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

Presented at the Royal Economic Society Conference, Swansea
April 2004

David Paton

Professor of Industrial Economics
Nottingham University Business School
Jubilee Campus
Wollaton Road
Nottingham
NG8 1BB
United Kingdom

Tel: + 00 44 115 846 6601
Fax: + 00 44 115 846 6667
Email: David.Paton@nottingham.ac.uk

Acknowledgements: I would like to thank Dick Churchill, Steve Clements, Paul Fenn, George Kinghorn, Steve Heasell, Philip Levine, John Richens, Jonathan Klick, Thomas Stratmann, participants at seminars at UCL Department of GUM and at Lancaster University School of Management and at the 2003 BSPS Conference in Bristol for many useful comments on earlier drafts of this paper. I would also like to thank Oliver Clarke at the PHLS, Jeff Kirk at the Department of Health, Andy Sneddon and other staff at the Office of National Statistics for help with data, as well as various Teenage Pregnancy Coordinators and Health Authority staff who provided information and/or comments.

Word count (including tables, references & abstract): 8,189

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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 for most age groups. I further find that the adverse 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 behaviour is assumed to be random.

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

JEL Classifications: J13, I18.

Random Behaviour or Rational Choice: Family Planning, Teenage Pregnancy and STIs

1. Background

The behavioural response of adolescents to the provision of family planning services remains something of a puzzle. At least two contrasting theories of adolescent sexual behaviour have been put forward (Levine, 2000). 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 behaviour.

In this paper, I demonstrate that recent policy developments in England lead to a series of specific predictions regarding the impact of family planning provision. I argue that testing these predictions on data relating to pregnancy rates of sexually transmitted diseases (STIs) simultaneously offers a novel and fruitful way of distinguishing between alternative models of sexual behaviour.

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

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 behaviour 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 behaviour 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 behaviour, 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 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]

[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 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.

In the following discussion, I use the terms 'rational choice model' and 'random behaviour 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.

Empirical work on the impact of family planning services includes that which focuses on specific projects (project evaluations) as well as that which analyses the impact of general policies at a more aggregate level (policy evaluations). The empirical work has covered the impact on conception rates, birth rates, rates of teenage sexual activity, STIs and contraceptive use.

A range of project evaluations (reviewed in Kirby, 2001 and DiCenso et al, 2002) and policy evaluations (for example, Evans, Oates and Schwab, 1992; Clements *et al.*, 1999; Paton, 2002) has found little or no evidence that access to family planning reduces overall rates of teenage pregnancy, a conclusion that is consistent only with rational choice model and inconsistent with random behaviour.[3] There is no evidence to date on the impact on rates of STIs amongst teenagers.[4] In contrast, DiCenso *et al*. (2002) and Kirby (2001) both conclude that specific interventions focusing on improved access to family planning have little or no significant impact on sexual activity rates amongst adolescents. Such a result is inconsistent with the rational choice model and consistent with the random behaviour model.

Lastly, DiCenso *et al*. (200s) and Kirby (2001) find that most family planning projects appear to have had little success in increasing overall rates of contraceptive usage amongst sexually active adolescents, a conclusion that is inconsistent with both the rational choice model and the random behaviour model.

Thus, empirical work to date has not been able to distinguish satisfactorily between the two competing theories of sexual behaviour. One possible reason for the inconsistent results is the presence of Type II errors. That is, there may be causative effects occurring that are consistent with either the rational choice or random behaviour models, but the data are simply not strong enough for the effects to be observed as statistically significant. An

[3] 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. There is also some evidence that access to family planning reduces adolescent *births* (for example, Davis, Olson and Warner, 1993; Wolfe, Wilson and Haverman, 2001)

[4] Klick and Stratmann (2003) analyses the impact of family planning on STI rates in the USA amongst all ages, finding that a younger legal age at which contraceptive services can be obtained without parental consent is associated with higher rates of gonorrhoea in some specifications.

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 behaviour. In the following section, I explain how to analysing pregnancy and STI rates simultaneously may be able to achieve this goal.

3. Using Evidence on STI rates to Distinguish between Theoretical Models

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 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.[5] We can use recent policy changes in England to illustrate the implications of this for alternative theories of sexual behaviour.

3.1 Family planning 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). In a parallel development, the Government has also adopted a National Strategy for Sexual Health and HIV (Department of Health, 2001) with the aim of stemming sharp increases in rates of STIs amongst young people in recent years, (Public Health Laboratory Service, 2002).[6]

Two key policy initiatives to achieve these aims are relevant to this paper. The first was an expansion of community based family planning services aimed specifically at adolescents, a policy that is common both to the Teenage Pregnancy Strategy and the National Strategy for Sexual Health. Responsibility and funding for implementing this policy were devolved to local areas, and there is good evidence that the rate of expansion has shown considerable regional variation (Wellings *et al,* 2002). The second relevant policy initiative was a nationwide shift in emphasis towards the provision of the morning after pill or emergency birth control (EBC). 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.

3.2 Implications of policy for rational choice and random behaviour

Consider firstly the uniform decrease in the *absolute* costs of all methods of family planning implied by the recent expansion of youth-oriented family planning clinics in England. Under the random behaviour model, there will be 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, we would expect the decrease in the marginal cost of family planning services to

[5] 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.

[6] 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 behaviour amongst young people.

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 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 behaviour model.

Next, consider the reduction in the *relative* cost of EBC relative to the price of other forms of family planning. It is known that a large proportion of teenage pregnancies result from contraceptive failure (see, for example, Churchill *et al.*, 2000). EBC provides a *post hoc* intervention whereby pregnancy can still be averted even after contraceptive failure or non-use. Under the random behaviour 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] A clear empirical consequence of this discussion 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 behaviour 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.

4. Methods and Data

[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) who find that adolescents prescribed with EBC were more likely than others subsequently to be referred for abortion.

4.1 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.

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

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

where FP = some measure of access to family planning;

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 behaviour 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:

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

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

where FP*1999 is an interaction term between FP and a dummy variable for the year 1999.

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 behaviour 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.[8]

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

[8] I have chosen to allow different effects for each year. An alternative is to allow a single shift in the family planning effect for years after 1999. The conclusions from using this approach are unaltered.

been used in earlier work, including clinic enrolment (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. Difference-in-differences panel data estimates (that is, with the variables demeaned for regional fixed effects and also for time fixed effects) 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 difference-in-differences estimator will yield consistent estimates of the family planning impact. We believe that this assumption is justified 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.

A counter-argument is that a regional health authority may increase family planning services in response to recent *increases* in teenage pregnancy (or STI) rates in the region. If, in addition, time-varying shocks to regional pregnancy rates are positively serially correlated, the estimates of α_1 and β_1 will be inconsistent and biased upwards. In other words, the estimates will bias us to rejecting the random behaviour model in favour of the rational choice model. In fact, we investigate this possibility by conducting formal tests for serial correlation. These suggest no evidence of its presence either in the pregnancy or STI models. In other words, past increases in pregnancy and STI rates do not appear to be positively associated with future increases and our treatment of family planning services as exogenous in the difference-in-differences models is justified.

One disadvantage of the difference-in-differences model is that the impact of the RHS variables must be identified solely from relative changes over time rather than from absolute levels. To see why this is a problem, assume that higher unemployment rates are associated with higher teenage conception rates. With our procedure, average differences in unemployment rates across regions are removed by the inclusion of regional fixed-effects, whilst average changes in unemployment over time are removed by the inclusion of time fixed-effects. We must therefore rely on differences across regions in unemployment rate trends over time to identify in the effect of unemployment. If, in fact, trends in unemployment are quite similar across regions, our estimation procedure is unlikely to be powerful enough to observe a significant unemployment effect. Put another way, with the difference-in-differences estimator, there is a high chance of a Type 2 error, unless there is significant variation across regions in changes in variables over time.

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, trends in family planning provision for young people display a good deal of regional variation over the time of the policy change.

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, 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.

4.2 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.[9]

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 several reasons, most notably the fact 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).[10] 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

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[9] The figures do not include miscarriages.

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 also repeated the estimates below excluding all cases of chlamydia. In fact, the results were very close to those reported here.[11]

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. Family planning is also available from other sources, most particularly general practitioners (GPs). I use data 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, I include the number of pharmacists in each of the pilot health authorities offering free provision of EBC to young people of any age. 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 fertility 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-

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

[11] These results are reported in Paton (2003). A further issue also discussed in Paton (2003) is possible bias due the fact that services at some GUM clinics are constrained by waiting times.

Burn, Haverman and Wolfe, 1993; Paton, 2002).[12] 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*); 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*).

5. Empirical Results

5.1 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 1, 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 behaviour model. Clearly, however, a range of wider trends and influences may have affected these national figures. I now go on to use our econometric

[12] 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

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.

5.2 Econometric Evidence

In Table 2, I summarize the cross-sectional (between), time-series (within) and 'difference-in-differences' variation of each of our key variables. Recalling that the models rely on differences in time-series variation across cross-sectional units to identify the impact of each variable, note that most of the variables display a considerable amount of 'difference in difference' 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 -88% 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.

I report a series of diagnostic tests, namely the modified Wald test for groupwise heteroskedasticity (Greene, 2000, p.598), the Breusch-Pagan test for independence across units (Greene, 2000, p.601) and an LM test for serial correlation in fixed effects models (Baltagi, 1995, p. 93). The results of these tests suggest the absence of serial correlation and support for the use of panel corrected standard errors for groupwise heteroskedasticity and cross-sectional correlation.

The econometric estimates for the pregnancy and STI models for all teenagers are reported in Table 3. In each case, I report the fixed-effects estimates with standard errors that allow for groupwise heteroskedasticity and contemporaneous correlation across authorities.

The difference-in-difference estimates of equation 1a (reported in Table 3, columns 1 and 2) suggest family planning clinic sessions for young people have no overall significant impact on teenage pregnancy rates, a finding consistent with previous work. When we look at changes to this coefficient over time (column 4), there is evidence of a significantly different impact on pregnancy rates in later years compared to the baseline year (1998).

variation in welfare entitlements across England. There is also a more limited literature looking directly at the determinants of teenage sexual activity (for example, Oettinger, 1999; Levine, 2000).

However, in no year is the overall impact on pregnancy rates significantly different to zero. For example, a test of the null hypothesis that the impact in 2000 (i.e. the sum of the baseline coefficient on clinic sessions and the coefficient on the 2000 interaction term) is equal to zero yields a z-statistic of just 1.14.

The estimates of the STI model (reported in columns 3 and 4 of Table 3) suggest that clinic sessions have a strongly positive impact on STI rates amongst young people. Further, looking at column 4 of Table 3, the (adverse) impact on STI rates appears to be significantly greater by the end of the period than at the start. To give an idea of the order of magnitude involved, the point estimate of the impact of clinic sessions on STI rates in Table 3, column 3 implies an elasticity (based on the sample means) of 0.062 (calculated as 8.35 x 0.83/111.21). In other words, a 100% increase in clinic sessions is predicted to lead to a 6.2% increase in STI diagnosis rates. At a national level, the increase in clinic sessions of about 23% between 1999 (the start of the Teenage Pregnancy Strategy) and 2001 are implied to have contributed to a 1.45% increase in STI rates.

Thus far, the results provide very strong support in favour 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 strengthened the (adverse) relationship with STI rates. Taken together, these results are clearly inconsistent with the predictions of the random behaviour model as discussed above.

The coefficients on the variable representing free pharmacy-based provision of EBC are universally positive, but are insignificantly different to zero at conventional levels. Given that these schemes were limited in their scope in the time period in question, it may be that future research will shed more light on this issue.[13]

Looking at the other variables in the model, access to GP contraception is associated with significantly higher teenage pregnancy rates, whilst the number of GP practices is associated with significantly lower rate. These variables have no explanatory power in the STI models. Of the socio-economic variables, the percentage gaining no qualifications at 16 is strongly and positively associated with teenage conception rates. The data are unable to pick up any effect from unemployment or the rate of children in care on conception rates.

[13] One possibility is that increases in STI infections are not revealed in the reported diagnosis rates due to the rationing of services at some GUM clinics. This is examined more closely in (Paton, 2003.

The rate of children in care and the percentage with no educational qualifications are negatively associated with STI rates.

As the UK Government has set itself specific targets to reduce pregnancy rates amongst under-18s and under-16s, differences amongst age groups are likely to be of interest. In Table 4, I report the fixed-effects results of the pregnancy model (equation 2a) for 16-19s, under-18s and under-16s. As STI data are not collected specifically for under-18s, I report the results of the STI model (equation 2b) just for 16-19s and under-16s.

Three results stand out from the pregnancy models. Firstly, clinic sessions are positively associated with pregnancy rates for the under 18 age group, and there is no differential impact in this effect over time. Secondly, GP contraceptive services are only associated with pregnancy rates for the older age group (16-19). Finally, the rate of children in care appears to be significantly and positively associated with conception rates for the youngest age group (under 16s).

For the STI models, the relationship between family planning clinics and STI rates appears to have worsened significantly over time for both age groups. However, the overall impact of clinics on STI rates amongst under 16s is not significantly different to zero. Indeed, the STI model for this age group appears not to be well specified, a result that may reflect the relatively low numbers of actual cases amongst this age group.[14]

6. Conclusions

In this paper, I have demonstrated how data on the outcomes of teenage sexual behaviour might be used better to differentiate between the alternative models of such behaviour. Recent policy changes in England provide suitable natural experiments for testing predictions arising from theoretical models. Using data over the period 1998 to 2001 from English health authorities and controlling for socioeconomic factors, I find that recent increases in the number of youth family planning clinic sessions did not lead to reductions in teenage pregnancy rates, but led to significantly higher rates of diagnoses of STIs amongst teenagers. The regression results imply that the increase in youth family planning sessions between 1999 (the start of the Teenage Pregnancy Strategy) and 2001 led to an increase in rates of STI diagnoses in health authorities by about 1.45%. A further finding is that the shift towards greater promotion of emergency birth control appears to have worsened the impact on STI rates since 2000. Taken together, this evidence is largely consistent with models of rational choice and inconsistent with models of random behaviour amongst adolescents. Of the socio-economic factors, the lack of educational qualifications is strongly associated with higher teenager pregnancy rates amongst all age groups.

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 behaviour 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 microeconomic models. Teenage sexual behaviour appears to be little different to other fields that economists have studied in at least one important respect: incentives matter to teenagers too!

[14] In Paton (2003) I report a fuller range of results including random effects models which incorporate a range of census data and a number of other robustness checks. The key results relating to family planning are extremely robust to all these experiments.

Table 1: Trends in Family Planning, Sexual Activity, Teenage Pregnancy & STI rates

	Year			
Variable	**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 2: Summary Statistics

Variable		Mean	St. Dev.
Conceptions rates (all teenagers)	overall	66.91	15.93
	between		14.91
	within		5.76
	diff in diff		3.53
STI rates (all teenagers)	overall	111.21	62.85
	between		59.93
	within		19.68
	diff in diff		16.49
Clinic Sessions per km^2	overall	0.83	1.23
	between		1.21
	within		0.26
	diff in diff		0.25
GP services per km^2	overall	0.79	1.05
	between		1.05
	within		0.03
	diff in diff		0.03
Pharmacies providing EBC per km^2	overall	0.006	0.041
	between		0.026
	within		0.032
	diff in diff		0.031
GP practices per km^2	overall	0.38	0.58
	between		0.58
	within		0.02
	diff in diff		0.02
Unemployment	overall	3.38	1.56
	between		1.48
	within		0.50
	diff in diff		0.24
Children in care	overall	115.13	47.84
	between		45.89
	within		14.12
	diff in diff		13.70
% no qualifications	overall	5.95	2.04
	between		1.86
	within		0.87
	diff in diff		0.51

Notes

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

(ii) ‘between’ indicates variation between health authorities, i.e. after subtraction of mean value for each year; ‘within’ indicates variation within health authorities over time, i.e. after subtraction of mean value for each authority; ‘diff in diff’ indicates the variation after subtracting both the ‘within’ mean and the ‘between’ mean.

Table 3: Fixed-effects Estimates of Teenage Pregnancy & STI Rates, England 1998-2001

Dependent Variable:	**Pregnancy Rates/1000 females aged 15-19**		**STI Rates/1000 females aged 15-19**	
Clinic sessions per km^2	0.77	-0.24	8.35**	-0.66
	(0.66)	(0.61)	(4.02)	(4.38)
*Clinic sessions per km^2*1999*	-	0.59***	-	4.00***
		(0.11)		(0.69)
*Clinic sessions per km^2*2000*	-	1.01***	-	8.24***
		(0.18)		(0.97)
*Clinic sessions per km^2*2001*	-	0.86***	-	7.64***
		(0.20)		(1.15)
GP contraceptive services per km^2	24.67**	24.09**	-5.75	-12.39
	(10.14)	(9.83)	(42.14)	(39.27)
Pharmacies providing EBC per km^2	4.233	3.38	97.17	87.33
	(3.07)	(2.86)	(80.46)	(77.47)
GP practices per km^2	-28.09**	-26.61**	-61.83	-50.39
	(12.88)	(12.25)	(74.4)	(65.82)
Unemployment	-0.20	0.22	2.26	6.01*
	(0.94)	(0.92)	(4.44)	(3.44)
Children in care	0.01	6.82 e-3	-0.17***	-1.54***
	(0.01)	(0.01)	(0.05)	(0.05)
% no qualifications	1.55***	1.74***	-4.46***	-2.78*
	(0.38)	(0.38)	(1.25)	(1.48)
1999 effect	-2.71***	-2.78***	4.02**	4.27***
	(0.42)	(0.37)	(1.73)	(1.66)
2000 effect	-7.83***	-7.89***	13.36***	13.34***
	(0.83)	(0.72)	(2.84)	(2.65)
2001 effect	-10.04***	-9.74***	17.22***	19.78***
	(1.07)	(0.99)	(3.32)	(3.15)
Constant	141.05***	138.31***	176.65*	232.23**
	(19.46)	(21.21)	(106.5)	(92.12)
Observations	380	380	380	380
Wald χ^2	698.90***	1510.16***	5591.40***	18935.26***
Serial Correlation	2.52	2.73*	0.07	0.05
Groupwise heteroskedasticity	1.2 e+05***	1.7 e+05***	2.8 e+05***	80531.4***
Cross-sectional independence	6683.0***	6892.5***	5989.9***	5902.7***

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 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). The serial correlation test is the LM test for fixed effects described in Baltagi (1995, p. 93).

Table 4: 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	-0.39	1.67***	0.07	-0.29	0.47
	(0.71)	(0.83)	(0.31)	(5.03)	(0.84)
*Clinic sessions per km^2*1999*	0.57***	0.11	0.06**	4.39***	0.58***
	(0.12)	(0.13)	(0.03)	(0.82)	(0.10)
*Clinic sessions per km^2*2000*	1.30***	0.17	0.17***	10.06***	0.34
	(0.22)	(0.25)	(0.06)	(1.11)	(0.24)
*Clinic sessions per km^2*2001*	1.42***	0.26	0.24***	8.90***	0.82***
	(0.23)	(0.36)	(0.08)	(1.31)	(0.29)
GP contraceptive services per km^2	34.49**	2.20	2.90	-5.60	-1.69
	(14.41)	(8.41)	(2.75)	(39.42)	(12.33)
Pharmacies providing EBC per km^2	4.91	-0.34	-0.03	103.62	1.28
	(3.56)	(8.77)	(1.03)	(87.65)	(12.53)
GP practices per km^2	-33.14	-6.67	-4.00	-86.18	-17.56
	(22.69)	(11.48)	(3.01)	(71.88)	(24.08)
Unemployment	0.12	-0.78*	0.07	7.74*	-0.40
	(1.27)	(0.45)	(0.16)	(3.86)	(0.59)
Children in care	-0.01	0.02*	6.47 e-3***	-0.26***	-0.12*
	(0.01)	(0.25)	(1.97 e-3)	(0.06)	(0.01)
% no qualifications	1.52***	1.44***	0.53***	-2.84	-0.54
	(0.39)	(0.25)	(0.15)	(1.77)	(0.44)
1999 effect	-3.39***	-0.30	-0.54***	6.18***	-0.13
	(0.39)	(0.33)	(0.11)	(2.01)	(0.34)
2000 effect	-10.70***	-1.83***	-0.26**	18.03***	0.31
	(0.86)	(0.53)	(0.13)	(3.15)	(0.50)
2001 effect	-14.00***	-3.90***	-0.61***	25.60***	1.00
	(1.20)	(0.69)	(0.13)	(3.72)	(0.63)
Constant	169.26***	32.07***	5.96	231.84***	19.07**
	(20.17)	(7.40)	(6.94)	(86.31)	(8.38)
Observations	380	380	380	380	380
Wald χ^2	1617.5***	46780***	19255.4***	166.0***	5337.0***
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 3, 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.

Baltagi, B., 1995, *Econometric Analysis of Panel Data*. Chichester: John Wiley and Sons.

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

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.

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

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.

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

Paton, David (2003), ‘Can Rational Choice Models Explain the Relationship between Family Planning, Teenage Pregnancy and STIs?’, *Nottingham University Business School Discussion Papers*, 2003.XI.

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.

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
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

Notes: 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