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Long term effect of teenage birth on earnings: Evidence from a British cohort study

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Abstract

We use data from the 1970 British Cohort Study and evaluate the effect of teenage motherhood on hourly earnings at age 30, 34, 38 and 42 using alternative non-experimental estimation methods including linear regression, matching methods, and Heckman sample selection models. We conclude that teenage motherhood has a significant negative long-term effect on hourly wages. At age 42, teenage mothers earn 12% less than other women and 29% less than women who have not had any children. When comparing to non-teenage mothers, the pay penalty reduces over time and becomes insignificant on the long term.

Codes JEL: J13; J31

1. Introduction

The recent figures of the decline of teenage pregnancy in the UK have made the headlines[1]; but it remains far from the UK government's aim to halve the teenage pregnancy rate within 10 years, as stated in the 1999 Social Exclusion Unit report 'Teenage Pregnancies' (Ingham, 2005 (1)); see Figure 1. England has the highest rate of teenage pregnancy in Western Europe and is just second after the USA, in the developed world (Dickins *et al*. 2012 (2)).

[Figure 1 about here]

What would be the rationale for reducing teenage pregnancy? Teen parenthood is commonly associated with long-run socioeconomic consequences in education, employment, social exclusion, and physical and mental health. By reducing the rate of teenage motherhood, the UK government aims to reduce health and social inequalities and to improve life chances for both young parents and their children. In this context, understanding the consequences of teenage birth on later adult outcomes is core to the design of effective policies preventing social exclusion and intergenerational poverty. If teenage parenthood is found to lead to poorer socioeconomic outcomes then policies aimed at reducing teenage pregnancy will fulfil the government's aims. On the other hand, if the differences in socioeconomic outcomes in adulthood are due to individual heterogeneity prior to early childbearing decision, policies strictly aiming at the reduction of teenage pregnancy will not help and poor outcomes are likely to remain in the absence of teenage pregnancy.

[1] BBC: http://www.bbc.co.uk/news/magazine-30275449 (Last accessed 21 May 2016); http://www.bbc.co.uk/news/uk-26353267 (Last accessed 21 May 2016) ; The Times: http://www.thetimes.co.uk/tto/health/child-health/article3700310.ece (Last accessed 21 May 2016) ; Guardian: http://www.theguardian.com/healthcare-network/2015/mar/17/how-halved-teenage-pregnancy-rates-haringey (Last accessed 21 May 2016); http://www.theguardian.com/society/2015/feb/24/teenage-pregnancy-rate-record-low (Last accessed 21 May 2016); http://www.theguardian.com/society/2015/feb/24/teenage-pregnancy-england-wales-lowest-46-years (Last accessed 21 May 2016) ; The Independent: http://www.independent.co.uk/news/uk/home-news/teenage-pregnancy-rates-fall-to-their-lowest-level-for-46-years-10068005.html (Last accessed 21 May 2016); The Telegraph: http://www.telegraph.co.uk/women/mother-tongue/9899809/Dont-panic-the-teenage-pregnancy-epidemic-is-over.html (Last accessed 21 May 2016)

The question of interest here is whether teenage parenthood has a causal impact on future earnings or whether teenage parents are systematically different from other teenagers in the first place (e.g. poorer social and family background) in a way that affects their socioeconomic outcomes in later life. Most studies have focussed on the short-term impact of teenage motherhood (Chevalier and Viitanen 2003 (3); Hotz *et al*. 2005 (4); Klepinger *et al*. 1999 (5)). A major limitation of the short run perspective is that it makes it challenging to clearly disentangle the impact on earnings of motherhood itself from the impact of early childbearing. One of the advantages of the 1970 British Cohort Study (BCS) is that it allows studying the long run impact of teenage motherhood, as data are available at several time-points in adulthood; our main outcome of interest is the hourly wage measured at ages 30, 34, 38 and 42. In addition, the cohort study provides us with a sample of people who experienced similar macroeconomic conditions and faced similar social, family and health policies. We compare long-term differences in earnings between teenage mothers, later childbearing mothers and childfree women and address the potential endogeneity of teenage parenthood using linear regressions, matching methods and selection models.

Our study adds to the literature at several levels. First, to our knowledge, the impact of teenage motherhood on earnings across a number of time points has never been investigated. Second, we develop a highly robust propensity scores matching approach to control pre-determined characteristics. As Blundell *et al*. (6) stated 'there are broadly two categories of non-experimental methods: those that attempt to control the correlation […] by way of an excluded instrument and those that attempt to measure all individual factors that may be the cause of such dependence and then to match on these observed variables'. In the presence of a rich vector of social and family background in the BCS data and in the absence of potential IV for teenage parenthood, the focus on the latter method is particularly recommended.

Our findings confirm that teenage motherhood has a significant negative effect on hourly wages. Our preferred estimates show a wage loss between 30% and 12% when comparing teenage mothers with any other women in their generation and between 39% and 29% over the four age points when comparing to childfree women. When comparing with women who delayed childbearing, the pay penalty reduces over time from 23% to 9% and becomes non significant on the long term. The use of Heckman selection and matching methods allows us to correct the estimates of the proportion of wage loss due to teenage birth and we conclude that there is evidence of long-term effects of teenage parenthood on earnings of women in the UK.

The paper proceeds as follows. In Section 2, the literature on the effects of teenage birth on social outcomes is reviewed. Section 3 presents the methods and Section 4 describes the data used in the analysis. Results are presented in Section 5 and in Section 6 we highlight our main conclusions.

2. Literature review

A large literature has looked at the determinants of teenage pregnancy. In the UK, three sets of variables have been identified as significant predictors for teenage parent: family of origin including parents' characteristics, geographical context, and teenagers' characteristics. Young parents are more likely to be born in socially disadvantaged families and to have experienced poverty in childhood (Hobcraft and Kiernan 2001 (7); Russell 2002 (8); Kiernan 1997 (9)); their family of origin often shows a disrupted family structure, with a lone mother, parental conflict, poor quality of family communication, and lack of interest in children's education (Russell 2002 (8); Robson and Pevalin 2007 (10)). In addition, a pattern of intergenerational transmission of teenage parenthood has also been shown with teen mothers being born from a teen mother (Kiernan 1997 (9); Manlove 1997 (11); Russell 2002 (8); Robson and Pevalin 2007 (10)). Young mothers are disproportionately represented in poorer areas (Wellings *et al*. 1999 (12)). In terms of teenagers themselves, educational ability and achievement, particularly low levels of success and high instances of school truancy, have been found strongly associated with teenage parenthood (Kiernan 1997 (9); Manlove 1997 (11)) as well as early conduct disorders, emotional problems in adolescence, and risk-taking behaviours (Wellings *et al*. 1999 (12); Robson and Pevalin 2007 (10)).

The impact of teenage parenthood on adult economic and social outcomes was analysed in a number of studies, which showed that teenage motherhood was associated with a high probability to receive social benefits (Hobcraft and Kiernan 2001 (7); Wellings *et al*. 1999 (12)), to have low earnings and experience poverty (Moffitt et al. 2002 (13)), and with a lower likelihood to complete high school (Hobcraft and Kiernan 2001 (7); Hofferth *et al*. 2001 (14)) and to participate in the labour force (Ermisch and Pevalin 2005 (15)). However, most studies aimed at showing statistical associations between teenage parenthood and later life outcomes without assessing a true causal effect. The main reason is the difficulty to control for the selection bias into teenage motherhood and to evaluate robustly whether teenage mothers would have been able to achieve higher earnings had they not been mothers in their teenage

years. Using Swedish data, Holmlund (2005) (16) investigated the causal effect of teen motherhood on years of schooling adopting a siblings approach. She compared outcomes of 322 pairs of teenage mothers and their sisters who never had a child or had a child after their teens. She concluded that teenage motherhood reduced years of schooling by 0.59 years even after controlling for heterogeneity between siblings using school performance. In the UK, Robson and Pevalin (2007) (10) identified miscarriage as an IV to account for selection into teenage parenthood. They considered a number of later life outcomes at age 30 including educational achievement, labour force participation, pay, social class, property ownership, social benefit dependence and concluded that pre-childbearing decisions characteristics were leading to later life disadvantage and that the relative impact of a teen birth was insignificant. Their instrumental variable (IV) regression models showed that young parenthood had no significant effects on any outcomes for men and women including pay at age 30. Focusing on schooling, labour market experience, and adult earnings at age 34, Chevalier and Viitanen (2003) (3) estimated the causal effect of teenage motherhood using age at menarche as an IV and then matching estimates based on pre-teen motherhood observable characteristics. They concluded that teenage birth decreased the probability of post-16 schooling, reduced employment experience by up to three years and had a negative effect on pay but this effect reduced when unobserved individual heterogeneity was accounted for. The pay differential at 34 years old between teenage mothers and other women ranged between 5% and 22% with their preferred estimate at 8%. A number of US studies have also concluded that the impact of teen parenthood on later earnings was over-estimated when the endogeneity of early childbearing decisions was not considered. Hotz *et al*. (2005) (4) used the occurrence of miscarriage as an IV to estimate the causal effect of teenage parenthood on a number of economic and social outcomes at age 28 including working hours and wage rate that were collected annually between 18 and 35 in the National Longitudinal Survey of Youth. They reported that the effects were short-lived and teenage childbearing did not result in permanently lower earnings rates. In addition, they estimated that teen mothers would have lower levels of earnings if they had delayed their childbearing decision. Unlike Hotz *et al*. (2005) (4), Klepinger *et al*. (1999) (5) found with the same dataset that teenage motherhood substantially reduced between 13 to 25% women's earnings at 25. They considered a childbearing decision model and an identification strategy based on a large set of IVs for fertility including age at menarche, state and county-level characteristics in relation with fertility and abortion. More recently, Fletcher and Wolfe (2009) (17) also found that having a child as a teenager reduced the probability of graduating by 5 to 10 percentage points and the

annual income in early twenties by $1,000 to $2,400; they used miscarriage as an IV along with community-level factors and compared outcomes of teenage mothers with their counterpart who had a miscarriage in teens.

This review of the literature shows that past studies have considered socioeconomic outcomes only in the short term or medium term (up to 33 years old) and the impact of teenage motherhood on earnings after 30 years is debated. Furthermore, differences in earnings of teenage mothers in comparison with other women or other mothers have been seldom studied in the UK.

3. Methods

The aim of this paper is to analyse whether there is a causal effect of teenage motherhood on earnings in the long run. We are particularly interested in identifying the gap in earnings between teenage mothers and their peers. Unlike most previous research which focused on comparing socioeconomic outcomes of teenage mothers with other women only, we consider three alternative control groups: all other women (control sample A), all other women being mothers when earnings are observed but not in their teen ages (control sample B), and women who never had children at the time earnings are observed (control sample C). These alternative control groups allow us to identify the scarring effects on earnings of teenage motherhood and motherhood in general.

Let us consider that $\boldsymbol{Y_i}$ represents the observed (log-transformed) earnings of individual $\boldsymbol{i}$ and $\boldsymbol{T_i}$ indicates whether the woman was a teenage mother. The model we wish to estimate can be written as follows:

$$\boldsymbol{Y_i^* = \alpha_i X_i + \beta_i T_i + u_i} \qquad (1)$$

where $\boldsymbol{\beta_i}$ is our estimate of interest: the impact of becoming a teenage mother relative to not becoming a teenage mother on hourly wages, and $\boldsymbol{\alpha_i}$ are the returns of a set of observed individual characteristics $\boldsymbol{X_i}$ on hourly wages and $\boldsymbol{u_i}$ is a vector of unobserved factors. The vector $\boldsymbol{X}$ is expected to be exogenous from the treatment and unrelated to the vector $\boldsymbol{u}$, typically $\boldsymbol{X}$ will include characteristics prior to becoming a teenage mother.

An issue in estimating earnings equations is that no earnings are observable for women who do not work. If the analysis uses only women who work then the estimation will be

biased and suffer from sample selection. An accurate estimate of the causal impact of teenage motherhood on earnings must initially correct for selection into labour force. Following Heckman (1976), a way to account for this bias is to estimate a preliminary selection equation based on the probability of being included in the sample (i.e. a probability of working):

$$\begin{cases} \boldsymbol{W_i^* = \gamma Z_i + \alpha_i X_i + \beta_i' T_i + \varepsilon_i} \\ \boldsymbol{W_i = 1 \ \ if \ \ W_i^* \geq 0} \\ \boldsymbol{W_i = 0 \ \ if \ \ W_i^* < 0} \end{cases} \quad (2)$$

where $\boldsymbol{W_i}$ is a binary variable that indicates whether the individual $\boldsymbol{i}$ works and $\boldsymbol{Z_i}$ is a vector of explanatory variables predicting the probability to work. Additionally as the probability of labour market participation varies by teenage motherhood status as evidenced in the literature, we include $\boldsymbol{T_i}$ in the equation. Equation (1) is the outcome equation while equation (2) is the participation equation; $\boldsymbol{Y_i}$ is not observed if $\boldsymbol{W_i = 0}$. The model is identifiable if we allow $\boldsymbol{Z_i}$ to contain at least one variable, which is not included in $\boldsymbol{X_i}$. We assume that the error terms $\boldsymbol{u_i}$ and $\boldsymbol{\varepsilon_i}$ are correlated and randomly distributed with a bivariate normal distribution. Let us assume that $\boldsymbol{\rho = Corr(u_i, v_i)}$; the Heckman correction is appropriate if we reject the following null hypothesis $\boldsymbol{H_0}$: $\boldsymbol{\rho = 0}$.

An additional issue when estimating the effect of teenage motherhood on earnings is that teenage mothers could earn less simply because they come from a less favoured background. In order to control for this potential bias on the estimation of the effect of teenage motherhood on earnings and other employment status, we rely on the potential-outcome model as developed by Roy (1951) (18) and Rubin (1974) (19), and consider teenage motherhood as a treatment. Two potential outcomes can be associated to the treatment: $\boldsymbol{Y_i^0}$ and $\boldsymbol{Y_i^1}$ **,** where $\boldsymbol{Y_i^0}$ are the earnings of individual $\boldsymbol{i}$ when individual $\boldsymbol{i}$ is untreated, i.e. when individual $\boldsymbol{i}$ was not a teenage mother; and $\boldsymbol{Y_i^1}$ are the earnings when individual $\boldsymbol{i}$ is treated, i.e. when individual $\boldsymbol{i}$ was a teenage mother. Let us consider that $\boldsymbol{Y_i^j}$ represents the observed (log-transformed) earnings of individual $\boldsymbol{i}$ according to the treatment $\boldsymbol{j = 0, 1}$. The causal effect of teenage motherhood on earnings of individual $\boldsymbol{i}$ can then be estimated as the difference between the outcomes $\boldsymbol{Y_i^1}$ and $\boldsymbol{Y_i^0}$, known as the average treatment effect (ATE) on the treated. In other words, the causal effect of teenage motherhood on earnings is the difference $\boldsymbol{\tau}$ between the earnings individual $\boldsymbol{i}$ obtains having been a teenage mother and the earnings individual $\boldsymbol{i}$ would have obtained had **i** not been a teenage mother:

$$\boldsymbol{\tau = E(E\left(\left(Y_i^1 - Y_i^0 \middle| X_i, T_i^1\right)\right) \middle| T_i^1\right))} \quad (3)$$

We cannot estimate $\boldsymbol{\tau}$ as only one of the outcome variable is observable; when $\boldsymbol{i}$ is a teenage mother $\boldsymbol{E\left(y_i^1 \middle| X_i, T_i^1\right)}$ is observed but not $\boldsymbol{E\left(y_i^0 \middle| X_i, T_i^1\right)}$.

A naïve estimator of the impact of teenage motherhood on earnings would consist in estimating the difference:

$$\boldsymbol{\tau^{naive} = \frac{1}{n_1}\sum_1^{n_1} Y_i^1 - \frac{1}{n_0}\sum_1^{n_0} Y_i^0} \quad (4)$$

where the total number of individuals in the treatment and control group are respectively $\mathbf{n_1}$ and $\mathbf{n_0}$. The difference parameter $\boldsymbol{\tau^{naive}}$ is potentially a biased estimator of the ATE. Intuitively, teenage mothers might be different from non-teenage mothers in the first place; even if they did not have a child in early age, they may have had different outcomes. The key issue is then that if teenage motherhood is not randomly distributed, which has been shown to be the case (Hobcraft and Kiernan 2001 (7); Robson and Pevalin 2007 (10)) then the two populations are likely to be self-selected and systematically differ from each other so that $\boldsymbol{Y_i^0}$ for the non-teenage mothers do not correctly estimate $\boldsymbol{Y_i^0}$ for the teenage mothers. A solution to the selection bias would be to produce experimental data and randomly assign individuals to the treatment. In our context, an experiment that would assign randomly the treatment (becoming a teenage mother) cannot be reasonably considered. We need to use observational data and use a quasi-experimental approach, such as IVs or matching estimators, which relies on stronger identifying assumptions. Instrumental variables are not an option in this analysis, as we do not have a suitable instrument such as miscarriage or age at menarche. We therefore consider three alternative strategies to deal with this selection issue: matching, fully interacted linear model, and Heckman.

3.1 Matching method

The matching method aims to re-create the conditions of an experiment for non-experimental data and construct the counterfactual for the treated outcomes had they not been treated using the non-treated sample. It consists in pairing up each treated individual with one or several individuals in the non-treated group (control) under the matching assumption so that the only remaining difference between the outcomes of the two groups is the effect of the

treatment. Matching techniques require identifying characteristics observed prior the treatment that could be used to match each treated individual with an untreated individual having identical pre-treatment characteristics. The main challenge in the matching method is to identify the appropriate matching variables and construct a consistent estimate of the treatment effect. The matching variables must affect both the outcome and the treatment hence the vector of matching variables will differ with each time-point being analysed. Among the previous vector of variables $\boldsymbol{X}$, we will distinguish a subset of variables $\boldsymbol{M}$, which will affect both the outcome $\boldsymbol{Y_i^0}$ and the teenage motherhood $\boldsymbol{T_i^j}$. Conditionally on $\boldsymbol{M}$, the assumption made is that the counterfactual outcome $\boldsymbol{Y_i^0}$ in the treated group is the same as the observed outcome $\boldsymbol{Y_i^0}$ in the untreated group. Rosenbaum and Rubin (1983) suggest the use of a balancing score $\boldsymbol{b(M)}$, which is a function of the relevant observed variables $\boldsymbol{M}$ such that the conditional distribution of $\boldsymbol{M}$ given $\boldsymbol{b(M)}$ is independent of the assignment to the treatment. The match does not need to be carried out on every pre-treatment characteristic, particularly when the vector $\boldsymbol{M}$ is large. The matching method allows us to match women who became teenage mothers to women who did not become teenage mother using a number of pre-teenage birth characteristics to construct a propensity score $\boldsymbol{P = Pr\left(T_i^1 \middle| M\right)}$ and assume that this matched comparison group constitutes the counterfactual outcome required. The average effect of teenage motherhood then becomes

$$\boldsymbol{\tau^{match} = E(E\left(\left(Y_i^1 - Y_i^0 \middle| P_i, T_i^1\right)\right) \middle| T_i^1\right)} \quad (5)$$

The matching between pairs of individuals can be done using several methods; one-to-one matching could be used but one treated individual (teenage mother) can also be matched to several untreated individuals (non-teenage mothers) using nearest neighbour, kernel or radius matching. The matching specification can influence the results and there are no consensus concerning the best matching specification in the literature. We use two different matching estimators, which allow us to check for sensitivity of the results. We first apply a nearest neighbour matching, which associates to the outcome of treated individual $\boldsymbol{Y_i}$ a 'matched' outcome given by the outcome of the most observably similar non-treated individual. We combine the nearest neighbour matching without replacement. When matching is performed with replacement, the same comparison group observation can be used repeatedly as a match. We then apply a Kernel matching that consists in matching the outcome $\boldsymbol{Y_i^1}$ of treated individuals to a weighted average of the outcomes of a number of non-

treated individuals. The weight is defined in proportion to the closeness of the characteristics of the individual $\boldsymbol{i}$ and the matched individuals; we use a bandwidth of 0.001 to exclude observations for which there is no close match, thus enforcing common support.

The propensity score is estimated using a Probit model and must respect two assumptions: unconfoundness and overlap. The unconfoundness assumption signifies that the assignment to the treatment is random conditional to the variables $\boldsymbol{M}$, i.e. when individuals share the same characteristics $\boldsymbol{M}$, their assignement to the treatment is random. The overlap condition (also known as common support) signifies that individuals with similar $\boldsymbol{M}$ have a probability of being treated strictly comprised between zero and one, so that $\boldsymbol{0 < Pr(T_i^1 | M) < 1}$. To choose the variable $\boldsymbol{M}$ it is advised to follow the literature on variables used to predict the assignment to the treatment and to use variables observed before the assignment to the treatment to avoid unconfoundness. The quality of a propensity score is evaluated with the mean bias of the model and each variable is expected to have a mean bias under 5%. There can be common support issues in a model if some individuals from the treated group have a value of the propensity score that none of the individuals from the non treated group have. In this case we will not be able to compare the treated individual with a counterfactual group and the observation will be dropped from the analysis.

3.2 Fully interacted linear model

A standard least squares regression specification would generally control linearly for the set of observables $\boldsymbol{X_i}$ and $\boldsymbol{T_i^j}$ as described in Equation (1). From the propensity score matching the vector of variables $\boldsymbol{M}$ was identified so the assignment to the treatment is independent and the difference in outcome is the effect of the treatment and is not influenced by $\boldsymbol{M}$. Therefore, if included in place of the larger vector $\boldsymbol{X}$ in Equation (1), the vector $\boldsymbol{M}$ will improve model specification and the estimation of $\widehat{\boldsymbol{\beta}}$. However, a source of bias in the estimation of $\widehat{\boldsymbol{\beta}}$ potentially remaining is related to the returns of the treatment that might differ with the $\boldsymbol{M}$ vector. A solution suggested by Blundell *et al*. (2005) is to allow for interactions between any of the $\boldsymbol{M_i}$ and the treatment $\boldsymbol{T_i^1}$ using a fully interacted linear model. This consists in including in Equation (1) an additional vector of terms $\boldsymbol{\alpha_i M_i T_i^1}$.

$$\boldsymbol{Y_i^j = \alpha_i M_i + \alpha_i M_i T_i^1 + \beta_i T_i^1 + u_i^j} \quad (6)$$

This third estimation method acts as bridge between a matching estimator and the naïve estimator. According to the literature, the ATT of fully interacted linear models should be close to the results found with the propensity score matching approach.

3.3 Heckman Selection bias control method

The Heckman correction, as suggested earlier, is relevant in our analysis as we might observe a selection bias of two forms. If teenage mothers are socially disadvantaged in comparison with their peers, they are more likely to be unemployed.

We apply the Heckman's sample selection model estimating preliminarily the impact of teenage motherhood on the probability to participate to the labour market (Equation 2) before we estimate the outcome equation (Equation 1). We consider a simultaneous estimation and a two-part estimation of the two equations. Using the advantage of the vector $\boldsymbol{M}$, which was found independent of the treatment at the matching stage, we estimate the following system of equations:

- participation equation

$$\begin{cases} \boldsymbol{W_i^* = \gamma Z_i + \alpha_i M_i + \beta' T^1_{j\,i} + \varepsilon_i} \\ \boldsymbol{W_i = 1 \;\; if \;\; W_i^* \geq 0} \\ \boldsymbol{W_i = 0 \;\; if \;\; W_i^* < 0} \end{cases} \tag{7}$$

- outcome equation

$$\boldsymbol{Y_i^j = \alpha_i M_i + \beta_i T_i^1 + u_i^j \;\; if \;\; W_i = 1} \tag{8}$$

and evaluate $\boldsymbol{\rho = Corr(u_i, v_i)}$.

4. Data

The 1970 British Cohort Study (BCS) is a continuous longitudinal study that focuses on all children born in the UK on the same week. The initial sample included 17,196 individuals and follow-ups have been carried out in 1975, 1980, 1986, 1991, 2000, 2004, 2008 and 2012. The survey includes questions on health, education, sexuality and professional development.

Descriptive statistics are available in Table 1. Teenage mothers are more likely to be born of a teenage mother and of parents with lower levels of qualification.

[Table 1 about here]

4.1 Teenage motherhood and control samples

Teenage motherhood includes any cohort member who had a birth prior to her 20th birthday[2]. Information on pregnancies and teenage motherhood were asked for the first time in 1991 (age 21). Cohort members reported how many children they had given birth to as teenagers. Any women who provided a strictly positive answer to the question were included as a teenage mother. In 1996 and 2000, cohort members reported a full detail of their pregnancies including dates and outcome of the pregnancy (birth, abortion, miscarriage). When women reported having had a pregnancy before 1990 that resulted in a live birth, they were added to the group of teenage mothers. The sample includes, after attrition, n=179 teenage mothers, which represents 2.5% of all women in the sample. Women who reported a birth after age 21 were then included in the control group of mothers. By age 30, 41% of women were mothers (n=2,953), 52% at age 34 (n=3,771), 59% at age 38 (n=4,268) and 67% at age 42 (n=4,859). Cohort members who did not answer questions regarding sexuality and parenthood were excluded from the sample.

4.2 Earnings and other socio-economic outcomes

We correct for the selection bias in earnings using labour market participation at age 30, 34, 38 and 42 as a first socioeconomic outcome and we then study the gross hourly earnings at these ages. Women reported their economic activity at each period; women who declared being in full time, part-time or self-employment were considered as working whereas women reporting being unemployed, in education, temporarily or permanently sick, were considered inactive. Gross weekly earnings at each period were computed gathering reports of the level

[2] Various age cut-offs have been used to define teenage motherhood in the literature; it includes pregnancy under 16, under 18, and giving birth while aged 19 or under. In our study, we used the latter, which was also used for most statistics reported in UK government documents (Social Exclusion Unit, 1999; NICE, 2007).

of gross pay and the period covered by this pay[3]. The number of working hours per week was available at each period for employed or self-employed women and hourly earnings were generated by dividing gross weekly earnings by the number of working hours per week. We adjusted gross hourly pay using the consumer price index with 2006=100 as a reference (Blue Book 2010 p.41 (20)); and we finally computed the log of hourly gross earnings at each age. When considering earnings at repeated time-points as the outcome of interest, we focus on 'snapshot' differences in earnings. However, we may also be interested in differences in earnings over the whole lifecycle, particularly because income is composed of permanent and transitory components. Permanent component of income also has consequences in term of inter-temporal choices such as investment and consumption decisions; we therefore consider as a fifth outcome for the analysis the average earnings over the four time-points[4].

At age 30, the rate of working teenage mothers is lower than other women (59% against 74%) (see Table 2.a) and when teenage mothers work only 26% are in full-time employment (compared to 49% for other women). On average teenage mothers are more likely to be unemployed or homemakers (see Table 2.b).

[Tables 2.a-d about here]

Teenage mothers work fewer hours and these hours are paid 42% lower in comparison with other women (£5.09/hour versus £8.96/hour) (see Tables 2c and 2d). Compared to other mothers, teenage mothers have a very similar labour market participation rate (59%) however on average they work marginally longer hours and receive significantly lower hourly wage rates. From age 34 and onwards, teenage mothers work significantly longer hours than other mothers and other women in general. At age 42, childfree women work longer hours (36.32 hours) and their hourly wage rate is higher (£18.05/hour) compared to teenage mothers (£14.94/hour). The income difference between teenage mothers and other women is equal to 40% at age 34, 41% at age 38, and reduces to 9% at age 42. Whereas other mothers seem to go back to work over time, the labour market participation of teenage mothers remains lower at all periods and even declines when they reach age 42. This difference is not caused by unemployment but by home making. Whereas only 2% at age 38 and 1.4% at age 42 of

[3] The gross pay amount was divided by two when the period declared was two weeks, by 26 when the period was 6 months, 52 when the period was one year.

[4] The average earning was calculated when individuals provided their income value for at least three time-points.

childfree women report taking care of home or families, this activity represents 21% among teenage mothers at ages 38 and age 42.

The evolution of labour market participation, working hours and hourly gross pay among the sample of teenage mothers and the three different control groups over the four time-points are summarised in Figures 2, 3, and 4.

[Figures 2-4 about here]

4.3 Childhood variables used in matching

Matching techniques require identifying characteristics observed prior to the treatment that explain the probability of teenage pregnancy and that are also related to the studied outcomes. Following the literature on the predictors of teenage parenthood we considered a number of predictors including family and social background characteristics, parents' interest in child's education, family activities, geographical environment, number of siblings, whether their mother was a teenage mother, risky health behaviours, a number of scores on problem behaviour, and happiness. All these variables were selected from the third wave of BCS carried out at age 10; this is therefore long before the assignment to the treatment happens. We generated a propensity score for each of the three control samples (A, B, and C) at age 30, 34, 38, and 42. The twelve scores are of good quality; Appendix 1 shows that the overlap condition is verified and the mean bias of the models varied between 0% and 8%, which is quite low; we were also able to match each observed treated women to at least one untreated women (see Figures 5 and 6). The propensity scores included some of the following variables: whether the teenage mother had a teenage mother (binary); if she came from a single parent family (binary); was the eldest (binary); the youngest (binary); the number of siblings; if the mother had any qualifications (binary); the level of qualification of the father (categorical); the region she grew up in (categorical); the interest of the father in the education (categorical); the frequency of eating (categorical) or going on holiday (categorical) together as a family; the interest in reading books at age 10 (binary); if she ever smoke (binary); the rate of friends smoking (categorical); how often they consider being bored in school; beliefs on the importance of the possibility to abort (categorical) and if hard work pays off in school. A summary of the alternative scores composition is available in Appendix 2.

[Figures 5-6 about here]

4.4 Heckman identification variables

To be identifiable the Heckman sample selection model requires an exclusion restriction such that we include at least one additional variable or a vector of variables $\boldsymbol{Z_i}$ in the selection equation that are not used in the outcome equation. Labour supply is likely to be impacted by individual characteristics observed in adult age such as family size and health, we therefore use as exclusion restrictions: the household size or the number of children[5] and reports of long-standing illness (LSI) at each period[6]. Descriptive statistics are available in Table 3. Teenage mothers are on average in larger households than other women at age 30 (3.54 people compared to 2.89). However, this rate is lower than other mothers, which may be explained by the higher likelihood of teenage mothers to be lone parents. At age 38, other mothers have on average twice more children than teenage mothers (1.86 and 0.93). Few differences in reports of long-standing illness (LSI) were observed between teenage mothers and other women between 30 and 34 years old. At age 42 teenage mothers reported higher rates of LSI compared to other women and other mothers (39%, versus 30% and 29% respectively).

[Table 3 about here]

5. Results

The estimated returns to teenage motherhood comparatively to each of the control groups (other women – control group A, other mothers – control group B, childfree women – control group C) are respectively presented in Tables 4.a, 4.b., and 4.c. The upper part of the tables presents the average treatment effect on hourly wages when controlling for (i) teenage parenthood, only and for (ii) teenage parenthood and a vector $\boldsymbol{X}$ of background variables on the reduced sample of observed hourly wages. The inclusion of controls typically shows a large reduction in the magnitude and significance of the ATE estimate as compared to the

[5] At age 30 and age 34 individuals reported the number of members in the household. At age 38, this question was changed to include the number of children in the household. At age 42, children absent from the household at the time of the questionnaires were also included.

[6] Being disabled was simply derived from a binary question asking individuals if they suffered from a long-standing illness (LSI). At age 38 however the question was slightly modified as individuals were asked if they had a LSI or a disability. This distinction may account for the lower rates of positive answer at this period.

naive specification (see ii). When comparing with women in general (control group A), the average effect of teenage motherhood is only significant at age 30 and shows a 25% reduction in hourly wages; the magnitude of the gap is similar when comparing with women who delayed childbearing (control group B). The largest and most significant gap in hourly wages is observed when comparing teenage mothers with childfree women (Table 4c); teenage mothers are paid between 41% and 16% less and the gap is significant over the four time points. There are no significant differences in average income over the 12-year period between teenage mothers and other women in general or other mothers. However the magnitude of the difference in average hourly wages with childfree women is -15% whilst not significant. These descriptive results show that teenage motherhood is associated with lower hourly wages mainly at age 30.

[Tables 4a-4c about here]

The sample-selection models produce very similar point estimates to those produced by the full specification OLS (see ii). The estimates were slightly biased downward when comparing with other women in general and other mothers whereas they were biased upward when comparing to childfree women. Correcting for labour market participation impacted on the significance of hourly wage gaps and emphasised a significant 16% to 18% difference in hourly wages at age 38 between teenage mothers and their counterparts. We also note that correcting for labour market participation had no impact on our estimation of permanent earnings.

These estimates may additionally be biased if the decision to have a child as a teenager is not random; we therefore control for the selection into teenage motherhood using two alternative matching models with a balancing score $\boldsymbol{b}(\boldsymbol{M})$ (see v and vi), a fully interacted OLS (see vii), and two Heckman specifications (see viii and ix). The vector $\boldsymbol{M}$ is used in the Heckman specifications since its composing variables have specifically been selected to have the same impact on both teenage mothers and non-teenage mothers. Fully interacted OLS (see vii), produced very similar point estimates to the matching estimates produced by the kernel specification for the propensity score (see vi). However the no replacement specification often produced slightly higher estimates. The Heckman estimates (vii) and (ix) are similar to the values obtained by OLS without the vector $\boldsymbol{X}$ as control (see i). Accounting for the double selection in teenage motherhood and labour force participation provides average effects,

which are negative and significant. The highest gap in hourly wages is observed between teenage mothers and childfree women; it is always significant and estimated between 39% and 25%. Women who became teenage mothers are also found to earn less than women who delayed childbearing; the gap in earnings is comprised between 25% and 17% and is significant at age 30, 34, and 38 and on permanent earning but not at age 42.

Figure 7 summarises the findings. While the gap in hourly wages reduces overtime between teenage mothers and the three control groups, it remains negative over time. Teenage parenthood appears to have a scarring long-term effect on transitory and permanent earnings. Considering that the double selection correction with simultaneous regression is our favoured estimates, it appeared that a naïve OLS specification overestimated the average effect of teenage parenthood at age 30 and age 34 while it underestimated the average effect at age 42.

[Figure 7 – about here]

6. Conclusion

We have developed in this paper a causal analysis of teenage motherhood on earnings on the long-term using cohort data from the 1970 British Cohort Study. Our study reveals a negative impact of teenage motherhood on earnings, and more generally it shows that motherhood has a (negative) effect on income. This article innovates at two levels: it provides additional elements to the debate on the consequences of teenage motherhood on earnings and it extends methodologically the benefits of selecting balanced variables via propensity score matching.

We studied labour participation and hourly earnings over a number of time-points as well as on average over 12 years. The time perspective appears essential to understand labour market behaviours of women as they show changes in trajectory over time in relation with childbearing. So far, literature in this area had demonstrated that for employed teenage mothers, their income is lower than the income of other working women. When we control for pre-determined characteristics, our findings confirm this result. In addition, we find that this phenomenon persists in the long-term and is much stronger if we compare teenage mothers with women who delayed childbearing or childfree women. Our results underline the

difference in labour participation and in wages that motherhood generates, both for teenage mothers[7], non-teenage mothers and childfree women.

Our preliminary biased findings suggested a short-lived (at age 30 only) significant negative impact of teenage motherhood on earnings in line with the results of Hotz *et al.* (2005) (4) comparing teenage mothers with teenage miscarriages. However, the use of propensity score matching based on pre-determined characteristics has enabled us to control for the impact of initial socioeconomic background and emphasised a significant long-term effect of teenage motherhood on earnings, especially when comparing teenage mothers with childfree women. This effect overall decreases over time, but remains at least significant for all control groups until age 38. These results are in line with Chevalier and Viitanen (2003) (3), who found a pay gap at age 34. However, their analysis did not show whether that gap would decrease progressively on the longer term particularly when other women would become mothers. Our study goes one step further analysing the potential scarring effects of teenage motherhood in the UK on a longer run and shows that at age 42, teenage mothers earn 12% less than their counterparts and 29% less than childfree women. However, the pay gap at age 42 is not significant when comparing with women who delayed childbearing.

Methodologically, our analysis gathers together a number of specifications to evaluate the causal impact of teenage parenthood on wages. While we undertook a propensity score matching approach, we also used the selected variables from that stage as a vector of key independent variables in a fully interacted linear model and confirmed that both specifications led to similar estimates. In addition our research question faced two different biases that we corrected for simultaneously using Heckman specification guided with our preliminary propensity score matching stage.

Our study presents caveats; the sample of teenage mothers in the British Cohort Study remains quite small and earnings were not collected annually. We were also restricted to the available data, we could not control if an older sibling had had a pregnancy or specific local area characteristics. Similarly, we could not control for women's work and family-related lifestyle preferences and life goals. According to preference theory, which explains women's

[7] Our results are similar when we consider only women who became mother prior to their 19th birthday. Teenage motherhood has a strong negative impact on income that decreases significantly overtime. Overall, the effect of teenage motherhood on income is even stronger for younger teenage mothers. Results are available upon request to the authors.

choices between market work and family work, women can be home-centred, work-centred or adaptive (Hakim, 2002 (21)). While work-centred women maximise their earnings, adaptive women give priority to convenient hours and work-life balance, and home-centred women give priority to family life. In our sample, one-third of teenage mothers do not work at age 42; we assumed that (all things equal) all women sought to maximise earnings, however it is important to underline that they may have plenty of other life goals. Had we had appropriate data, it could have been interesting to interpret our results in the light of women's preferences.

From our analysis we can infer some guiding elements for policy-makers. Our results indicate that teenage motherhood leads to important losses in earnings on the long term in comparison with childfree women while the earning gap vanishes when compared with women who delayed childbearing. Policies that overcome poor initial economic background of parents are therefore likely to be more appropriate than policies that strictly target teenage pregnancies.

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Figure 1 - Relative changes in age-specific conception rates. 1990–2011 in England and Wales

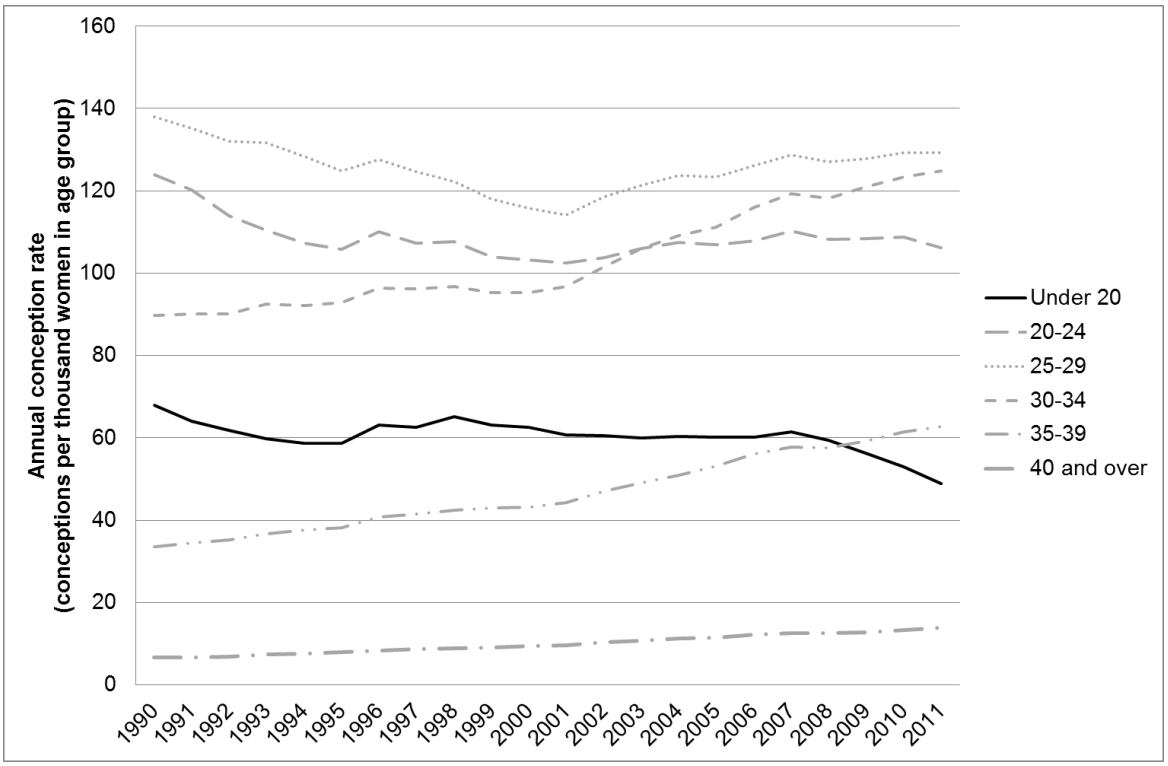

Figure 2 - Evolution of labour market participation rates (BCS70)

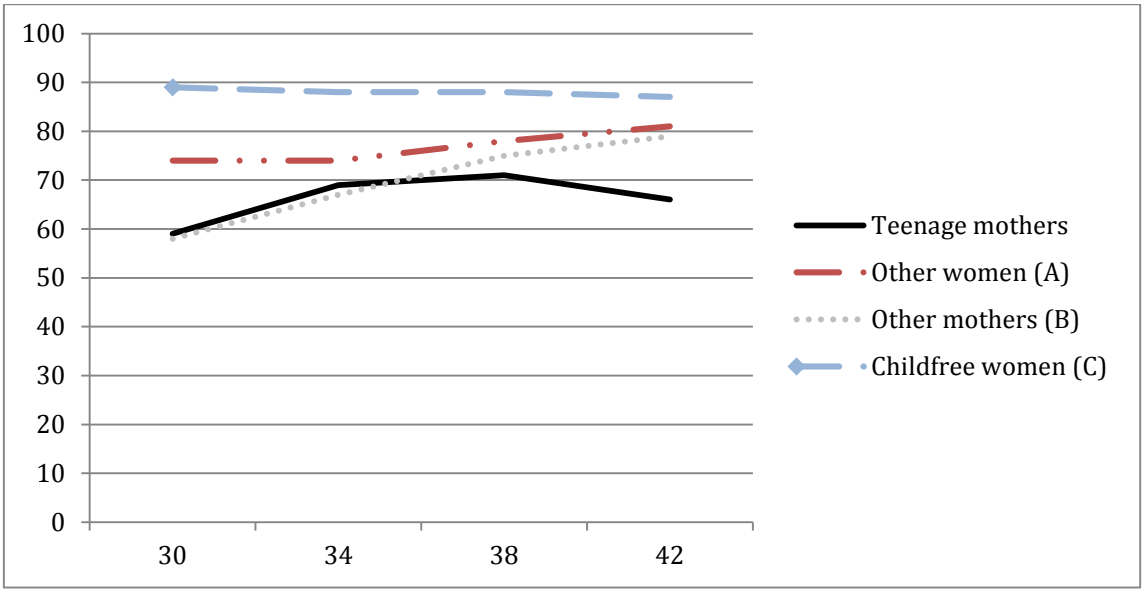

Figure 3 - Evolution of working hours (BCS70)

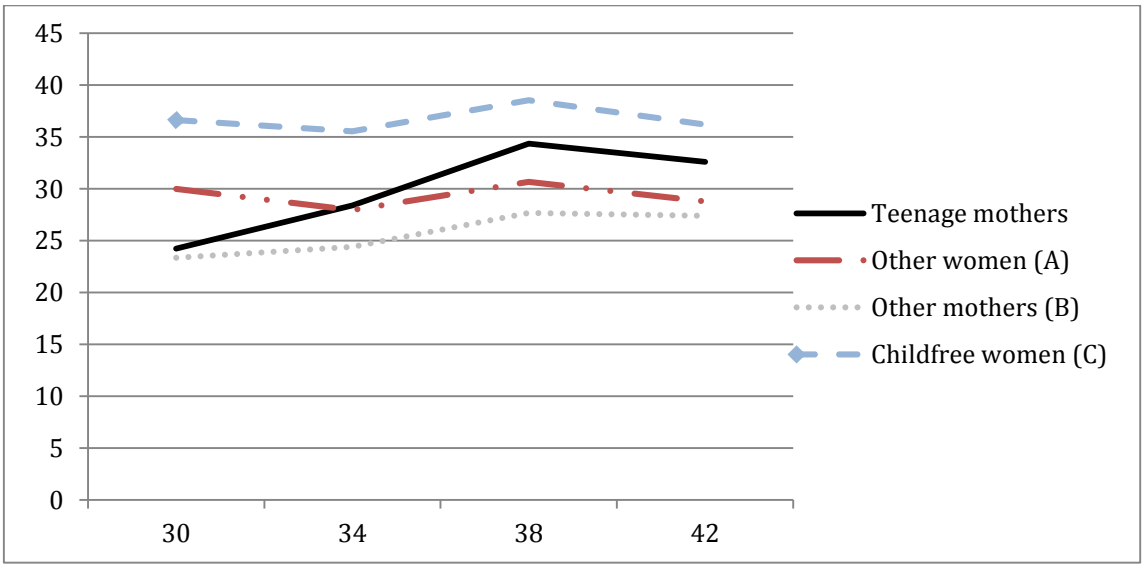

Figure 4 - Evolution of hourly gross pay (BCS70)

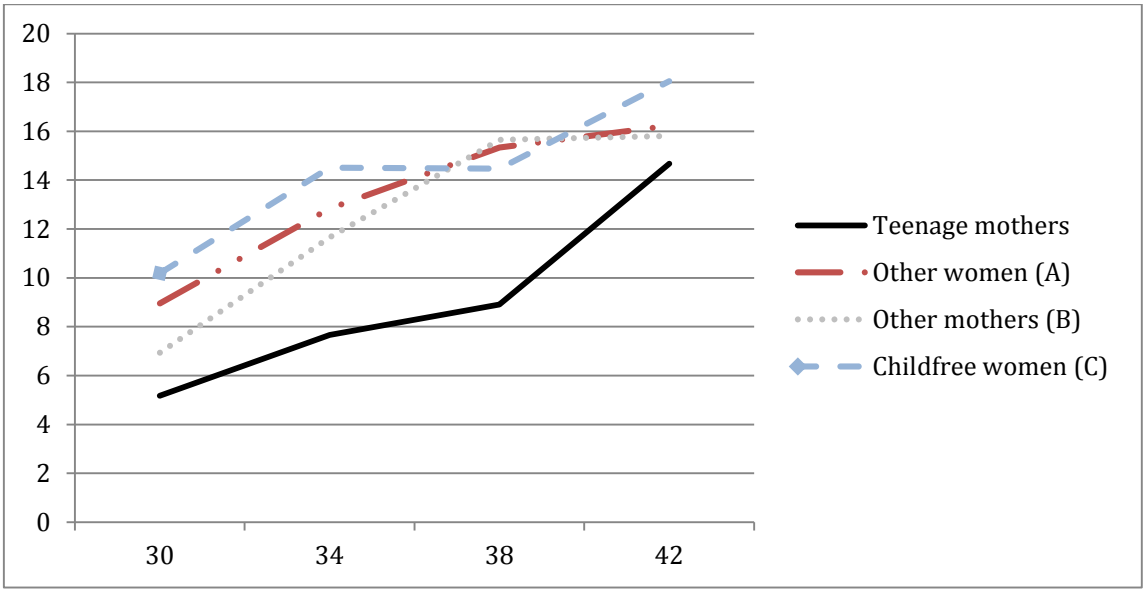

Figure 5 - Distribution of propensity scores on teenage motherhood choices: panel A (all women) age 42

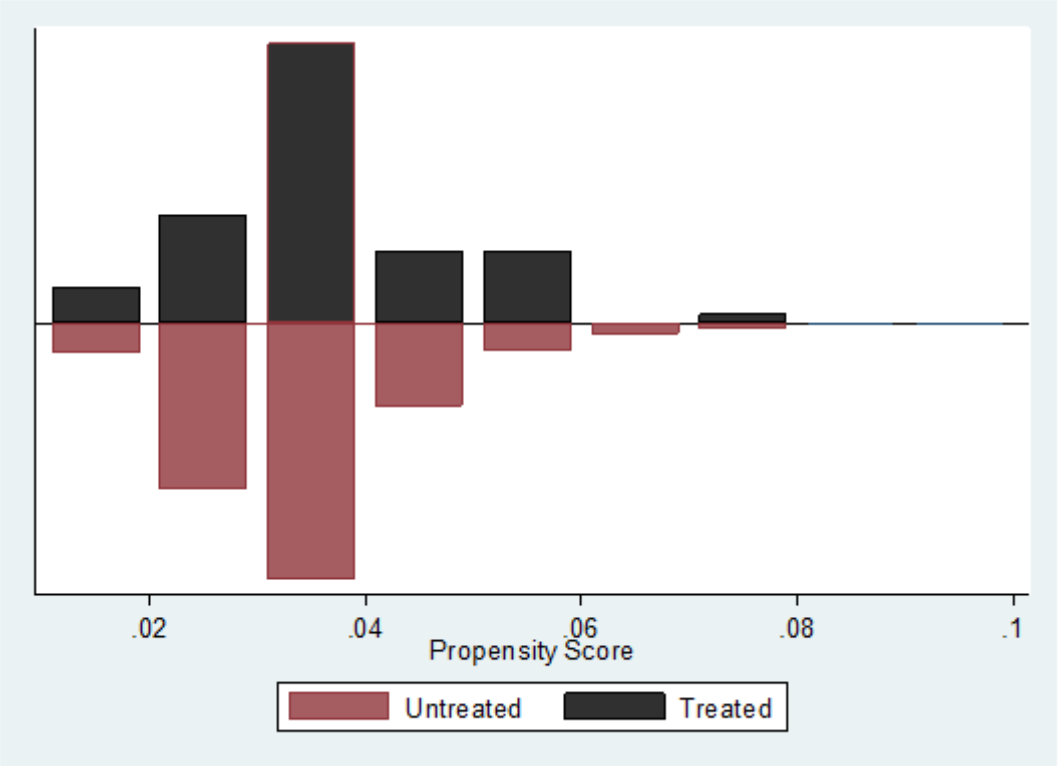

Figure 6 – Percentage of bias for the explaining variables of the propensity score: panel A (all women) age 42

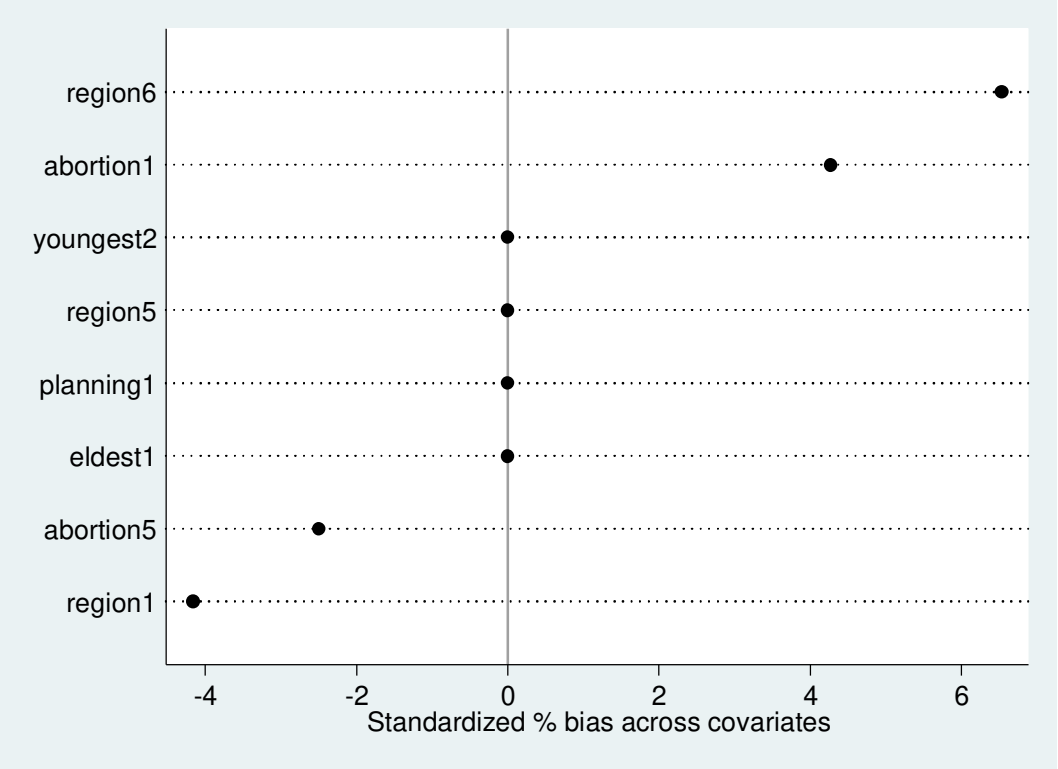

Figure 7 - Evolution of ATT of teenage motherhood on hourly pay

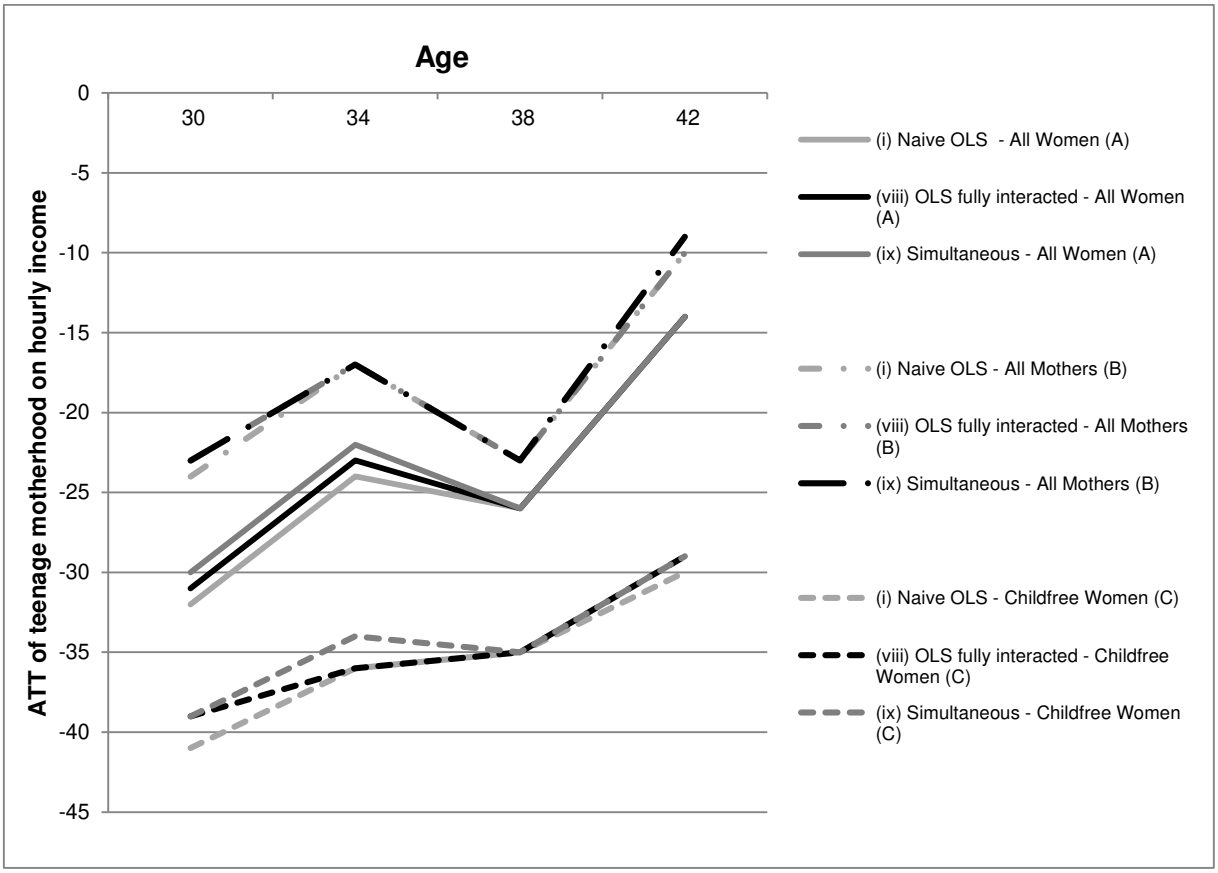

Table 1 – Family and social background, descriptive statistics on sample at age 42

	Teenage mothers	Other women (A)	Other mothers (B)	Childfree Women (C)
Family characteristics at age 10				
Number of siblings (mean)	1.91	1. 57	1. 58	1. 55
Single child (%)	9.20	10.10	9.51	11.34
Respondent is the youngest (%)	47. 85	49.93	48.73	52.47
Respondent is the eldest (%)	34.96	42.27	42.68	41.42
Mother's age at birth (mean)	24.87	25.99	25.78	26.44
Child of a teenage mother (%)	14.52	8. 68	9. 04	7. 92
Mother works (%)	56.41	63.88	65.00	61.48
Mother stays at home (%)	38.46	32.69	31.51	35.21
Mother has superior education (%)	1.45	7.67	7.34	8.42
Father interested in education (%)	16.75	27.89	27.95	27.77
Mother interested in education (%)	30.16	41.37	41.94	40.19
Region of residence at age 10				
North-East (%)	8.09	6.58	6.89	5.93
North-West (%)	25.74	16.14	16.09	16.27
Yorkshire-Humber (%)	7.35	12.90	12.67	13.39
East-Middlands (%)	11.03	8.01	7.85	8.34
West-Middlands (%)	19.12	12.60	12.47	12.86
East-of-England (%)	8.09	11.69	11.72	11.63
London (%)	10.29	10.55	10.17	11.33
South-East (%)	5.15	11.42	11.49	11.27
South-West (%)	5.15	10.11	10.65	8.98
Characteristics and belief at age 10				
Like to read books	74.86	76.07	77.38	73.40
Plays an instrument often	22.90	35.67	37.39	32.15
Do not believe in planning ahead	06.14	32.73	34.15	29.85
Useful to work in school	59.21	64.94	65.65	63.49
Girls of 16 should have access to pill	25.13	25.23	27.29	21.03
Agree girls should be able to abort	09.49	10.13	10.50	09.38
Never smoked	75.97	76.68	77.74	74.53
Have no friends who smoke	67.59	75.22	76.01	73.62

Table 2a Percentage working by age and group

	Teenage mothers	Other women (A)	Other mothers (B)	Childfree women (C)
Sample size	n=144	n=5181	n= 2609	n=2513
Working age 30 (%)	59.02	74.19	58.71	90.29
(SD)	(49.34)	(43. 76)	(49.24)	(29.61)
Sample size	n=109	n=4554	n=3105	n=1449
Working age 34 (%)	69. 72	74. 65	67. 60	89. 78
(SD)	(46.15)	(43.50)	(46.80)	(30.29)
Sample size	n=104	n=4217	n=3262	n=955
Working age 38 (%)	71.15	78. 98	75.84	89.73
(SD)	(45.52)	(40.74)	(42.81)	(30.36)
Sample size	n=116	n=4589	n=3797	n=792
Working age 42 (%)	66. 37	81. 01	79. 61	87. 75
(SD)	(47. 44)	(39. 21)	(40. 29)	(32. 80)

Table 2b Distribution of economic activity of women by age and sample

	Teenage mothers	Other women (A)	Other mothers (B)	Childfree women (C)	Teenage mothers	Other women (A)	Other mothers (B)	Childfree women (C)
			Age 30				Age 34	
Full-time employment	25.69	48.95	19.55	79.52	35.78	40.11	23.18	76.25
Part-time employment	31.94	20.54	34.61	5.96	32.11	28.44	38.55	6.86
Full-time self-employment	1.39	2.95	2.11	3.82	1.83	3.02	2.19	4.80
Part-time self-employment	0	1.7	2.45	0.91	0	2.87	3.57	1.37
Unemployment	6.94	1.95	1.99	1.95	2.75	1.45	1.16	2.06
Full-time education	2.08	1.35	1.34	1.39	0.92	1.07	0.96	1.30
Government training scheme	0	0.12	0.04	0.20	0	0.11	0.16	0
Temporary sickness/disablity	0	0.31	0.38	0.24	0	0.2	0.19	0.21
Permanent sickness/disablity	2.08	1.83	1.69	1.99	2.75	2.3	1.77	3.43
Looking after the home/family	27.08	18.69	34.47	2.35	22.02	18.59	26.69	1.30
Other	2.78	1.62	1.42	1.82	1.83	1.84	1.41	2.32
			Age 38				Age 42	
Full-time employment	46.67	38.51	28.83	71.25	40.52	38.96	32.57	69.56
Part-time employment	20.95	31.41	38.43	7.65	20.69	31.88	36.91	7.8
Full-time self-employment	2.86	4.32	3.55	6.93	2.59	5.02	4.65	6.79
Part-time self-employment	0	4.37	4.83	2.79	2.59	4.93	5.28	3.27
Unemployment	1.9	1.65	1.47	2.28	2.59	1.37	1.1	2.64
Full-time education	0	0.94	0.95	0.93	1.72	0.56	0.6	0.38
Government training scheme	0	0	0	0	0	0.04	0.05	0
Temporary sickness/disablity	0	0.31	0.28	0.41	1.72	0.61	0.55	0.88
Permanent sickness/disablity	3.81	2.08	1.66	3.41	5.17	2.72	2.15	5.41
Looking after the home/family	20.95	15.1	18.92	2.17	20.69	12.82	15.21	1.38
Other	2.85	1.33	1.01	2.27	1.72	1.08	0.93	1.89

Table 2c Number of working hours by age and sample

	Teenage mothers	Other women (A)	Other mothers (B)	Childfree women(C)
Sample size	n=51	n=1912	n=958	n=931
Working hours age 30	24.23	30.00	23.35	36.80
(SD)	(11.57)	(12.68)	(11.83)	(9.57)
Sample size	n=40	n=1916	n=1339	n=577
Working hours age 34	28.42	27.95	24.34	36.32
(SD)	(11.22)	(12.32)	(11.36)	(10.32)
Sample size	n=74	n=3320	n= 2468	n=852
Working hours age 38	34.37	30.66	27.79	38.98
(SD)	(11.39)	(12.98)	(12.45)	(10.69)
Sample size	n=37	n=2032	n=1709	n=323
Working hours age 42	32.61	28.79	27.39	36.19
(SD)	(14.30)	(12.84)	(12.62)	(11.37)

Table 2d Hourly wage by age and sample

	Teenage mothers	Other women (A)	Other mothers (B)	Childfree women (C)
Sample size	n= 76	n= 3292	n= 1261	n= 2013
Working age 30 (%)	5.09	8.96	6.94	10.26
(SD)	(3.37)	(29.56)	(14.60)	(35.94)
Sample size	n=63	n=2763	n= 1683	n=1080
Working age 34 (%)	7.66	12.37	11.65	13.50
(SD)	(5.36)	(41.13)	(41.76)	(40.12)
Sample size	n=50	n=2320	n=1737	n=583
Working age 38 (%)	8.91	15.33	15.66	14.36
(SD)	(3.51)	(94.30)	(108.57)	(16.39)
Sample size	n=70	n= 3119	n=2534	n=585
Working age 42 (%)	14.94	16.23	15.81	18.05
(SD)	(25.93)	(15.28)	(16.07)	(11.06)

Table 3 Descriptive statistics by age and sample

	Teenage mothers	Other women (A)	Other mothers (B)	Childfree women (C)
Variables at age 30				
Long standing illness (%)	25.69	23.22	21.54	24.88
Number of members of HH	3,54	2.89	3.64	2.12
Variables at age 34				
Long standing illness (%)	26.60	28.49	26.19	33.40
Number of members of HH	3.63	3.21	3.79	1.97
Variables at age 38				
Long standing illness (%)	13.46	12.43	11.03	17.22
Number of children in HH	0.93	1.45	1.86	0.05
Variables at age 42				
Long standing illness (%)	39.13	30.85	29.48	37.51
Total number of children	2.57	1.87	2.26	0

Table 4a – Log of hourly wages of teenage mothers compared with other women (control group A): average treatment effect

Method*	**Hourly earnings change for ATT (%)**				
	Age 30	Age 34	Age 38	Age 42	Mean
(i) Naive OLS	-.32***	-.24***	-.26***	-.14**	-.25***
95% CI	(-.48 ; -.17)	(-.39 ; -.10)	(-.40 ; -.11)	(-.27 ; -.00)	(-.39 ; -.12)
(ii) OLS – control	-.25**	-.07	-.15*	.03	-.00
95% CI	(-.50 ; -.00)	(-.28 ; .13)	(-.34 ; .02)	(-.14 ; .21)	(-.18 ; .16)
Selection into employment					
Heckman					
(iii) Simultaneous	-.24**	-.06	-.16*	.04	-.01
95% CI	(-.48 ; -.00)	(-.27 ; .13)	(-.33 ; -.01)	(-.12 ; .22)	(-.20 ; .16)
(iv) Two steps	-.24**	-.07	-.18**	.04	-.01
95% CI	(-.48 ; -.00)	(-.27 ; .12)	(-.36 ; -.00)	(-.13 ; .22)	(-.19 ; .16)
Selection into teenage motherhood					
Propensity score matching[$]					
(v) Common no rep.	-.34	-.18	-.25	-.19	-.28
95% CI	(-.65; -.13)	(-.54 ; -.14)	(-.57; -.23)	(-.48 ; -.11)	(-.51 ; -.26)
(vi) Kernel	-.32	-.22	-.26	-.14	-.23
95% CI	(-.48 ;-.16)	(-.35 ; -.09)	(-.36 ; -.16)	(-.28 ; -.00)	(-.36 ; -.10)
(vii) OLS – FILM	-.31***	-.23***	-.26***	-.14**	-.22***
95% CI	(-.47 ; -.15)	(-.39 ; -.06)	(-.40 ; -.11)	(-.28 ; -.00)	(-.26 ; -.09)
Double selection					
Heckman					
(viii) Simultaneous	-.30***	-.22***	-.26***	-.12*	-.22***
95% CI	(-.46 ; -.14)	(-.38 ; -.05)	(-.41 ; -.12)	(-.26 ; .01)	(-.36 ; -.07)
(ix) Two steps	-.29***	-.20***	-.28***	-.10	-.20***
95% CI	(-.45 ; -.14)	(-.36 ; -.05)	(-.43 ; -.13)	(-.24 ; .02)	(-.34 ; -.05)

[*]Significance levels for the regression models: *** 1%, **5%, *10%. They were not estimated for the matching models. Numbers in parentheses are the 95% confidence intervals based on robust standard errors for specifications bootstrapped 95% bias-corrected percentile confidence intervals (500 repetitions) for the matching models.

[$]Matching specification included a propensity score estimated on a large vector of family background information pre-teenage childbearing; stata psmatch2 command was used.

Table 4b – Log of hourly wages of teenage mothers compared with other mothers (control group B): average treatment effect

Method*	**Hourly earnings change for ATT**				
	Age 30	Age 34	Age 38	Age 42	Mean
(i) Naive OLS	-.24***	-.17**	-.23***	-.10	-.23***
95% CI	(-.39 ; -.09)	(-.32 ; -.02)	(-.38 ; -.07)	(-.24 ; .02)	(-.36 ; -.09)
(ii) OLS – controls	-.24**	-.02	-.12	.07	.02
95% CI	(-.48 ; -.01)	(6.24 ; .19)	(-.31 ; .06)	(-.11 ; .25)	(-.15 ; .19)
Selection into employment					
Heckman					
(iii) Simultaneous	-.25**	-.03	-.13	.07	.00
95% CI	(-.47 ;-.03)	(-.25 ; .17)	(-.32 ; .04)	(-.10 ; .25)	(-.17 ; .18)
(iv) Two steps	-.25**	-.05	-.15	.07	.00
95% CI	(-.47 ;-.03)	(-.27 ; .16)	(-.33 ; .03)	(-.11 ; .25)	(-.17 ; .18)
Selection into teenage motherhood					
Propensity score matching[$]					
(v) Common no repl.	-.34	-.15	-.16	-.14	--.18
95% CI	(-.40 ; .00)	(-.49; -.06)	(-.38 ; -.08)	(-.25 ; .03)	(-.37 ; .00)
(vi) Kernel	-.23	-.16	-.23	-.11	-.21
95% CI	(-.38 ; -.09)	(-.30 ; -.03)	(-.33 ; -.13)	(-.25 ; .02)	(-.34 ; -.08)
(vii) OLS – FILM	-.23***	-.17**	-.23***	-.10	-.21***
95% CI	(-.38 ; -.08)	(-.33 ; -.00)	(-.42; -.06)	(-.25; .03)	(-.35 ; -.06)
Double selection					
Heckman					
(viii) Simultaneous	-.23***	-.17**	-.23***	-.09	-.18**
95% CI	(-.38 ; -.08)	(-.34 ;-.01)	(-.39 ; -.08)	(-.24 ; .04)	(-.33 ; -.02)
(ix) Two steps	-.24***	-.19***	-.25***	-.09	-.17**
95% CI	(-.39 ; -.09)	(-.36 ; -.02)	(-.40 ; -.10)	(-.24 ; .05)	(-.32 ; -.01)

[*]Significance levels for the regression models: *** 1%, **5%, *10%. They were not estimated for the matching models. Numbers in parentheses are the 95% confidence intervals based on robust standard errors for specifications bootstrapped 95% bias-corrected percentile confidence intervals (500 repetitions) for the matching models.

[$]Matching specification included a propensity score estimated on a large vector of family background information pre-teenage childbearing; stata psmatch2 command was used.

Table 4c – Log of hourly wages of teenage mothers compared with childfree women (control group C): average treatment effect

Method*	**Hourly earnings change for ATT**				
	Age 30	Age 34	Age 38	Age 42	Mean
(i) Naive OLS	-.41***	-.36***	-.35***	-.30***	-.35***
95% CI	(-.57 ; -.25)	(-.49 ; -.22)	(-.48 ; -.22)	(-.42 ; -.18)	(-.49 ; -.22)
(ii) OLS - controls	-.30**	-.21**	-.28***	-.16*	-.15
95% CI	(-.59 ; -.00)	(-.41 ; -.02)	(-.46 ; -.09)	(-.34 ; .01)	(-.36 ; .05)
Selection into employment					
Heckman					
(iii) Simultaneous	-.30**	-.20**	-.27***	-.14	-.15
95% CI	(-.58 ; -.02)	(-.38 ; -.01)	(-.44 ; -.09)	(-.31 ; .02)	(-.35 ; .05)
(iv) Two steps	-.30**	-.13	-.26	-.14*	-.11
95% CI	(-.58 ; -.02)	(-.32 ; .05)	(-.61 ; .07)	(-.31 ; .02)	(-.34 ; .11)
Selection into teenage motherhood					
Propensity score matching[$]					
(v) Common no repl.	-.26	-.31	-.30	-.31	-.34
95% CI	(-.64 ; -.22)	(-.46 ; -.08)	(-.36; -.06)	(-.39 ; -.05)	(-.51 ; -.21)
(vi) Kernel	-.39	-.35	-.34	-.31	-.32
95% CI	(-.55 ; -.23)	(-.48 ; -.22)	(-.44 ; -.24)	(-.45 ; -.16)	(-.45 ; -.19)
(vii) OLS – FILM	-.39***	-.35***	-.35***	-.29***	-.33***
95% CI	(-.55 ; -.23)	(-.50 ; -.20)	(-.48 ; -.23)	(-.42 ; -.16)	(-.46 ; -.19)
Double selection					
Heckman					
(viii) Simultaneous	-.39***	-.35***	-.35***	-.29***	-.32***
95% CI	(-.55 ; -.23)	(-.50; -.20)	(-.48 ; -.22)	(-.42 ; -.17)	(-.46 ; -.17)
(ix) Two steps	-.39***	-.35***	-.35***	-.30***	-.29***
95% CI	(-.55 ; -.23)	(-.50; -.20)	(-.53 ; -.17)	(-.42 ; -.17)	(-.44 ; -.13)

[*] Significance levels for the regression models: *** 1%, **5%, *10%. They were not estimated for the matching models. Numbers in parentheses are the 95% confidence intervals based on robust standard errors for specifications bootstrapped 95% bias-corrected percentile confidence intervals (500 repetitions) for the matching models.

[$]Matching specification included a propensity score estimated on a large vector of family background information pre-teenage childbearing; stata psmatch2 command was used.

Appendix 1 - Indicators of bias and unconfoundness of propensity scores by time-point and sample

Age	**Age 30**			**Age 34**			**Age 38**			**Age 42**			**Mean**		
Control group	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
No replacement															
*Common support**															
Untreated (n)	1,439	746	762	2,274	1,395	879	2,320	1,737	583	2,958	2,301	563	3,067	2,236	622
Treated (n)	41	45	45	51	51	51	50	50	50	64	64	64	68	62	68
Bias															
Mean Bias	2.3	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	1.5
Median Bias	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kernel															
*Common support**															
Untreated (n)	1,439	746	762	2,274	1,395	879	2,320	1,737	583	2,958	2,301	563	3,067	2,236	622
Treated (n)	41	45	45	51	51	51	50	50	50	64	64	64	68	62	68
Bias															
Mean Bias	4.6	5.0	5.0	4.9	2.5	1.8	2.3	3.2	5.7	8.0	5.3	2.8	4.0	2.6	4.3
Median Bias	3.3	5.0	2.0	4.6	1.0	2.4	1.0	2.1	0.3	7.5	2.1	2.3	3.8	2.5	2.2

*None of the observations are off support.

Appendix 2 – Variables included in each propensity scores by time-point and sample

Age	**Age 30**			**Age 34**			**Age 38**			**Age 42**			**Mean**		
Control group	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Family characteristics at age 10															
Mother's a teenage at birth (mean)															
Number of siblings (mean)	x				x										
Single child (%)												x			
Respondent is the youngest (%)										x	x	x			
Respondent is the eldest (%)										x					
Mother was a teenage mother (%)						x									
Mother works (%)															
Mother stays at home (%)											x			x	
Mother has superior education (%)				x	x	x									
Father interested in education															x
Mother interested in education															x
Region of residence at age 10															
North-East (%)								x	x	x		x			
North-West (%)												x			
Yorkshire-Humber (%)	x				x		x	x	x				x		x
East-Middlands (%)	x	x	x											x	x
West-Middlands (%)				x	x	x				x	x				
East-of-England (%)				x	x	x				x					
London (%)															
South-East (%)				x											
South-West (%)				x											
Characteristics and belief at age 10															
Like to read books		x	x		x	x	x	x			x	x	x	x	x
Plays an instrument often	x	x	x										x		
Believe in planning ahead				x			x	x	x	x	x	x			x
Useful to work in school			x	x										x	x
Girls of 16 should have access to pill					x										
Agree should be able to abort	x	x	x				x	x	x	x	x		x	x	
Never smoked							x	x							
Have no friends who smoke												x			