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Random Behavior or Rational Choice? Family Planning, Teenage Pregnancy and STIs

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Abstract

Rational choice of teenage sexual behaviour lead to radically different predictions than do models that assume such behaviour is random. Existing empirical evidence has not been able to distinguish conclusively between these competing models. Using regional data from England between 1998 and 2001, I find that recent increases in availability of youth family planning clinics are associated with increases in teenage STI rates, but are not associated with changes in pregnancy rates. I further find that the impact on STI rates has increased significantly since emergency birth control has become more widely available. The observed relationships are largely consistent with economic models of rational choice and inconsistent with models in which teenage sexual behavior is assumed to be random.

Keywords: family planning; teenage pregnancy; underage conceptions; sexually transmitted infections.

JEL Classifications: J13, I18.

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I. Background

The behavioral response of adolescents to the provision of family planning services remains something of a puzzle. At least two contrasting theories of adolescent sexual behavior have been put forward. A standard economic approach is to assume some level of rational decision-making amongst adolescents, whereas an approach common in other disciplines is to assume that adolescent sexual activity is the outcome of decisions that are essentially random in nature (Levine, 2000). Although there is a substantial empirical literature on the impact of family planning on teenage fertility, including a significant contribution from economists, it has proved difficult to reconcile this evidence satisfactorily with either model of behavior.

In this paper, I explore the possible reasons for the inconsistency between theory and evidence and suggest ways in which data might be better used to inform theory. I argue that analyzing the impact of family planning provision on pregnancy rates *and* rates of sexually transmitted infections (STIs) simultaneously offers a novel and useful way forward. Further, the shift in emphasis from contraceptive methods that protect both against pregnancy and STIs towards methods, such as emergency birth control, that protect only against pregnancy leads to a series of specific predictions regarding the impact of family planning provision on teenage pregnancy and STI rates. Testing these predictions offers a potentially fruitful way of distinguishing between alternative models of teenage sexual behavior.

Recent policy developments in England, introduced with the aim of reducing rates of teenage pregnancy, provide researchers with a wealth of useful evidence on these issues. I use panel data on family planning services, teenage conception and STI rates from 99 health authority regions across England over the years 1998 to 2001 to test the alternative models of sexual behavior.

The rest of the paper is laid out as follows. In the next section, I summarize the current state of knowledge regarding the impact of family planning on the sexual health of adolescents. In section III, I outline the key policy changes that have occurred in England over the past few years and summarize the related theoretical predictions generated by alternative models of adolescent sexual behavior. In section IV, I introduce the data and explain the empirical methods used in the paper. In section V, I describe and discuss the empirical results. In section VI, I make some concluding remarks.

II. What do we know about family planning, teenage pregnancy and STIs?

The issue of teenage fertility attracts a multi-disciplinary approach and contributions have been made from the fields of economics, sociology, medicine, social policy and political science. One distinguishing feature of economics research, at least in the neo-classical tradition of the discipline, is the use of formal theoretical models to predict the impact of policy changes and to create a framework within which to analyze data. Following the seminal work of Becker (1963), the distinctive contribution of much of the economic work in this area is an insistence that decisions on sexual activity, use of family planning and pregnancy resolution should be treated endogenously (see, for example, Akerlof, Yellen and Katz, 1996; Kane and Staiger, 1996; Oettinger, 1999; Levine, 2000).

Models of rational behavior which emerge from this approach lead to ambiguous predictions about whether an increase in the availability of family planning leads to an increase or decrease in observable outcomes such as teenage pregnancy rates. Consider, for example, a rational choice model in which teenagers choose between sexual activity and abstention based on their expected utility of each choice (Oettinger, 1999; Paton, 2002).

Those who choose sexual activity must further choose whether or not to use contraception to protect against pregnancy and/or STIs. The expected utility of each choice is a function of the utility of sexual activity, of outcomes (for example, pregnancy or an STI), of the perceived probability of each outcome and of the relative costs of each choice.

Consider further, in the context of such a model, the impact of a policy that reduces the marginal cost of family planning for adolescents. Those who choose sexual activity will be more likely to use some method of family planning and (to the extent that their method of choice is effective) will face a lower probability of pregnancy. At the same time, for adolescents who would prefer not to get pregnant, the decrease in the probability of pregnancy will lead to an increase in the expected utility of sexual activity relative to abstinence. As a consequence, we would expect some adolescents who would otherwise have chosen abstinence to participate in sexual activity (and others to choose more sexual activity more of the time). Some of this group will get pregnant due to contraceptive failure or mis-use. Theoretical models of this type, therefore, offer no simple predictions of whether adolescent pregnancy rates would increase or decrease as a result of such a policy. Rates may increase, decrease or not change. The underlying intuition behind this type of model is no different to many microeconomic models of behavior in other fields. Put simply, we expect people to respond to incentives. When the marginal cost of birth control goes down, the incentive to use it is increased both for adolescents who were previously having sex and not using birth control, but also for adolescents who were previously not having sex at all.[1]

In contrast to models of rational behavior, some work, largely based in disciplines other to mainstream economics, assumes that teenagers' decisions about whether to engage in sexual activity are essentially random, at least in so far as that makes them exogenous to

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[1] There is also a complementary and extensive literature on risk displacement in the context of automobile safety. Authors such as Peltzman (1975) and Adams (1994) argue that the beneficial effects of a technical

family planning policy (see, for example, Moore *et al.*, 1995). The rationale behind this approach is that teenagers may not have the necessary information, or may not process that information in a way that would prompt them then to respond rationally to incentives. Under this assumption, a policy change that, for example, provides teenagers with easier access to emergency birth control after (random) acts of sex will reduce fertility rates amongst the (constant) proportion of sexually active teenagers. As a result, such a policy is predicted unambiguously to increase rates of family planning and to reduce teenage pregnancy rates. For an explicit example of this approach, see Kahn, Brindis and Glei (1999).[2]

In the following discussion, I use the terms 'rational choice model' and 'random behavior model' to distinguish between these two alternative theoretical approaches. Given that each approach has potentially contradictory implications for public policy on, for example, how best to reduce teenage pregnancy rates, it seems reasonable to turn to empirical evidence to try to choose between them.

The empirical evidence can usefully be divided into two categories, project evaluations and policy evaluations. Project evaluations examine the impact of particular projects on specified outcomes, for example, the introduction of a family planning clinic at a single school. This type of approach is more common in the medical literature and the most persuasive evidence uses Randomized Controlled Trials (RCTs), in which an 'intervention' group is compared to a 'control' group for which there is no intervention but which is otherwise similar.[3] Much more common in the field of economics are policy evaluations in which the impact of particular policies is analyzed using data aggregated across a region,

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improvement in road safety may be offset by an increase in dangerous driving. Richens *et al*. (2000) explicitly link these ideas to the issue of condoms and protection against STIs.

[2] Arguably, there is a logical inconsistency in assuming that decisions on sexual activity are exogenous to policy, but that the uptake of family planning is not. A further intuitive advantage of the rational choice model is that its predictions depend only on some adolescents responding rationally to incentives, not that all youngsters do. The issue of which model is most intuitively appealing, however, is not the primary focus of this paper.

State or country. Research in this category often uses large-scale secondary data sets, in many cases aggregated to the State or regional level.

Both types of evidence can be useful in testing theoretical predictions. RCTs represent an extremely powerful method for clearly identifying the impact of a specific intervention and isolating this impact from other factors. However, RCTs can suffer from problems such as response bias, attrition rates and from the confounding influences of related projects. In contrast, the use of aggregate data sets (for example, those relating to pregnancy or abortion rates) minimizes the potential for response bias. Further, given that the formulation of policy is generally undertaken at national, state or regional level, it seems appropriate to examine whether policies have impacts that can be observed at aggregate levels.

Evaluations of family planning projects have examined the impact on rates of teenage sexual activity, contraceptive use, births, abortions and overall pregnancy rates. Policy evaluations have largely been restricted to examining the impact on births, abortions and pregnancy rates.

In a systematic review of the impact of a range of interventions (including family planning projects) aimed at reducing adolescent pregnancy rates, DiCenso *et al*. (2002) conclude that, to date, primary prevention strategies have had insignificant effects on pregnancy rates. Similarly, an influential review of over 250 experimentally-based evaluations of program for school-age children in the U.S.A. finds little or no evidence that school or community based family planning clinics reduced pregnancy rates (Kirby, 2001). No systematic review of the policy evaluation literature currently exists. However, the majority of authors find no evidence of a significant impact of access to family planning services on teenage pregnancy rates (for example, Singh, 1986; Evans, Oates and Schwab,

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[3] Evidence based on 'observational studies', in which no control group is present, has been shown to be

1992; Hughes, Furstenberg and Teitler, 1995; Clements *et al.*, 1999; Paton, 2002)[4]. There is, however, some evidence that access to family planning reduces adolescent *births* (Forrest, Hermalin and Henshaw, 1981; Singh, 1986; Anderson and Cope, 1987; Davis, Olson and Warner, 1993; Wolfe, Wilson and Haverman, 2001). In summary, the weight of evidence on this point, from both project and policy evaluations, is consistent with the endogenous rational choice model and inconsistent with the random behavior model.

To date, the only evidence from either project or policy evaluations relating to impact of access to family planning services on rates of sexually transmitted infections is provided by Klick and Stratmann (2003). The main finding of this paper is that the incidences of gonorrhoea and syphilis in the USA are positively and significantly correlated with abortion legalization. The authors also include the earliest legal age at which contraceptive services can be obtained without parental consent as a control variable. For some specifications, they find that a younger legal age is associated with higher rates of gonorrhoea. Note, though, that Klick and Stratmann (2003) use data on STI infections to people of all ages and, to date, there is no work at all that focuses on infections amongst teenagers.

Turning to the evidence on the impact of family planning services on sexual activity rates (which is restricted to project evaluations), DiCenso *et al*. (2002) and Kirby (2001) both conclude that specific interventions focusing on improved access to family planning have no significant impact on sexual activity rates amongst adolescents. Such a result is inconsistent with the rational choice model and consistent with the random behavior model.

Lastly, there is a body of RCT evidence that examines the impact of family planning projects on overall contraceptive use. DiCenso *et al*. (200s) and Kirby (2001) find that most family planning projects appear to have had little success in increasing overall rates of

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biased in favor of interventions (Guyatt *et al.*, 2000).

[4] An exception to this conclusion is provided by Lundberg and Plotnick (1995) who find that restrictive contraceptive laws are positively correlated with pre-marital pregnancies for whites, but not for blacks.

contraceptive usage amongst sexually active adolescents. This conclusion is inconsistent with both the rational choice model and the random behavior model.

Thus, empirical work to date has not been able to distinguish satisfactorily between the two competing theories of sexual behavior. Null results on the impacts of family planning on sexual behavior and outcomes are particularly difficult to interpret. One possible hypothesis is that, for adolescents who wish to avoid pregnancy, the costs of family planning for adolescents are so low relative to the costs of pregnancy that they are effectively irrelevant to the adolescent decision-making process on sexual activity. As a result, a policy-induced reduction in the marginal cost of family planning has no impact on any aspect of behavior. This explanation is not entirely satisfactory. Given that the utility of adolescents from sexual activity is likely to follow a continuous distribution, one would expect that some teenagers are taking decisions at the margin. In these cases, even a marginal change in a relatively small cost should have an impact on decisions. A modified form of this explanation is that null results are the result of Type II errors. In other words, there may be causative effects occurring that are consistent with either the rational choice or random behavior models, but the data are simply not strong enough for the effects to be observed as statistically significant.

A second possibility relates to the fact that evidence on sexual activity and contraceptive use is restricted largely to project evaluations.[5] As explained above, these studies focus on specific projects, the effects of which may be impossible to isolate from confounding influences of related projects. For example, Kirby (2001) attributes the finding that school-based condom projects did not increase overall contraceptive usage to a substitution effect in which teenagers simply replaced their existing source for contraceptives

[5] Indeed, the limited direct evidence from economists on the determinants of sexual activity suggests that costs and benefits do make a difference (Oettinger, 1999; Levine, 2000).

with the new, school-based source. In other words, the findings on sexual activity and contraceptive usage may simply be artefacts of their limited evidence base.

Whatever the explanation, an important question for researchers in the field is whether it is possible to use available data more imaginatively to improve our understanding of teenage sexual behavior. The fact that there has been no research at all on the determinants of sexually transmitted diseases rates *amongst adolescents* represents an important gap in the evidence base. The impacts of family planning on STI rates predicted by the rational choice model are likely to be different to those on pregnancy rates and these differences may provide a way of 'triangulating' the existing empirical evidence. For example, barrier contraceptive methods provide significant levels of protection against STIs whereas most non-barrier methods provide little or no protection. Both barrier and non-barrier methods are commonly used by adolescents, the choice of method being determined by availability, perceived side effects and personal circumstances.[6] Consider, then, a uniform decrease in the marginal cost of all methods of family planning and assume, for the moment, no impact either on rates of sexual activity or on other risk factors (such as the number of partners). A sexually active adolescent who switches from using no method of family planning to a barrier method will face a lower probability of pregnancy and a lower probability of contracting an STI. An adolescent who switches from no method to a non-barrier method will also face a lower probability of pregnancy, but will experience no change to the probability of contracting an STI. Thus, intuitively, under the random behavior model, we would expect the decrease in the marginal cost of family planning services to have a beneficial impact on adolescent pregnancy rates and a beneficial (albeit weaker by comparison) impact on STIs. With the rational choice model, sexual activity is expected to

[6] Ahituv, Hotz and Philipson (1995) report evidence that the demand for condoms is endogenous to the local prevalence of AIDS. However, evidence from England (ONS, 2003) suggests that the dominant motivation amongst adolescents for using family planning is prevention of pregnancy.

increase in response to greater access to family planning. As a result, the overall impacts on STIs and pregnancies are more difficult to predict. It is quite possible, for example, that teenage pregnancy rates may be unchanged but that STI rates will increase. Alternatively, pregnancy rates may decrease whilst STI rates do not change or increase. In any case, if less costly access to family planning leads to an increase in either pregnancy or STI rates, this can be consistent only with the rational choice model, and not with the random behavior model.

A second avenue to explore is the case when policy causes a shift in the relative costs of barrier compared with non-barrier methods. In recent years, a feature of family planning policy in many countries has been increased promotion of emergency birth control (sometimes called 'emergency contraception' or the 'morning after pill') to young people as a means of reducing pregnancy rates. It is known that a large proportion of teenage pregnancy rates result from contraceptive failure (see, for example, Churchill *et al.*, 2000). Emergency birth control (EBC) provides a *post hoc* intervention whereby pregnancy can still be averted even after contraceptive failure or non-use. Under the random behavior model, the shift to EBC will be predicted to lead to a reduction in pregnancy rates, but STI rates should not be affected. Under the rational choice model, the availability of EBC enables young people to reduce the risks of pregnancy even more than in the presence solely of other methods and, thus, will be predicted to lead to an increase in rates of sexual activity. This effect may be reinforced if the knowledge that EBC is available weakens a woman's bargaining power at the time when effective decisions over sexual activity are taken (Akerlof *et al*, 1996). The overall impact on pregnancy rates is impossible to predict. On the other hand, as EBC offers no protection at all from STIs, the relative reduction in its cost would be predicted to result in an increase in STI rates.[7]

[7] It is notable that the impact of access to emergency birth control has to date received no specific attention in the economic literature. To my knowledge, the only related research is that of Churchill *et al*. (2000)

As we will see below, recent policy experience in England provides a highly promising setting in which to test these hypotheses. The relevant policy initiatives are described in the next section.

III. Recent Policy in England

Teenagers in England have been able to access contraceptive advice and services free of charge from a network of family planning clinics since the mid-seventies. Following a landmark judgement in 1985, these services have been available to under-16s (under certain conditions) without the need for parental consent or notification. Health care services related to STIs are provided in specialist Genitourinary Medicine (GUM) clinics. On the whole, services related to family planning and STIs have been kept separate from each other.

Teenage pregnancy rates in England have remained amongst the highest in the developed world and this prompted the Government to instigate a major inquiry into the issue. The report of this inquiry was published in April 1999 (Social Exclusion Unit, 1999). In the report, it was argued that an important factor contributing to high teenage pregnancy rates in England was a lack of knowledge of and access to family planning services aimed specifically at young people. In June 1999, the UK Government officially adopted the recommendations of the report by launching the Teenage Pregnancy Strategy for England. Contained within this Strategy was a commitment to reducing under-18 conception rates in England by 50% by the year 2010 and to establish a downward trend in under-16 conception rates (Social Exclusion Unit, 1999). Two key policy initiatives to achieve these aims are relevant to the themes of this paper. The first was an expansion of community based family planning services aimed specifically at adolescents. Responsibility and funding for implementing this policy were devolved to local areas, and there is good evidence that the

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who find that adolescents prescribed with EBC were more likely than others subsequently to be referred for rate of expansion has shown considerable regional variation (Wellings *et al*, 2002). The second relevant policy initiative was a nation-wide shift in emphasis towards the provision of emergency birth control. Regulations that came in at the start of 2000 made it much easier to dispense the hormonal version of EBC without a doctor's prescription at family planning clinics and other sources and there have been many initiatives to promote this form of birth control to young people. Pharmacies were also permitted to supply EBC from this time. Except for a few pilot areas, however, pharmacy provision is restricted to those over the age of 16 and was subject to a fee, whereas provision at family planning clinics is available free of charge without age limit.

In a parallel development, the Government has also adopted a National Strategy for Sexual Health and HIV (Department of Health, 2001) aimed at reducing rates of STIs. There have been sharp increases in rates of STIs across the UK in recent years, especially amongst young people (Public Health Laboratory Service, 2002) and the expansion of youth oriented family planning services is emphasized in the National Strategy for Sexual Health and HIV as a way of reversing this trend.[8]

In terms of the models discussed above, the expansion of youth-oriented family planning clinic services implies a reduction in the effective price of all birth control. The promotion of EBC implies a reduction in the effective price of EBC both in real terms and relative to the price of other forms of birth control.

These policy changes have contrasting implications for different models of teenage sexual behavior. Using the rational choice model, it is unclear *a priori* what will be the impacts of the expansion of family planning services for young people on pregnancy and STI

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abortion.

[8] Part of the increase may be due to greater awareness and diagnosis of STIs. However, the PHLS attribute a significant proportion of the increase to a rise in risky sexual behavior amongst young people.

rates. Using the random behavior model, the expansion of services should have led unambiguously to a reduction in pregnancy rates and also to a reduction in STI rates.

The rational choice model would predict that the reduction in the real and relative price of EBC will lead to greater use of EBC relative to other forms of birth control (some of which provide protection against STIs). A clear empirical consequence is that we would expect the relationship between family planning and STIs to have worsened from 2000 *relative* to the relationship between family planning and pregnancy rates. In contrast, the random behavior model would predict the relationship between family planning and pregnancy rates to have improved from 2000 whilst the relationship between family planning and STI rates should have remained unchanged.

The consistency of the models with different combinations of observed relationships are summarized in Tables 1a and 1b. Clearly, we cannot guarantee being able to use the empirical outcomes to confirm any one of the two models of behavior. By observing both pregnancy and STI outcomes, however, we greatly increase the likelihood that we are able to eliminate models that are inconsistent with the evidence.

IV. Methods and Data

Empirical Methodology

I estimate two variants of econometric models of teenage pregnancy and STI rates in different regions (i) over time (t). In the first instance, I use the following model to test for the overall impact of family planning access on pregnancy and STI rates.

$$\text{pregnancy}_{it} = \alpha_0 + \alpha_1 \text{FP}_{it} + \gamma\mathbf{x}_{it} + \eta_i + \nu_t + \mu_{it} \quad (1a)$$

$$\text{STI}_{it} = \beta_0 + \beta_1 \text{FP}_{it} + \delta\mathbf{x}_{it} + \eta_i + \nu_t + \omega_{it} \quad (1b)$$

where FP = some measure of access to family planning;
$\mathbf{x}$ = vector of other variables likely to affect pregnancy and STI rates;
η = region-specific effects;

ν = time-specific effects;
μ and ω are classical disturbance terms.

Recalling the discussion above, a positive coefficient on either α_1 or β_1 would be sufficient to reject the random behavior model.

In order to test whether the impact of family planning access has changed with the shift in emphasis since 2000 towards emergency birth control, I also estimate the following variant:

$$pregnancy_{it} = \alpha_0 + \alpha_1 FP_{it} + \alpha_2 FP*1999 + \alpha_3 FP*2000 + \alpha_4 FP*2001 + \gamma \mathbf{x}_{it} + \eta_i + \nu_t + \mu_{it} \quad (2a)$$

$$STI_{it} = \beta_0 + \beta_1 FP_{it} + \beta_2 FP*1999 + \beta_3 FP*2000 + \beta_4 FP*2001 + \delta \mathbf{x}_{it} + \eta_i + \nu_t + \omega_{it} \quad (2b)$$

where 1999, 2000, 2001 are indicator variables for each of those years.

In this specification, α_2 is the differential impact of family planning on teenage pregnancy in 1999 compared to 1998, α_3 is the differential impact for 2000, whilst α_4 is the differential impact for 2001. The coefficients β_2 - β_4 can be interpreted similarly. Note that on the basis of the random behavior model, we would expect that α_3 and α_4 will be negative, whilst β_3 and β_4 will be zero. On the basis of the rational choice model, we have no *a priori* expectations about the signs of α_3 and α_4, but we would expect that β_3 and β_4 will be positive.[9]

Several methodological issues arise at this point. The first one is that of correctly identifying the family planning impact. Several measures of family planning access have been used in earlier work, including clinic enrolment (Forrest, Hermalin and Henshaw, 1981; Anderson and Cope, 1987; Paton, 2002), state-specific legal restrictions (Lundberg and Plotnick, 1995), travel distance from clinics (Clements *et al.*, 1999), State expenditure (e.g.

Wolfe, Wilson and Haverman, 2001) and number of clinics (Evans, Oates and Schwab, 1992). Whichever measure is used, however, identification of the family planning provision effect is not easy. Specifically, family planning services are more likely to be set up in areas where pregnancy rates (and perhaps STI rates) are high. Thus, we may observe a spurious positive correlation between the family planning and teenage pregnancies. Put another way, unobservable high rates of sexual activity in an area due, for example, to socioeconomic factors, are likely to lead to a high demand for family planning services as well as high pregnancy and STI rates. The estimation problem is that, in this event, a right hand side (RHS) variable (family planning access) is correlated with an unobservable effect and this will render OLS and random-effects panel data estimates inconsistent. Fixed-effects panel data estimates (that is, with regional effects included) are consistent, however, even when the fixed-effects are correlated with a RHS variable. As long as the random (and unobservable) rates of sexual activity within each region do not change relative to each other, the fixed-effects estimator will yield consistent estimates of the family planning impact. This assumption is almost certainly valid in our case. We consider here a relatively short time period of 4 years, over which there has been a significant policy shift. As a result, changes induced on the supply side to family planning services in each region are likely to outweigh by far any demand side changes caused by exogenous changes in sexual activity.

One disadvantage of the fixed-effects model is that the impact of the RHS variables must be identified solely from relative changes over time rather than from absolute levels. This is unlikely to be a serious problem for the key variable here, family planning, due to the significant variation over time caused by the major policy shift in England. Indeed, as we will see below, the data used here display a good deal of regional variation over time in the family planning provision for young people over the time of the policy change. Nevertheless,

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[9] I have chosen to allow different effects for each year. An alternative is to allow a single shift in the

it will be more difficult to identify the impact of other variables such as education or unemployment if they show little time-series variation. Similarly, the impact of variables that do not vary over time cannot be estimated at all with the fixed-effects model. For this reason, despite the focus here on the fixed-effects model, I also report estimates of equations 1 and 2 using the potentially more efficient random-effects estimator.

Another methodological issue is that teenagers resident in a particular region may use family planning services in an adjacent area, thus confounding the correlation between family planning and pregnancy. The problem is most likely to be severe within large metropolitan areas such as London. In fact, omitting areas such as London has little impact on the key results. In any case, though, I report panel estimates that allow for contemporaneous correlation across cross-sectional units as well as groupwise heteroskedasticity (Greene, 2000, pp.598-603).

The final econometric issue considered here is the nature of the dependent variable. The dependent variables here are measured as rates. In principle, then, they are bounded below and above and this raises a question about the appropriate regression methods. The bounds are never approached in the data used in this paper and so the practical problem is likely to be very slight. One alternative would be to specify the dependent variables in absolute numbers and to include the base population on the right hand side. Count data techniques could then be applied to the data, such as Poisson regression. Another approach would be to use grouped logit regression. In fact, neither technique leads to significant changes to our conclusions. The estimates using these alternative techniques are not reported here but are available from the author on request.

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family planning effect for years after 1999. The conclusions from using this approach are unaltered.

Data

The units of analysis are the 99 health authorities within England. Health authorities represent the most disaggregated level for which all the relevant data are available. I have annual data from 1998 to 2001. The English Teenage Pregnancy Strategy was adopted in June 1999, meaning that our period of analysis covers one full year before the Strategy, the year of adoption and two full years of implementation of the Strategy.

Pregnancy data in England is of high quality relative to many other countries. There are legal requirements for the reporting of live births and abortions. The Office of National Statistics estimate the time of conception in each case to arrive at annual conception rates for each health authority in the country. Rates are available for a several age groups: all teenagers, 16 to 19 year-olds, under-18s and under-16s.[10]

The Public Health Laboratory Service (PHLS) provided data on STI diagnoses broken down by health authority. These data cover cases of major STIs diagnosed at genitourinary medicine (GUM) clinics in each health authority area. STI rates are available for the same age groups as conceptions data with the exception that rates for under-18s are not collected.

A potentially important issue is that we are only able to observe diagnoses of STIs and not actual infections. Diagnoses will underestimate infections for at least two substantive reasons, one on the demand-side and the other on the supply-side. The demand-side reason is that some STIs (in particular genital chlamydia) are largely asymptomatic and may go unreported (Fenton *et al*., 2001). This is not a problem in itself. If, however, the extent of the underestimation is correlated with one or more of the explanatory variables (for example, family planning services) then the estimates will be biased. The direction of any bias is not immediately obvious. Although family planning and STI services are largely separated from each other in England, some family planning clinics in England offer STI screening and treatment services, most commonly for chlamydia (Kirkwood *et al.*, 1999).[11] If adolescents are subsequently referred on to GUM clinics for treatment (Tobin, Bateman, Banks and Jeffs, 1999), then family planning clinics may show a spurious positive correlation with diagnosed STI rates. On the other hand, some family planning clinics also offer treatment for chlamydia. This will have the effect of reducing diagnosis at GUM clinics and may reveal itself in a spurious negative correlation. To alleviate this problem, I first drop from the analysis two health authorities in which a pilot scheme for more general screening of young people for chlamydia took place during the time period in question. Second, given that chlamydia is the infection most likely to be affected by these considerations, I present alternative estimates of 'all STIs diagnosed at GUMs' and also 'STIs diagnosed at GUMs excluding chlamydia'.[12]

The supply-side reason why diagnoses are likely to underestimate infections is that services are rationed at many GUM clinics. The rapid increase in demand for GUM services in the past few years has forced some clinics to impose long delays between when a young person first contacts the clinic and the time when the young person actually sees a health professional at the clinic (Foley et al, 2001). In these cases, there will be a supply-induced constraint on the number of diagnoses reported by the clinic. These constraints are unlikely to be random in nature. Rather, a supply-side constraint is more likely in response to a large, exogenous increase in demand for services. This has implications for our estimates. If, for example, increased promotion of EBC in an area is associated with an increase in STI infection rates which is not observed in diagnosis data due to supply-constraints, then the

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[10] The figures do not include miscarriages.

[11] Although GUM clinics commonly provide condoms for their clients, such a service will not be included in the family planning measures used here.

[12] It has been pointed out to me that there is a case for focusing *only* on chlamydia as this disease is particularly prevalent amongst young women. In fact, the results on chlamydia alone are very close to those for all infections reported below.

impact of EBC promotion on STIs will be underestimated. In the empirical analysis below, I explore this issue using data on waiting times at GUM clinics in England.

Finally, as general practitioners (GPs) are another source of diagnosis, treatment and referral for STIs, I include the number of GPs per km^2 in each authority as an additional control variable in every model.

Data on family planning are collected by the Department of Health and are also available on an annual basis for each health authority. Since 1998, data have been collected on the number of clinic sessions (including those in schools) offered primarily to young people in each region. Specialist clinic provision for young people is a key policy measure both for the Teenage Pregnancy Strategy and the National Strategy for Sexual Health and HIV, so this variable is an important measure. Note that a 'session' represents a period of time in which the services of a family planning clinic are made available specifically to young people. The advantage of using this measure instead of, for example, clinic visits is that clinic sessions more closely represent supply, whereas visits are a function both of demand and supply. I divide the number of sessions by the area (in km^2) of each health authority to arrive at a measure of geographical costs.[13] Family planning is also available from other sources, most particularly general practitioners (GPs). I have data available from the National Database for Primary Care Groups and Trusts (PCGT) on the number of GPs in each health authority who offer a free contraceptive service to any patient (that is, not just to patients on the GP's list). This type of service is particularly relevant to teenagers who may be unwilling to approach their family doctor for advice on family planning. In addition, since the start of 2000, a few areas have piloted free provision of EBC at pharmacists to young people of any age without a doctor's prescription. I control for this effect by including the

[13] Deflating by population does not materially change our results.

number of pharmacists in each health authority offering this service. As with clinic sessions, the number of GPs and pharmacists are deflated by the area of the health authority.

A good deal of previous work suggests that a series of socioeconomic factors can significantly affect pregnancy rates. In general, teenage pregnancy rates have been found to be correlated with low educational achievements, unemployment rates, unstable family background, race and religiosity (Evans, Oates and Schwab, 1992; Plotnick, 1992; Chong-Burn, Haverman and Wolfe, 1993; Paton, 2002).[14] Very few studies have examined the impact of these factors on rates of STI, the one exception being Klick and Stratmann (2003) who find that education and income levels have no consistently significant impact on overall rates of gonorrhoea and syphilis infections in the population. Some of the socioeconomic effects will be picked up in the regional and time effects but I also include four additional control variables that vary both over time and across regions. These variables are as follows: claimant unemployment rate in each authority (*unemployment*); proportion of families in each authority headed by a lone parent (*% lone parents*); rates of children between 10 and 18 who are looked after by the local authority (*children in care*); proportion of pupils in each authority gaining no educational qualifications at age sixteen (*% no qualifications*).

For the random-effects estimates, I also include variables taken from the 2000 census and other sources and for which data is only available at one point in time. These are the proportion of non-white people in the total population (*ethnic minorities*), the proportion of people (in the adult population) who are divorced or separated (*divorces*), the proportion of people describing themselves as Muslims (*Muslims*) and the proportion of the people who

[14] Oettinger (1999) and Evans, Oates and Schwab (1992) are amongst those authors who consider the impact of sex education programs. Relevant data on this was not available to me. Further, although welfare may be an important determinant of fertility amongst young people (for example, Rosenzweig, 1999), there is no variation in welfare entitlements across England. There is also a more limited literature looking directly at the determinants of teenage sexual activity (for example, Brewster, Billy and Grady, 1993; Billy, Brewster and Grady, 1994; Oettinger, 1999; Levine, 2000).

state that they regularly attend a Christian service (*Christians*). Full details of the specification of all variables are given in the Appendix.

V Empirical Results

National Trends

I first consider national trends over the period of the Government's Teenage Pregnancy Strategy. The strategy first began to be implemented from the middle of 1999. In Table 2, I report national data on conception rates, STI rates and the number of youth-oriented family planning clinic sessions for each year between 1998 and 2001. Of particular interest are the changes between 1999 (the year in which the Strategy was adopted) and 2001 (the second full year of implementation).

The direct effect of the policy of increasing clinic-based family planning services for young people is clear. Nationwide, between 1999 and 2001, the number of clinic sessions offered rose from 27,075 to 33,369, an increase of 23.2%, whereas the number of GPs offering services to any person rose just 1.78%. Government survey data reveals that, between 1999 and 2001, the proportion of 16 to 19 year olds who claim not to be sexually active fell from 39% to 27%. Over the same period, conception rates amongst all teenagers fell by 3.5% whilst rates of STIs rose by 15.8% (ONS 2003). Thus, there is *a priori* evidence of a differential impact of the Teenage Pregnancy Strategy on conceptions and on STIs. The pattern of this difference is consistent with the rational choice model (in which greater access to family planning encourages more young people to engage in sexual activity) but is inconsistent with the random behavior model. Clearly, however, a range of wider trends and influences may have affected these national figures. I now go on to use our econometric model on the health authority data to test, formally, both for the existence of a differential family planning impact and for significant changes in the nature of that impact over time.

Econometric Evidence

In Table 3, I summarize the cross-sectional (between) and time-series (within) variation of each of our key variables. Recalling that the fixed-effects models rely on time-series variation to identify the impact of each variable, note that most of the time-varying variables display a considerable amount of 'within' variation. As the quantity of clinic sessions is the key policy variable in this study, it is worthwhile confirming that there is indeed a significant amount of regional variation in the impact on this variable with which to be able to identify the policy impact. Between 1998 (the year before the start of the Teenage Pregnancy Strategy) and 2001, the mean percentage increase in clinic sessions across the 99 authorities was 51.2%. The variation around this mean is considerable: the standard deviation is 101.51%, with a minimum figure of -81% and a maximum of +510%. Survey evidence provided by Wellings *et al.* (2002) confirms that the rate and intensity of policy implementation on family planning services for young people has varied considerably across different regions.

The two variables that show little variation over time are the number of GP practices per km^2 and the number of GPs providing contraceptive services to any person, for both of which nearly all the variation is 'between'. For this reason, the fixed-effects estimates for these variables should be treated cautiously. By definition, the census variables display no 'within' variation and it is not possible to derive fixed-effects estimates for those variables.

For each model, I report a series of diagnostic tests. The first is the Hausman test for fixed-effects over random-effects. A significant value for this test indicates significant differences between the fixed-effects and random-effects estimates and suggests that the random-effects estimator may be inappropriate. The second test is the modified Wald test for groupwise heteroskedasticity (Greene, 2000, p.598), whilst the third is the Breusch-Pagan test for independence across units (Greene, 2000, p.601). In every case, the results of these tests suggest support for the correction for groupwise heteroskedasticity and cross-sectional correlation.

The econometric estimates for the pregnancy and STI models for all teenagers are reported in Tables 4 and 5 respectively. I report the GLS random-effects estimates (with semi-robust standard errors) in the first column of each table, including the four census variables. In the second column, I report the fixed-effects estimates without the census variables and with standard errors that allow for groupwise heteroskedasticity and contemporaneous correlation across authorities.

The Hausman tests suggest that the random-effects estimates are appropriate for the pregnancy models, but may be inconsistent for the STI models. The random-effects estimates of the coefficients on the socioeconomic variables in the pregnancy models generally follow the pattern predicted by economic theory and are consistent with a good deal of previous research. For example, lone parents, lack of educational qualifications and the number of divorces are all associated with increases in pregnancy rates, whilst rates are significantly lower when more people state that they attend a weekly Christian service. The fixed-effects estimates of these variables are much less easy to interpret, whilst the variables appear to have very little explanatory power at all in the STI models.

The coefficients on the family planning variables are much closer across the random-effects and fixed-effects models. As expected, given the limited ‘within’ variation, we are unable to observe any significant impact of GP contraceptive services or GP practices in any specification. However, clinic sessions for young people and free pharmacy provision of EBC prove to have significant explanatory power in at least some specifications.

The random-effects and fixed-effects estimates of equation 1a (reported in Table 4, columns 1 and 2) suggest family planning clinic sessions for young people have no significant impact on teenage pregnancy rates, a finding consistent with previous work. When we look at changes to this coefficient over time (columns 3 and 4), there is evidence of a significantly positive effect on pregnancy rates in 1998 and a significantly negative effect by 2001. In other words, there is evidence that greater promotion of the morning after pill may have improved the impact of family planning access on teenage pregnancies. Even for clinic sessions in 2001, however, the aggregate impact is not significantly different to zero at conventional levels.

The estimates of the STI model (reported in Table 5) suggest that clinic sessions have a strongly positive impact on STI rates amongst young people. Further, looking at column 3 of Table 4, the (adverse) impact on STI rates appears to be significantly greater by the end of the period than at the start.

Thus far, the results provide very strong support in favor of the rational choice model. The increase in provision of youth family planning services appears to have had no overall impact on pregnancy rates but to have significantly increased STI rates. Further, the shift towards promotion of emergency birth control has rendered the relationship with pregnancy rates somewhat more negative (less positive) and strengthened the (adverse) relationship with STI rates. Taken together, these results are clearly inconsistent with the predictions of the random behavior model as discussed above.

The results on the impact of free pharmacy-based provision of EBC are not quite so clear cut. The fixed-effects estimates suggest these schemes have significantly increased pregnancy rates (Table 4, columns 2 and 4), a result that is consistent with the rational choice model, but not with random behavior. This finding also fits in well with the idea in Akerlof *et al.* (1994) that family planning reduces female bargaining power over sexual relations. The impact of EBC on STI rates, however, is insignificant (Table 5, columns 2 and 4). There appears to be no ready explanation for this pattern of results. Given that EBC provides no protection against STIs, it is difficult to conceive of a theoretical route whereby lower cost of EBC results in more pregnancies (presumably as a result of more sexual activity) yet does not increase STI rates.[15] It is possible that, as discussed above, increases in STI infections are not revealed in the reported diagnosis rates due to the rationing of services at some GUM clinics. This issue is explored further below.

Robustness Experiments

I conduct a number of experiments to examine the robustness of the results reported above.[16] Following the earlier discussion on the issue of the difference between rates of STI diagnoses and infections, I report in Table 6, random-effects and fixed-effects estimates for STI rates excluding all cases of genital chlamydia on the grounds that this infection is generally asymptomatic and is the most likely STI both to remain undetected and to be correlated with the family planning variables. In fact, the results are not materially different to those for all STIs. In this case, the Hausman test statistics are insignificant, suggesting that the random-effects results are preferred to the (less efficient) fixed-effects estimates. However, in every specification, family planning clinics are still estimated to increase STI rates significantly and this impact is estimated to strengthen over time.

The second experiment is to consider the impact of supply-side rationing of STI services. Information is available from the Association of Genitourinary Medicine (AGUM) on those GUM clinics in England for which waiting times during 2002 significantly exceeded national minimum standards. In these cases, it is sensible to view the reported diagnosis rates

[15] One possible route by which this result might occur is if the increase in pregnancies results in a reduction in the amount of risky sexual behavior.

[16] In addition to the experiments reported here, I carried out a number of other robustness checks. These checks included excluding health authorities in London, excluding health authorities in which Brook Advisory Centres offer clinics and for which session numbers were estimated and deflating the family planning variables by population rather than area. In no case were the results materially different from those reported. Full results are available from the author on request.

as being right censored. In other words, we know that the true figure is greater or equal to that reported, but do not know its exact value. An appropriate regression technique in these cases is censored regression. Unfortunately, no unbiased parametric estimator for the fixed-effects censored regression model is available (Neuhaus, 1992). Consequently I report in Table 7, the random-effects censored regression estimates of the STI models (equations 1b and 2b). Observations are treated as censored if the reported waiting time in 2002 was in excess of 20 days.[17] This results in 19 health authorities being treated as censored, although the precise cut-off point has little impact on the results.

The results pertaining to clinic sessions are very close to those for the uncensored regression. However, the coefficient on the EBC variable is now positive and strongly significant: the censored regression model suggests free pharmacy provision of EBC is associated with significantly higher STI rates amongst adolescents, a result that is consistent with the earlier finding relating to pregnancy rates and with the rational choice model. Note also that, in this specification, higher proportions of Muslims and Christians in an area are associated with significantly lower STI rates amongst adolescents.

The third experiment is to consider the impact of excluding the year effects. Although the year dummies are strongly significant in all of the models, there may be a multicollinearity problem with some of the other variables. For example, it may be that the significant values of the year dummies in previous models may be picking up some effect from the general increase in clinic sessions. In Table 8, I report the random- and fixed-effects estimates for the pregnancy and STI models without the year dummies. For reasons of space, I only report the models in which the coefficient on family planning clinics is allowed to vary with time. The main differences to the other models relate to the socioeconomic variables in the fixed-effects model, which appear to be more in accordance with prior expectations. For

[17] Time series data on waiting times is not available.

example, lack of educational qualifications and children in care are now both estimated to increase teenage pregnancies significantly, whilst the coefficient on unemployment is now positive, albeit insignificant.[18] The interpretation of the family planning variables remains the same as with the earlier results.

The final experiment reported here is an examination of the impact on different age groups. The UK Government has set itself specific targets to reduce pregnancy rates amongst under-18s and under-16s and these groups may be of particular interest. Unfortunately, STI data are not collected specifically for under-18s. In Table 9, I report the fixed-effects results of the pregnancy model (equation 2a) for 16-19s, under-18s and under-16s and the results of the STI model (equation 2b) just for 16-19s and under-16s. Family planning clinics appear to have significantly increased STI rates for both age groups, especially in the later years. For pregnancy rates, the impact of clinic sessions generally appears to become more negative over time, although the pattern for the lower age groups is not as clear-cut as for the 16-19 year olds. Looking at the socioeconomic variables, children in care and educational achievement both have significant effects on pregnancy rates for under-18s and under-16s.

VI Conclusions

In this paper, I have clarified the contrasting predictions of standard economic models of rational choice applied to teenage sexual behavior with the predictions generated by models in which teenage sexual behavior is the outcome of random behavior. I have also demonstrated how data on the outcomes of teenage sexual behavior might be used better to differentiate between the alternative models.

[18] Note that the significance of the year effects in Tables 5-7 suggests that excluding them may lead to inconsistent estimates. The relevance of reporting the results without the time effects is to demonstrate that it is difficult to identify satisfactorily the impacts of some of the socioeconomic variables. The fact that the family planing variables coefficients are almost invariant to their inclusion is reassuring in this regard.

Recent policy changes in England provide suitable natural experiments for testing a number of different predictions relating to the link between family planning and teenage pregnancy rates, as well as to the link between family planning and teenage rates of STIs. Using data over the period 1998 to 2001 from English health authorities, I find convincing evidence in favor of rational choice models. Specifically, I find that recent increases in the number of youth family planning clinic sessions had little overall impact on teenage pregnancy rates did not lead to reductions in teenage pregnancy rates, but led to significantly higher rates of diagnoses of STIs amongst teenagers.

A further finding is that the shift towards greater promotion of emergency birth control appears to have improved the impact on pregnancy rates and to have worsened the impact on STI rates since 2000. This evidence is inconsistent with models of random behavior.

There is clearly scope to distinguish between short and long run effects as more data on the experience in England become available. Further, the fact that STI data relates to diagnoses rather than actual infections limits the conclusions that can be drawn from the STI models. Despite these caveats, the results reported here demonstrate an important lesson for policy makers and one that is very familiar to economists. It is not enough to introduce a measure aimed at a specific outcome without considering the endogenous response of agents to the policy itself. In the case in question, it appears that some measures aimed at reducing adolescent pregnancy rates induced changes in teenage behavior that were large enough not only to negate the intended impact on pregnancy rates but to have an adverse impact on another important area of adolescent sexual health - sexually transmitted infections. The results in this paper should give some heart to proponents of standard neo-classical micro-economic models. Teenage sexual behavior appears to be little different to other fields that economists have studied in at least one important respect: incentives matter to teenagers too!

Table 1a: Consistency of models with the observed relationship between family planning access and pregnancy/STI rates

		Impact of family planning access on pregnancy rates		
		Positive	*Negative*	*Zero*
Impact of family planning access on STI rates	*Positive*	Rational Choice ✓ Random Behavior ✗	Rational Choice ✓ Random Behavior ✗	Rational Choice ✓ Random Behavior ✗
	Negative	Rational Choice ✗ Random Behavior ✗	Rational Choice ✓ Random Behavior ✓	Rational Choice ✗ Random Behavior ✗
	Zero	Rational Choice ✗ Random Behavior ✗	Rational Choice ✓ Random Behavior ✓	Rational Choice ✓ Random Behavior ✗

Note
(i) 'Positive' and 'negative' relate to the direction of the correlation. In other words, a positive impact implies that an increase (a decrease) in family planning access leads to an increase (a decrease) in the outcome variable.

Table 1b: Consistency of models with the impact of EBC on the observed relationship between family planning access and pregnancy/STI rates

		Impact on family planning/pregnancy relationship		
		More +ve (less -ve)	*More -ve (less +ve)*	*No change*
Impact on the family planning/STI relationship	*More +ve (less -ve)*	Rational Choice ✓ Random Behavior ✗	Rational Choice ✓ Random Behavior ✗	Rational Choice ✓ Random Behavior ✗
	More -ve (less +ve)	Rational Choice ✗ Random Behavior ✗	Rational Choice ✗ Random Behavior ✗	Rational Choice ✗ Random Behavior ✗
	No change	Rational Choice ✗ Random Behavior ✗	Rational Choice ✗ Random Behavior ✓	Rational Choice ✗ Random Behavior ✗

Note
(i) See Table 1a.

Table 2: Trends in Family Planning, Sexual Activity, Teenage Pregnancy & STI rates

Variable	Year 1998	1999	2000	2001
Adolescent family planning clinic sessions	28,115	27,075	30,710	33,369
GP contraception provision	23,547	23,873	24,065	24,299
Proportion Sexually Inactive (16-19)	32%	39%	33%	27%
Conception rates:				
all teenagers	65.43	62.94	62.45	60.71
16 - 19	74.84	72.33	72.22	70.31
under-18	47.03	45.35	43.86	42.32
under-16	8.88	8.19	8.28	7.92
STI rates:				
all teenagers	93.08	102.96	114.59	119.27
16-19	110.32	122.19	137.5	142.53
under-16	7.76	8.70	9.15	10.13

Notes

(i) Adolescent family planning clinic session numbers include estimates for Brook clinics, as described in the Appendix.

(ii) GP contraception provision is the number of GPs offering a contraceptive service to any patient, not just to those patients on their list.

(iii) Proportions sexually active are the percentage of women aged 16-19 who stated that they had no sexual partner in the previous year, as given by the annual Contraception and Sexual Health Survey published by the ONS.

(iv) Conception and STI rates are as described in the Appendix.

Table 3: Summary Statistics

Variable		Mean	St. Dev.
Conceptions rates (all teenagers)	overall	67.28	19.92
	between		18.10
	within		8.47
STI rates (all teenagers)	overall	334.61	212.84
	between		204.28
	within		62.52
Clinic Sessions per km^2	overall	0.88	1.41
	between		1.37
	within		0.36
GP services per km^2	overall	0.76	0.99
	between		1.00
	within		0.03
Pharmacies providing EBC per km^2	overall	0.005	0.046
	between		0.024
	within		0.039
GP practices per km^2	overall	0.36	0.55
	between		0.55
	within		0.01
Unemployment	overall	0.06	0.02
	between		0.02
	within		0.01
% lone parents	overall	5.93	1.86
	between		1.86
	within		0.07
Children in care	overall	112.65	45.97
	between		44.33
	within		12.78
% no qualifications	overall	5.92	2.02
	between		1.83
	within		0.86
ethnic minorities	between	9.07	10.76
divorces	between	10.63	0.80
Muslims	between	3.10	4.25
Christians	between	8.27	2.14

Notes
(i) Full definitions and sources of each variable are provided in the Appendix.

Table 4: Random- & Fixed-effects Estimates of Teenage Pregnancy Rates, England 1998-2001

Dependent variable: teenage pregnancy rates per 1000 females aged 15-19	**1** Random-Effects	**2** Fixed-Effects	**3** Random-Effects	**4** Fixed-Effects
Clinic sessions per km²	0.66	0.51	2.15	1.85
	(1.31)	(0.55)	(1.92)	(0.92)
*Clinic sessions per km²*1999*	-	-	-0.63	0.11
			(0.51)	(0.28)
*Clinic sessions per km²*2000*	-	-	-0.65	-0.17
			(0.72)	(0.51)
*Clinic sessions per km²*2001*	-	-	-3.25	-2.94***
			(2.08)	(0.49)
GP contraceptive services per km²	-2.52	-9.66	1.35	5.03
	(8.77)	(11.91)	(7.29)	(5.32)
Pharmacies providing EBC per km²	2.59	15.61***	18.65*	31.15***
	(3.53)	(5.59)	(10.03)	(4.16)
GP practices per km²	9.00	56.83	1.36	48.92
	(17.71)	(41.72)	(13.97)	(38.36)
Unemployment	-42.43	-145.02**	-27.89	-135.28**
	(112.39)	(50.08)	(105.50)	(52.14)
% lone parents	2.83**	-15.76***	2.67**	-15.72***
	(1.32)	(3.50)	(1.36)	(4.51)
Children in care	0.02	0.02	0.02	0.02
	(0.03)	(0.02)	(0.03)	(0.01)
% no qualifications	0.88*	-0.04	0.49	-0.55
	(0.50)	(0.50)	(0.67)	(0.75)
ethnic minorities	0.02	-	-0.01	-
	(0.47)		(0.48)	
divorces	5.73***	-	5.63**	-
	(2.01)		(1.99)	
Muslims	0.75	-	0.90	-
	(1.32)		(1.33)	
Christians	-1.95***	-	-2.00***	-
	(0.62)		(0.63)	
1999 effect	-2.12**	-2.07***	-2.05**	-2.86***
	(0.91)	(0.38)	(1.05)	(0.69)
2000 effect	-7.74***	-7.89***	-8.09***	-9.07***
	(1.58)	(0.62)	(1.57)	(1.11)
2001 effect	-11.62***	-12.15***	-9.66***	-11.05***
	(3.59)	(0.76)	(3.15)	(1.61)
Constant	1.57	141.05***	4.41	138.31***
	(22.06)	(19.46)	(21.97)	(21.21)
Observations	372	372	372	372
Wald χ^2	214.57***	646.58***	583.61***	1753.75***
Hausman	18.49*	-	19.91	-
Groupwise heteroskedasticity	-	1.2 e+05***	-	1.7 e+05***
Cross-sectional independence	-	6683.0***	-	6892.5***

Notes:

(i) Figures in brackets are semi-robust standard errors for the random-effects. For the fixed-effects estimates the standard errors are corrected for groupwise heteroskedasticity and for contemporaneous correlation over cross-sectional units.

(ii) *** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.

(iii) The Wald χ^2 test is for the joint significance of all variables.

(iv) The Hausman test is for the consistency of the random-effects estimator compared to the fixed-effects estimator. The test for groupwise heteroskedasticity is that described in Greene (2000, p.598). The test for cross-sectional independence is that described in Greene (2000, p.601)

Table 5: Random- and Fixed-effects Estimates of STI Rates, England 1998-2001

	1	**2**	**3**	**4**
Dependent variable: rates of teenage STI diagnoses per 1000 females aged 15-19	**Random-Effects**	**Fixed-Effects**	**Random-Effects**	**Fixed-Effects**
Clinic sessions per km^2	10.71***	8.21**	2.70	0.15
	(3.41)	(4.01)	(2.67)	(3.53)
*Clinic sessions per km^2*1999*	-	-	3.32	3.98***
			(2.41)	(0.67)
*Clinic sessions per km^2*2000*	-	-	11.59***	11.65***
			(3.77)	(1.03)
*Clinic sessions per km^2*2001*	-	-	8.64**	9.59***
			(3.18)	(1.19)
GP contraceptive services per km^2	54.25	-27.66	32.43	-59.94
	(38.43)	(51.58)	(32.06)	(40.88)
Pharmacies providing EBC per km^2	102.50*	21.80	42.40	-16.70
	(53.82)	(90.76)	(54.90)	(98.34)
GP practices per km^2	-33.40	-212.09	8.96	-78.71
	(65.51)	(132.41)	(53.58)	(120.61)
Unemployment	211.11*	168.84	192.62	197.04
	(116.36)	(154.26)	(118.91)	(134.05)
% lone parents	-1.87	-6.49	-2.02	-22.15
	(5.15)	(17.01)	(5.11)	(15.36)
Children in care	0.00	-0.10**	0.00	-0.08**
	(0.06)	(0.04)	(0.05)	(0.04)
% no qualifications	0.04	-3.57**	2.10	-0.82
	(2.09)	(1.57)	(2.05)	(1.22)
ethnic minorities	0.00	-	0.23	-
	(1.32)		(1.34)	
divorces	12.75*	-	13.25*	-
	(7.04)		(7.12)	
Muslims	-1.37	-	-2.02	-
	(2.58)		(2.73)	
Christians	-4.02*	-	-3.82	-
	(2.43)		(2.40)	
1999 effect	11.66***	7.50***	11.59***	9.40***
	(2.52)	(1.72)	(2.57)	(1.60)
2000 effect	23.21***	17.42***	17.63***	15.59***
	(3.68)	(2.51)	(3.46)	(2.57)
2001 effect	28.33***	22.48***	26.37***	24.44***
	(4.12)	(3.48)	(3.68)	(3.46)
Constant	-42.17	176.65*	-54.25	232.23**
	(78.79)	(106.5)	(82.01)	(92.12)
Observations	372	372	372	372
Wald χ^2	276.82***	723.42***	374.15***	827.88***
Hausman	25.25***	-	22.06*	-
Groupwise heteroskedasticity	-	2.8 e+05***	-	80531.4***
Cross-sectional independence	-	5989.9***	-	5902.7***

Notes
(i) See Table 5, notes (i) to (iv).

Table 6: Random- & Fixed-effects Estimates of STI Rates Excluding Chlamydia, England 1998-2001

	1	2	3	4
Dependent variable: rates teenage STI diagnoses (excluding Chlamydia) per 1000 females aged 15-19	**Random-Effects**	**Fixed-Effects**	**Random-Effects**	**Fixed-Effects**
Clinic sessions per km²	4.85***	3.95**	1.54	0.62
	(1.44)	(2.03)	(1.28)	(1.87)
*Clinic sessions per km²*1999*	-	-	1.23	1.48***
			(1.06)	(0.27)
*Clinic sessions per km²*2000*	-	-	5.12***	5.22***
			(1.50)	(0.42)
*Clinic sessions per km²*2001*	-	-	3.26**	3.75***
			(1.30)	(0.51)
GP contraceptive services per km²	27.17	-8.67	18.02	-20.25
	(18.86)	(26.57)	(15.59)	(21.29
Pharmacies providing EBC per km²	36.00	-0.48	11.41	-18.83
	(27.46)	40.67)	(28.41)	(36.44)
GP practices per km²	-13.76	-81.70	3.97	-22.51
	(33.01)	(55.14)	(26.24)	(47.64)
Unemployment	76.74	67.46	73.17	82.85
	(74.47)	(66.85)	(76.07)	(58.47)
% lone parents	-2.02	-2.09	-2.16	-8.53
	(2.66)	(7.08)	(2.61)	(6.78)
Children in care	0.03	-0.01	0.03	0.00
	(0.03)	(0.02)	(0.04)	(0.02)
% no qualifications	0.99	-0.26	1.89	0.94
	(1.21)	(0.64)	(1.23)	(0.78)
ethnic minorities	-0.02	-	0.08	-
	(0.72)		(0.73)	
divorces	8.04**	-	8.21**	-
	(3.45)		(3.50)	
Muslims	-0.80	-	-1.07	-
	(1.29)		(1.36)	
Christians	-1.25	-	-1.17	-
	(1.24)		(1.22)	
1999 effect	5.09***	3.63***	5.26***	4.64***
	(1.45)	(0.79)	(1.48)	(1.04)
2000 effect	8.59***	6.58***	6.09***	5.57***
	(2.00)	(1.20)	(1.80)	(1.62)
2001 effect	9.39***	7.43***	9.02***	8.61***
	(2.21)	(1.73)	(2.18)	(2.13)
Constant	-37.37	79.62*	-42.25	100.47***
	(39.32)	(42.17)	(40.74)	(36.31)
Observations	372	372	372	372
Wald χ^2	139.53***	282.54***	183.90	291.03***
Hausman	14.07	-	13.17	-
Groupwise heteroskedasticity	-	70611.8***	-	96300.3***
Cross-sectional independence	-	5739.4***	-	5832.8***

Notes
(i) See Table 5, notes (i) to (iv).

Table 7: Censored Random-effects Estimates of STI Rates, England 1998-2001

Dependent variable: rates teenage STI diagnoses per 1000 females aged 15-19	**1** **Random-Effects**	**3** **Random-Effects**
Clinic sessions per km²	10.83***	1.73
	(1.17)	(1.71)
*Clinic sessions per km²*1999*		2.59
	-	(1.98)
*Clinic sessions per km²*2000*		10.79***
	-	(1.95)
*Clinic sessions per km²*2001*		5.88***
	-	(2.03)
GP contraceptive services per km²	48.55***	26.69***
	(7.35)	(6.59)
Pharmacies providing EBC per km²	211.56***	155.85***
	(52.38)	(52.64)
GP practices per km²	-22.42*	6.37
	(13.08)	(11.34)
Unemployment	241.62***	224.76***
	(76.91)	(71.53)
% lone parents	2.65**	11.24***
	(1.27)	(1.20)
Children in care	0.04	0.01
	(0.04)	(0.03)
% no qualifications	-1.67*	-2.50***
	(0.87)	(0.88)
ethnic minorities	-0.08	0.68**
	(0.31)	(0.29)
divorces	15.93***	2.49
	(2.57)	(1.85)
Muslims	-1.08**	-4.08***
	(0.53)	(0.49)
Christians	-4.14***	-4.70***
	(0.62)	(0.54)
1999 effect	11.17***	8.29***
	(2.78)	(3.01)
2000 effect	22.86***	13.38***
	(2.94)	(3.10)
2001 effect	27.31***	22.23***
	(3/09)	(3.21)
Constant	-84.91***	32.34
	(26.26)	(19.96)
Uncensored Observations	296	296
Censored Observations	76	76
Wald χ^2	2087.7***	2231.9***

Notes
(i) Observations are treated as right-censored if the waiting time at a GUM clinic in that health authority is ≥ 20.
(ii) See Table 5, notes (i) to (iv).

Table 8: Random- and Fixed-effects Estimates, excluding year effects

	1	2	3	4
	Teenage Pregnancy Rates		**Teenage STI Rates**	
	Random-Effects	**Fixed-Effects**	**Random-Effects**	**Fixed-Effects**
Clinic sessions per km^2	2.91	1.88	0.99	-0.21
	(2.00)	(1.17)	(2.97)	(3.65)
*Clinic sessions per km^2*1999*	-0.54	0.94**	4.70**	3.54***
	(0.58)	(0.35)	(2.21)	(0.68)
*Clinic sessions per km^2*2000*	-1.78**	-0.20	12.70***	10.89***
	(0.86)	(0.62)	(4.15)	(0.97)
*Clinic sessions per km^2*2001*	-4.55**	-2.97***	11.42***	10.28***
	(2.31)	(0.60)	(3.83)	(1.04)
GP contraceptive services per km^2	-0.49	-5.95	39.63	-40.39
	(7.10)	(5.75)	33.93)	41.38)
Pharmacies providing EBC per km^2	23.83**	40.56***	19.60	-56.29
	(10.92)	(8.68)	(58.18)	(95.57)
GP practices per km^2	0.86	59.81	8.17	-106.96
	(13.59)	(39.55)	(58.19)	(127.60)
Unemployment	96.96	34.77	-158.61	-176.06**
	(77.25)	(53.64)	(97.77)	(79.78)
% lone parents	0.57	-31.03***	4.83	8.26
	(1.07)	(6.55)	(4.63)	(13.60)
Children in care	0.03	0.04***	-0.06	-0.15***
	(0.04)	(0.01)	(0.06)	(0.03)
% no qualifications	2.16***	1.71**	-3.00	-5.30***
	(0.41)	(0.69)	(1.91)	(0.80)
ethnic minorities	0.30	-	-0.71	-
	(0.43)		(1.36)	
divorces	5.55**	-	13.96**	-
	(2.07)		(7.16)	
Muslims	0.68	-	-1.44	-
	(1.35)		(2.67)	
Christians	-1.78***	-	-4.43*	-
	(0.62)		(2.55)	
Constant	-8.22	185.64***	-22.28	114.22*
	(23.79)	(31.17)	(81.26)	(84.02)
Observations	372	372	372	372
Wald χ^2	335.00***	9252.8*		96725.3***
Hausman	27.68***	-	50.00***	-
Groupwise heteroskedasticity	-	6459.39***	-	6460.6***
Cross-sectional independence	-	49715.9***	-	46853.4***

Notes

(i) Dependent variables are rates per 1000 pregnancies and per 10,000 diagnosed STIs for all teenagers.

(ii) See Table 5, notes (i) to (iv).

Table 9: Fixed-Effects Estimates of Family Planning Impacts for Different Age Groups

	1	2	3	4	5
	Pregnancy Rates			**STI Rates**	
	16-19	**U18**	**U16**	**16-19**	**U16**
Clinic sessions per km^2	2.34*	1.35*	0.40**	1.55	-0.54
	(1.36)	(0.75)	(0.14)	(3.72)	(0.71)
*Clinic sessions per km^2*1999*	0.34	0.01	-0.07***	3.45***	0.70***
	(0.22)	(0.24)	(0.02)	(0.74)	(0.18)
*Clinic sessions per km^2*2000*	-0.17	0.31	0.11***	13.00***	1.05***
	(0.50)	(0.36)	(0.03)	(0.80)	(0.28)
*Clinic sessions per km^2*2001*	-3.29***	0.07	0.04	12.30***	0.75**
	(0.53)	(0.45)	(0.05	(1.01)	(0.28)
GP contraceptive services per km^2	10.55*	1.77	3.08	-7.88	-9.94
	(5.52)	(7.90)	(2.14)	(35.79)	(8.89)
Pharmacies providing EBC per km^2	37.64***	6.79*	0.37	96.08	2.62
	(5.13)	(3.59)	(0.94)	(98.33)	(15.64)
GP practices per km^2	49.40	-2.79	3.89	-57.00	-31.14
	(40.48)	(12.59)	(4.45)	(103.80)	(28.85)
Unemployment	-146.38**	-25.33	-6.42	225.92	44.64*
	(81.53)	(1.24)	(7.20)	(150.95)	(23.51)
% lone parents	-20.02***	0.10	-0.59	-24.71	-6.47*
	(3.29)	(1.24)	(1.44)	(15.09)	(3.35)
Children in care	0.03	0.02**	0.008***	-0.05	-0.02
	(0.03)	(0.01)	(0.002)	(0.04)	(0.01)
% no qualifications	-1.29	1.25***	0.51***	-1.10	-0.68*
	(0.85)	(0.27)	(0.13)	(1.65)	(0.39)
1999 effect	-3.57***	0.23	-0.29	12.96***	0.67
	(0.84)	(0.41)	(0.15)	(1.87)	(0.46)
2000 effect	-10.94***	-1.24**	-0.11	20.78***	1.04
	(1.25)	(0.50)	(0.23)	(2.90)	(0.71)
2001 effect	-13.73***	-2.94***	-0.48	29.61***	2.84***
	(1.90)	(0.56)	(0.30)	(3.71)	(0.93)
Constant	169.26***	32.07***	5.96	231.84***	51.66***
	(20.17)	(7.40)	(6.94)	(86.31)	(18.00)
Observations	372	372	372	372	372
Wald χ^2	1410.9***	36453***	46494***	2379.1***	3942.2***
Groupwise heteroskedasticity	1.9e+05	14807***	3.9e+06***	66064***	80919***
Cross-sectional independence	6706.2***	5747.1***	5710.7***	5897.6***	5833.9***

Notes

(i) Dependent variables are pregnancy rates per 1000 women and STI rates per 10,000 people for the relevant age groups. Population deflator for under-18s is 15-17 and for under-16s, 13-15.

(ii) See Table 5, notes (i) to (iv).

References

Adams, John G U (1994), ‘Seat Belt Legislation: the evidence revisited’, *Safety Science*, 18: 135-52.

Ahituv, Avner, Hotz, V. Joseph and Philpson, Tomas (1995), ‘The Responsiveness of the Demand for Condoms to the Local Prevalence of AIDS’, *Journal of Human Resources*, 31 (4): 869-97.

Akerlof, George, A, Yellen, Janet, L and Katz, Michael, L. (1996), ‘An Analysis of Out-of-Wedlock Childbearing in the United States’, *Quarterly Journal of Economics*, 111 (2, May): 277-317.

Anderson, John E. and Cope, Lisa G. (1987), ‘The Impact of Family Planning Program Activity on Fertility’, *Family Planning Perspectives*, 19 (4, Jul-Aug): 152-7.

Becker, Gary S. (1963), *A Treatise on the Family*, Cambridge, Mass: Harvard University Press.

Billy John O.G., Brewster Karin L., Grady William R. (1994), ‘Contextual effects on the sexual behavior of adolescent women’, *Journal of Marriage and the Family*, 56: 387-404.

Brewster Karin L., Billy John O.G., Grady William R. (1993), ‘Social context and adolescent behavior: the impact of community on the transition to sexual activity’, *Social Forces*, 71(3): 713-740

Chong-Burn, An, Haverman, Robert and Wolfe, Barbara (1993), ‘Teen Out-of-Wedlock Births and Welfare Receipt: the role of childhood events and economic circumstances’, *Review of Economics and Statistics*, 75 (2, May): 195-208.

Churchill D, Allen J, Pringle M, Hippisley-Cox J, Ebdon D, Macpherson M and Bradley S. (2000), ‘Consultation patterns and provision of contraception in general practice before teenage pregnancy: case-control study’, *British Medical Journal,* 321: 468-89.

Clements, S, N. Stone, Diamond, I. and Ingham, R. (1999), ‘Spatial Variation in Teenage Conceptions in South and West England’, *Journal of the Royal Statistical Association, Series A*, 162 (3): 273-89

Davis, William L., Olson, Kent W. and Warner, Larkin (1993), ‘An Economic Analysis of Teenage Fertility: some evidence from Oklahoma’, *American Journal of Economics and Sociology*, 52 (1): 85-99.

Department of Health (2001), *The National Strategy for Sexual Health and HIV*, July, London: Department of Health.

DiCenso, Alba, Gordon Guyatt, Andrew Willan and Lauren Griffith (2002), 'Interventions to Reduce Unintended Pregnancies among Adolescents: systematic review of randomised controlled trials', *British Medical Journal*, 324, 15 (June).

Evans, William N, Oates, Wallace E. and Schwab, Robert M (1992), 'Measuring Peer Group Effects: a study of teenage behavior', *Journal of Political Economy*, Oct., 100 (5): 966-91.

Fenton, K.A., Korovessis, C., Johnson, A.M. *et al.* (2001), 'Sexual behaviour in Britain: reported sexually transmitted infections and prevalent genital Chlamydia trachomatis infection', *Lancet*, 358: 1851-4.

Foley, E., Patel, R., Green W. and Rowen, D. (2001), Access to GUM in the UK', *Sexually transmitted Infections*, 77: 12-14.

Forrest, Jacqeline Darroch, Hermalin, Albert I. and Henshaw, Stanley K. (1981), 'The Impact of Family Planning Clinic Programs on Adolescent Pregnancy', *Family Planning Perspectives*, 13 (3, May-Jun): 109-16.

Greene, William H. (2000), *Econometric Analysis*, New Jersey: Prentice-Hall.

Guyatt, Gordon H., Alba DiCenso, Vern Farewell, Andrew Willan and Lauren Griffith (2000), 'Randomized Trials versus Observational Studies in Adolescent Pregnancy Prevention', *Journal of Clinical Epidemoiology*, 53, 167-74.

Hughes, Mary Elizabeth, Furstenberg Jr, Frank F. and Teitler, Julien O. (1995), 'The Impact of an Increase in Family Planning Services on The Teenage Population of Philadelphia', *Family Planning Perspectives*, 27: 60-6 & 78.

Kahn, James G., Brindis, Claire D. and Glei, Dana A. (1999), 'Pregnancies Averted among U.S. Teenagers by the Use of Contraceptives', *Family Planning Perspectives*, Jan./Feb., 31 (1): 29-34.

Kane, Thomas, and Staiger, Douglas (1996), 'Teen Motherhood and Abortion Access', *Quarterly Journal of Economics*, May, 111 (2): 467-506.

Kirby, Douglas (2001), *Emerging Answers: research findings on programs to reduce teen pregnancy*, Washington D.C.: National Campaign to Prevent Teen Pregnancy.

Kirkwood K., Horn K., Glasier A., Sutherland S., Young H. and Patrizio C. (1999), 'Non-invasive screening of teenagers for chlamydia trachomatis in a family planning setting', *British Journal of Family Planning*, 25(1): 11-12.

Klick, J. and Stratmann, T. (2003), 'The effect of abortion legalization on sexual behavior: evidence from sexually transmitted diseases', *Journal of Legal Studies*, forthcoming.

Levine, Phillip B. (2000), 'The Sexual Activity and Birth Control Use of American Teenagers', *NBER Working Paper 7601*, March, Cambridge, MA: NBER.

Lundberg, Shelly and Plotnick, Robert D. (1995), 'Adolescent Premarital Childbearing: do economic incentives matter?', *Journal of Labor Economics*, 13 (2): 177-200.

Moore, Kristin A., Miller, Brent C., Glei, Dana and Morrison, Donna Ruane (1995), *Adolescent Sex, Contraception and Childbearing: a review of recent research*', Washington, DC: Child Trends Inc.

Neuhaus, J. M. (1992), 'Statistical Methods for Longitudinal and Clustered Designs with Binary Responses, *Statistical Methods in Medical Research*, 1: 249-73.

Oettinger, Gerald S. (1999), 'The Effects of Sex Education on Teen Sexual Activity and Teen Pregnancy', *Journal of Political Economy*, 107 (3): 606-44.

ONS (2003), *Contraception and Sexual Health, 2001*, London: Office for National Statistics.

Paton, David (2002), 'The Economics of Abortion, Family Planning and Underage Conceptions', *Journal of Health Economics*, 21 (2, March): 27-45

Peltzman, Sam (1975), 'The Effects of Automobile Safety Regulation', *Journal of Political Economy*, 83 (August): 677-723.

Plotnick, Robert D (1992), 'The Effects of Attitudes on Teenage Premarital Pregnancy and its Resolution', *American Sociological Review*, 57 (6, Dec): 800-11.

Public Health Laboratory Service (2002). *Trends in Selected STIs: 1991-2001*, London: PHLS.

Richens, John, Imrie, John and Copas, Andrew (2000), 'Condoms and Seat Belts: the parallels and the lessons', *Lancet*, 355 (9201, January): 400-403.

Rosenzweig, Mark R. (1999), 'Welfare, Marital Prospects and Nonmarital Childbearing', *Journal of Political Economy*, 107 (6, S Dec), S3-S32.

Singh, Susheela (1986), 'Adolescent Pregnancy in the United States: an interstate analysis', *Family Planning Perspectives*, 18 (5, Sept-Oct), 210-20.

Social Exclusion Unit (1999), *Teenage Pregnancies*, London: HMSO CM4342.

Tobin J.M., Bateman J., Banks B. and Jeffs J. (1999), 'Clinical audit of the process of referral to genitourinary medicine of patients found to be chlamydia positive in a family planning service', *British Journal of Family Planning*, 24(4): 160-3.

Wellings K., Wilkinson P., Grundy C., Kane R., Jacklin P., Stevens M. and Gerressu M. (2002), *An audit of contraceptive service provision in England, with special reference to service provision for young people*. London: Teenage Pregnancy Unit.

Wolfe, Barbara, Wilson, Kathryn and Haverman, Robert (2001), 'The Role of Economic Incentives in Teenage Nonmarital Childbearing Choices', *Journal of Public Economics*, 81: 473-511.

Appendix

Table A1: Data definition and sources

Dependent Variables	Definition	Source
Pregnancy rates	Number of live pregnancies and abortions to the relevant age group in each health authority per 1000 females. Miscarriages are excluded. Age at conception is estimated by the ONS. The population deflator is the mid-year resident female population as estimated from the 2001 Census. The base population for all teenagers is 15-19, for under-18s 15-17 and for under-16s, 13-15.	ONS: supplied to the author
STI rates	Annual number of new cases of sexually transmitted diseases diagnosed in GUM clinics in each health authority per 10,000 people of the relevant age group. The population is as for pregnancy rates, but for both males and females.	PHLS: supplied to the author
Independent Variables		
Clinic sessions per km^2	Annual number of family planning clinic sessions aimed at young people per KM^2 . The numbers of clinic sessions offered by each Brook clinic were estimated from attendance figures. Where the Brook figures cross over more than one health authority (London and Sandwell Brook clinics), the figures are allocated in proportion to the population of the relevant age group.	DOH: supplied to the author
GP contraceptive services per km^2	Annual number of GPs in each authority offering a contraceptive service to all patients (i.e. not just those on their patient list) divided by the area in KM^2.	PCGT
Pharmacies providing EBC per km^2	Number of pharmacies in each health authority providing free emergency birth control to young people of any age, divided by the area of the health authority in KM^2. When a scheme was introduced during a year, the variable is divided by the number of months in that year in which the scheme was in operation.	PCTs, HAZ, Teenage Pregnancy Co-ordinators & Sexwise.
GP practices per km^2	Annual number of GP Practices in each authority divided by the area of the health authority in KM^2.	PCGT
Unemployment	Annual claimant count rate of unemployment in each authority.	ONS
% lone parents	Annual percentage of households in each authority headed by a lone parent.	ONS
Children in care	Annual number of all children aged 10-18 under local authority care in each health authority per 10,000 people of the relevant age group. For the under-16 models, the number of children in care aged 10-15 is used. For the 16-19 models, the number of children in care aged 16 and 17 is used.	DOH.

% no qualifications	Two year moving average of the annual percentage of pupils in each health authority gaining no GCSEs at age 16.	DFES
ethnic minorities	Percentage of the population in each health authority describing their ethnic background as "non-white" in the 2001 Census.	ONS
divorces	Proportion of the adult population in each health authority stating in the 2001 Census that they are separated or divorced.	ONS
Muslims	Percentage of the population in each health authority describing themselves as Muslims in the 2001 Census	ONS
Christians	Percentage of the population in each authority who regularly attend a Sunday Church service.	Brierley (2001)
1999 effect	Indicator variable for 1999.	-
2000 effect	Indicator variable for 2000.	-
2001 effect	Indicator variable for 2001.	-

Notes:
Brierley, Peter (editor) (2001), *Religious Trends 3*, London: Christian Research.
DFES: www.dfes.gov.uk/statistics
DOH: Department of Health, www.doh.gov.uk/public/xllist.htm
HAZ: www.haznet.org.uk
ONS: Office of National Statistics, www.statistics.gov.uk
PCGT: National Database for Primary Care Groups and Trusts, www.primary-care-db.org.uk
PHLS: Public Health Laboratory Services
Sexwise: national database of family planning services throughout England, www.ruthinking.co.uk