded as a ”double-agent” for principals (the hospital department, the County Council and the patient) with at least partly conflicting interests (3). In principle, two kinds of mistakes (wrong decisions) are possible: to perform a cesarean section when it is ”unnecessary”, and not to perform it when ”necessary”. Both kinds of mistakes may have medical, as well as, economic consequences. However, the consequences are not the same, and attempts to reduce the probability of the first kind of misstake, may increase the probability of the second, and vice versa. The incentives to avoid the second kind of mistake seem to be much stronger than the incentives to avoid the first, which means that there is a built-in bias towards ”overutilization”.

To summarize: We assume that systematic variation (i.e. excluding measurement errors and random variation) in cesarean section rates among obstetrical departments may be explained by variation in demand-related and supply-related factors. All demand-related factors are assumed to be positively correlated with the cesarean section rate. Among supply-related factors, resource capacity (in a wide sense) are assumed to be positively correlated with cesarean section rate, while the opposite applies to workload. Tradition and practice style are assumed to have a great influence. We will be more precise on these hypotheses as we define the regression variables in next section.

4. CROSS-SECTIONAL STUDY 1991

Material and methods

Data

Using data from The Swedish Medical Birth Registry 1991, a special database was compiled, containing the following information on all 122 000 newborns in Sweden that year:

- cesarean section (yes=1, no=0)
- maternal age (xx years)
- parity (order of delivery=1, 2, 3 etc)
- stillbirth (yes=1, no=0)
- perinatal mortality (stillbirth or dead within first week), (yes=1, no=0)
- mother and father living together (yes=1, no=0)
- number of newborns (one=1, two=2, etc)
- prevalence of asphyxia (Apgar score<7 at five minutes), (yes=1, no=0)
- hospital (five digit code, National Board of Health and Welfare)
- indication for cesarean section (placenta praevia=1, ablatio=2, disproportion=3, pre-eclampsia=4, dystocia=5, fetal distress=6, twins or more=7, malpresentation=8, psycho-social indication=9, other indication=10).

In 1991, 13 643 newborns were delivered by cesarean section in Sweden, corresponding to 11.2 percent of all newborns. In order to make relevant comparisons on the department level, we excluded units with less than 600 deliveries per year. Our material thus include data from 59 obstetrical departments, covering 98 percent of all newborns. The average cesarean section rate was 11.2 percent, ranging from 5.6 percent to 18.0 percent among departments.

On average, the university hospitals had a higher cesarean section rate than others. The difference was, however, not very large and the variation within different types of hospitals was much larger.

There was also a large variation among, and within, the six health care regions. The cesarean section rate increases with maternal age, most pronounced for women who have their first child.

Table 1 shows the frequency of different indications for cesarean section, the percentage of cesarean section per obstetrical indication, and the distribution of the cesarean sections over different indications.

(TABLE 1)

The ten classes of indications more or less frequently resulted in cesarean section. The highest frequency was on the indication *disproportion*. The most common indications, given that cesarean section was performed, were *disproportion* (25%), *malpresentation* (25%), and *fetal distress* (15%).

Measurement and model specification

Based on our theoretical discussion and the database described above we defined a dependent variable (cesarean section rate), and a number of independent variables in order to specify and estimate an econometric model to explain the variation in cesarean section rate among different obstetrical departments. The variables are shown in Table 2.

(TABLE 2)

As noted above, there was a positive correlation between maternal age and cesarean section rate. The rate was considerably higher for mothers over 35 years. Even if the ”risk” is a continously increasing function of age, we defined the variable **age** as percentage of mothers over 35 years, which also happens to be the most common measure in previous studies. Cesarean section is more frequent among nullipara (mothers having their first child). **Parity,** defined as the percentage of nullipara, is thus supposed to be positively correlated with cesarean section rate. Cesarean section is more common when two or more children are born at the same time, 40.1 percent, compared to 10.4 percent for single births. This is captured in the variable **twins**. The variable **asphyx** is a proxy for the percentage of newborns suspected to suffer from lack of oxygen, a reason for acute cesarean section. The variables **indik 1** - **indik 9** are defined as percentage of cases with these indications, respectively. The indications are based on obstetrical diagnoses and mutually exclusive on the individual level. The last group, ”other indication”, is a residual, and is not included in the analysis.

Since some risk-cases are referred from smaller to larger hospitals, it seems to be a reasonable assumption that departments with many deliveries perform a higher rate of cesarean sections. The variable **number** is a measure of the number of newborns per year (1991). We also included a dummy variable **univhosp**, as a proxy for the level of available medical technology.

Many other variables have been considered. Workload and availability of beds may have an influence on the propensity to perform a cesarean section. Number of newborns per obstetrician or available bed, and number of admissions at gynecological wards per doctor has also been tested as explanatory variables. All of these variables showed a negative, but not statistically significant, correlation with the cesarean section rate. Furthermore, since the quality of data was questionable, these variables were not included.

We also considered variables related to ”the physician practice style”. The two dummy-variables **management** and **education** measure whether there is a senior obstetrician with special responsibility for the delivery-unit, and whether there is a systematic follow-up of all cesarean sections performed within the unit, as part of the internal education. Some other variables were tested, e.g. the percentage of routine use of electronic fetal monitoring. Problems concerning the definition of ”routine”, made us exclude that variable from the analysis. However, available (incomplete) data did not support the hypothesis of a correlation between this variable and cesarean section rate.

To summarize, all included variables, except the last two (**management** and **education**), are assumed to be positively correlated with the cesarean section rate.

We started the regression analysis with a general model, including all independent variables enumerated in Table 2. This model was then reduced by successive elimination of variables not significantly correlated with the cesarean section rate.

Results

The result is summarized in Table 3.

(TABLE 3)

The final, reduced model can be written as follows:

$$\mathbf{c\text{-}section} = \underset{(5.83)}{8.00} + \underset{(2.51)}{0.29}\ \mathbf{age} + \underset{(2.87)}{4.27}\ \mathbf{indik\ 1} - \underset{(-2.68)}{1.52}\ \mathbf{education} \qquad (R^2=0.31)$$

That is, the cesarean section rate increases with the percentage of the mothers over 35 years, and with the percentage of cases with indication 1 (placenta praevia), but decreases with the existence of systematic follow-up of performed cesareans. The model explains 31 percent of the variation.

The hypothesis that all coefficients for variables excluded in the reduced model are equal to zero (slope restrictions), was tested using a joint F-test, and could not be rejected at the 5 percent level. To test for normality in residuals, we applied the Jarque-Bera´s test (J-B) on both models. The null hypothesis could not be rejected at the 5 percent level. From the Breusch-Pagan test (B-P), it appears that none of the models showed heteroscedastic residual variance. The RESET test does not indicate functional form misspecification for any of the models (4, 16, 38).

To test for the stability of the model we used a correlation matrix to choose those independent variables that showed a statistically significant ($p<0.05$) correlation with the cesarean section rate. First we run a regression with a single independent variable - the one with the lowest p-value. Then the other variables were included in turn. Finally, this model was reduced through elimination of non-significant variables ($|t\text{-value}|<1.96$). This resulted in the same model as above.

We also tested all the independent variables one by one as single regressors in (bivariate) linear regressions. Again the above variables were significant, now accompanied by **twins**, **asphyx** and **indik 4**. None of the other bivariate regressions were significant at the 5 percent level.

To further test for the stability of the model we excluded the university hospitals. This resulted in the same reduced model as above, but with a slightly higher explanatory value ($R^2 = 0.35$).

Since our model could, theoretically, predict inconsistent values, outside the interval 0-100 percent, we also run a regression where the dependent variable was transformed to a logit, i.e. the log of the odds. After reduction of the general model, we ended up with the same explanatory variables, but a slightly lower explanatory value ($R^2 = 0.29$).

Discussion

The final model includes a constant term and three independent variables. It explains about one third of the observed variation, which is acceptable for a cross-sectional study. Anyhow, there is good reason to ask whether we have made some serious mis-specifications.

Most of the independent variables considered are demand-related, and could be defined differently. We tried a number of alternative definitions, e.g. of the age-variable, without any significant effect on the explanatory value. We also tried to cluster some of the indications, again without much effect.

Two of the supply-related variables included describe the size of department (number of newborns) and level of care (university hospital or not), respectively. Both were eliminated at an early stage in the reduction process. Some other variables, reflecting resource capacity and work load, were tested. Since none of the partial effects were statistically significant, and since the data quality was questionable, we did not include these variables in the ”general” model.

Even within different indication groups we found large variations in cesarean section rates among departments. This indicates that the decision on mode of delivery to a large extent is governed by what we call *practice style*, i.e. the attitudes or beliefs of the responsible obstetricians. The variation in cesarean section rates within the various indication groups, is probably due not only to differences in probability of cesarean section, given a certain indication (*treatment practice style*), but also to differences in propensity to set a certain diagnosis (*diagnosis practice style*). Furthermore it can not be excluded that the variation is partly due to vague criteria for different diagnoses or faulty registration routines. A high cesarean section rate, given a certain indication, may be partly due to a low propensity to set (and/or lacking carefulness in the registration of) diagnoses leading to this indication. And vice versa, a low cesarean section rate may be due to a generous attitude to setting (and/or carefullness to register) the actual diagnoses. In summary, we have reason to believe that much of the unexplained variation in cesarean section rates has to do with differences in practice patterns. However, these are difficult to identify and even more difficult to quantify and model.

Differences in cesarean section rates may have medical as well as economic consequences. Most interesting from an economic perspective is the extent to which the variation indicate productivity or efficiency problems. Our study focuses mainly on the potential efficiency problems related to the overutilization of cesarean sections. An evidently necessary cesarean section which is not performed may, of course, create an even more serious problem from an efficiency perspective. However, this situation is probably quite rare.

Since we were unable to fully identify the causes of variation, we have a limited opportunity to evaluate the consequences of variation. In the individual case, an ”unnecessary” cesarean section is an expression of inefficient resource utilization. The practitioner has intervened beyond the indications, i.e. used the method where the marginal value to the patient is exceeded by the marginal cost, including the increased risk. Unnecessary costs are incurred; *direct costs* of the procedure itself and patient care, which are higher than those of the alternative, vaginal delivery, and *indirect costs* related to the increased risk for complications during and following the surgery, which in turn generate costs.

However, it is difficult to estimate the *opportunity cost*, which may vary over time, e.g. depending on the workload of the clinical departments. It is also equally difficult to determine the *number* of ”unnecessary” cesarean sections. No universal agreement exists in applying the indications for cesarean section. Furthermore, the tendency to meet patients´ preferences for cesarean section, generated by the fear or anxiety of childbirth, may vary among the clinical departments. Is a cesarean section which is not strictly motivated by medical indications (not ”appropriate”), but which meets a patient´s preference, ”unnecessary”? Opinions are also divided concerning the value of cesarean section for prolonged deliveries where other complications appear.

Lacking anything better, we have used the average *additional cost* of a cesarean section as an approximation of the opportunity cost. Using Swedish DRG data from 1993, this cost - defined as the difference in cost between DRG 371, cesarean section without complications, and DRG 372 (373), vaginal delivery with (without) complications - has been estimated at 14,202 (95 percent confidence interval; 13,568 - 14,836) and 16,671 (95 percent confidence interval; 16,124 - 17,218) Swedish crowns (SEK), respectively. The number of ”unnecessary” cesarean sections are, for reasons mentioned above, difficult to calculate. If we assume that it were possible - without complications for mother or child - to lower the number of cesarean sections at the clinical departments which exceed the average rate (12 percent at the university hospitals and 11 percent at the others), it would mean about 850 fewer cesarean sections per year (1991). This corresponds to an additional cost for ”unnecessary” cesarean sections of 12 -14 million SEK.

5. CONCLUDING REMARKS

In this study we used data from the Swedish Medical Birth Registry, including all deliveries in 1991. Alternatively, we could have made a sample study, using questionnaires or interviews to gather the information needed. Both approaches have their pros and cons. A disadvantage with the method chosen is the difficulty to capture exactly what governs the decision to carry out a cesarean section or not.

The choice of method for statistical analysis is governed by which ”decision-level” is focussed. Most available studies on variations in cesarean section rates seem to focus the individal patient, and use some kind of logistic regression with a dichotomous dependent variable. In our study, however, the focus was on the clinical department level, and consequently we used multiple linear regression analysis.

To find out more in detail which factors govern the choice of mode of delivery, we probably have to carry out a survey study based on a sample of deliveries. In particular, careful studies of a number of individual cases might enable us to learn more about the influence of practice patterns on the variation in cesarean section rates. Finally, it should be noted that variations per se tell us nothing about the potential for greater efficiency. If the distribution as a whole is ”off target”, a small variation may be a greater problem than a large variation where the distribution is generally ”on target”. No particular level is ”right” for all clinical departments. It may be possible to determine what is right after the fact, when we have access to the final results. Some variation is of course desirable - assuming it reflects the differences in medical needs and patients´ preferences.

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FIGURE 1

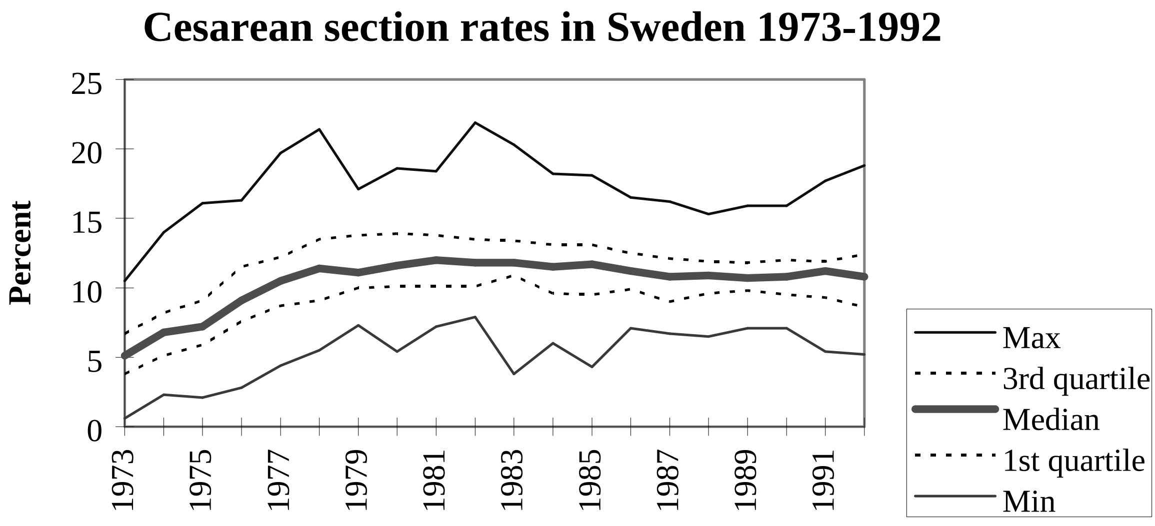
Cesarean section rates in Sweden 1973-1992
Percent
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
Max
3rd quartile
Median
1st quartile
Min

TABLE 1 Incidence of different indications for cesarean section

Indication	Number of cases	Cesareans;%	% of all cesareans
Placenta praevia	299	84	2
Ablatio	657	77	4
Disproportion	4 038	88	25
Pre-eclampsia	2 957	33	7
Dystocia	8 792	20	10
Fetal distress	5 890	40	15
Twins	2 074	33	5
Malpresentation	15 258	22	25
Psycho-social	999	53	4
Other indication	78 351	1	3
	119 315	11.2	100

TABLE 2 Variables

Variables	Description
Dependent variable	
c-section	percentage cesarean sections
Independent variables	
age	percentage mothers >35 years
parity	” nullipara
twins	” twin (or more) births
asphyx	” with asphyxia
indik 1	percentage with indication 1 (placenta praevia)
indik 2	” 2 (ablatio)
indik 3	” 3 (disproportion)
indik 4	” 4 (pre-eclampsia)
indik 5	” 5 (dystocia)
indik 6	” 6 (fetal distress)
indik 7	” 7 (twins or more)
indik 8	” 8 (malpresentation)
indik 9	” 9 (psycho-social)
number	number of newborns
univhosp	university hospital? (yes=1, no=0)
management	senior obstetrician? (yes=1, no=0)
education	continuous follow-up? (yes=1, no=0)

TABLE 3 Multivariate regression

Parameter/variable	General model		Reduced model	
	Coefficient	t-value	Coefficient	t-value
constant	7.445	1.542	7.998	5.828
age	0.310	1.884	0.287	2.511
parity	-0.043	-0.343		
twins	-0.097	-0.087		
asphyx	0.351	1.385		
indik 1	4.000	2.337	4.274	2.876
indik 2	0.310	0.333		
indik 3	0.205	0.857		
indik 4	0.265	0.647		
indik 5	-0.036	-0.528		
indik 6	-0.155	-0.866		
indik 7	0.416	0.281		
indik 8	0.275	0.690		
indik 9	0.232	0.565		
number	6.563E-05	0.133		
univhosp	-0.125	-0.131		
management	-0.808	-0.942		
education	-1.128	-1.516	-1.520	-2.681
d.f.	41		55	
R^2 (R^2 adj)	0.425 (0.186)		0.313 (0.275)	
SSE	149.965		179.097	
Slope restr	-		F(14;41)=0.569	
J-B (d.f.)	JB(2)=0.849		JB(2)=0.702	
B-P (d.f.)	$\chi^2(17)=21.884$		$\chi^2(3)=6.233$	
RESET (d.f.)	F(3;38)=0.390		F(3;52)=1.472	