Smoking Habits: Like Father, Like Son, Like Mother, Like Daughter

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Abstract

We use instrumental variable methods to investigate whether the impact of parental smoking habits on their children's smoking decisions is a causal one. We find evidence of same-sex role models in two-parent households: mothers play a crucial role in determining their daughters' smoking decisions, while fathers' smoking habits are primarily imitated by their sons.

JEL Code: I1, C5.

Keywords: youth smoking, intergenerational habit transmission, multivariate probit, instrumental variables.

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1 Introduction

Youth smoking behaviour is the object of both extensive public-policy interest and academic research. This interest arises due to two main reasons. First, most smokers start as youths and youth smoking often translates into adult smoking, with the well known consequences on morbidity and mortality.[1] For example, in the US, 42% of current or former adult smokers started before their 16^{th} birthday, and 75% started before their 19^{th} birthday (Gruber and Zinman 2000). The analogous figures for the UK are 37% and 75%, respectively.[2] More importantly, Gruber (2001) and Gruber and Zinman (2000) have shown that this intertemporal correlation in smoking behaviour does not merely stem from intertemporal correlation in unobserved tastes for this activity. Second, as Gruber (2002) has argued, youths are unlikely to meet the conditions of "homo economicus". Although it is generally believed that teenagers in industrialized societies are aware that smoking is hazardous to one's health (Viscusi 1992; Lundborg 2007), there is evidence that a high percentage of adolescent smokers deny the short-term risks of smoking and see no health risks from smoking the "very next cigarette", failing to consider the addictive properties of tobacco (Slovic 2000; World Bank 1999, ch. 3). In this sense, Chaloupka (1991) has shown that younger individuals behave more myopically than their older counterparts. Actually, among high school seniors who smoke, 56% say that they won't be smoking 5 years later, but only 31% of them have in fact quit five years later (Department of Health and Human Services 1994).

Traditionally, public policies have mostly relied on the following tools in order to regulate smoking: excise taxation, limits on smoking in public places, advertising regulations, information campaigns and restrictions on youth access to tobacco products.[3] There is a substantial amount of literature focusing on the price elasticity of youth smoking that has not yielded unanimous conclusions. Some studies have lent empirical support to the notion that youth smoking is price responsive (Lewit, Coate and Grossman 1981; Chaloupka and Grossman 1996; Tauras, O'Malley and Johnston 2001), while others find low or nonexistent

[1] The World Bank (1999, ch.2) and the Department of Health and Human Services (2004), among others, provide reviews of the health consequences of smoking.

[2] These figures are based on authors' calculations using data from the British Household Panel Survey.

[3] See Chaloupka and Warner (2000) and Gruber and Zinman (2000) for more detailed reviews and further references on the effectiveness of such regulations.

price responsiveness among teenagers (Chaloupka 1991; Wasserman et al. 1991; Douglas and Hariharar 1994; DeCicca, Kenkel and Mathios 2002). Gruber and Zinman (2000) use several surveys providing data on smoking for repeated cross-sections of teens and consistently find that older teens are sensitive to the price of cigarettes while younger teens are not.

There is a small amount of literature which has analysed the impact of other anti-smoking policies on youth smoking, but there is not much consistent evidence that their effects are robust. Chaloupka and Grossman (1996) find that youth access restrictions are ineffective but their evidence indicates that clean air regulations have a negative impact on youth smoking. Gruber and Zinman (2000) instead find little consistent evidence that clean air restrictions matter for youth smoking decisions, although according to their results there is some indication that laws which restrict youth access to tobacco products reduce the intensity of youth smoking, but not smoking participation. Chaloupka and Pacula (1998) focus on youth access restrictions enforcement and find that more tightly enforced restrictions lower youth smoking. DeCicca, Kenkel and Mathios (2002) find that neither restrictions on smoking in public places nor youth access restrictions have a significant impact on youth smoking.

To summarize, the literature on both prices and other anti-smoking policies has produced somewhat mixed results. In this context, it is useful to analyse the causal role played by other background characteristics of teenagers in determining their smoking behaviour. In particular, this paper focuses on the intergenerational transmission of smoking behaviour, which is crucial for understanding long-term policy effectiveness. The intergenerational transmission of smoking habits has been the object of extensive physiological and medical research. Not surprisingly, the majority of such research reveals that adolescents are significantly more likely to smoke if their parents smoke (see for instance, Ary et al. 1999; Harakeh et al. 2004; Hill et al. 2005; Jackson and Henriksen 1997; Jackson et al. 1997; Lai, Ho and Lam 2004; Wakefield et al. 2000; Wen et al. 2004). However, studies analysing the link between parental smoking choices and youth smoking behaviour are rare in the economic literature. One exception is Powell and Chalopuka (2004), who jointly examine the relevance of parental influences, prices and tobacco control policies on the smoking behaviour of youths using 1996 US data from a nationally representative survey of high school students. They find that parental influence is a key factor on youth smoking, and that the likelihood of youth smoking is significantly

increased when either parent smokes. However, to the best of our knowledge, no study to date has attempted to establish whether the observed association between parents' and their children's smoking behaviour is a causal one. There are many channels through which the tobacco consumption of parents and children might be linked and this association may, totally or partially, reflect causal mechanisms. For instance, it could arise from the intentional or unintentional transmission of parental consumption preferences to children or be the result of imitation, parents being role models for their children, easier access to tobacco in households with smoking parents or the diminished credibility of warnings about the dangers of tobacco consumption that come from parents who smoke.

However, it could also be the case that the link between children's and their parents' smoking habits does not reflect causal pathways, but instead, is due to the presence of unobserved factors common to all family members, such as shared attitudes towards risk, rates of time preference and, ultimately, genetic traits. Along these lines, Dohmen et al. (2006) document the existence of a strong intergenerational correlation in willingness to take health risks (among other types of risks), Becker and Mulligan (1997) show that parents devote resources to shaping their children's discount rates and Knowles and Postlewaite (2005) find evidence of transmission of savings behaviour through the family.

In this paper, we use instrumental variable techniques to overcome the potential endogeneity of parental smoking behaviour. For this purpose, we rely on individual data from the British Household Panel Survey (BHPS hereafter). The household nature of this survey allows us to link parents to their cohabiting children; additionally, adult individuals (the teenagers' parents) are asked questions about their own parents (the teenagers' grandparents), which further allows us to gather information on children's grandparents that it is used to construct instrumental variables. More specifically, we use information on grandparents' past socioeconomic status to sort out the parental smoking effects from other effects of unmeasured factors which simultaneously determine the smoking behaviour for both parents and their children. Our identification strategy relies on the assumption that, once teenagers' and their parents' characteristics have been controlled for, unmeasured intergenerational influences do not survive past two generations.

There is an additional question that this paper attempts to answer, and that has not

been addressed so far within the youth smoking literature: are mothers and fathers equally important role models for their daughters and sons as far as smoking choices are concerned? From a policy perspective it is of interest to document whether male and female teens' smoking determinants differ, since this may help to explain heterogeneous effects of anti-smoking programmes and improve the design of targeted policies.

Several papers in various fields have shown that patterns of smoking behaviour do significantly differ by gender. For example, Bauer, Hölmann and Sinning (2007) provide evidence that there are differences in smoking behaviour between adult males and females, and, in line with this result, Chaloupka and Pacula (1999) find that clean indoor laws are correlated with a decreased smoking participation only for male teenagers and that male teens are significantly more responsive to changes in the price of cigarettes than female teens. Moreover, previous research focusing on outcomes other than smoking suggests that relevant same-sex parent-child links exist. Thomas (1994) finds that the educational attainment of the parent of the same sex as the child has a greater impact on his/her health achievement (as measured by height for age). Ortega and Tanaka (2007) show that paternal (maternal) education is more important for the educational attainment of sons (daughters), interpreting these results as evidence that fathers are more important role models for sons while mothers are more important references for daughters. Lundberg, Pabilonia and Ward-Batts (2007) analyse time-use data and find that married fathers spend significantly more time with sons than with daughters, and that both married and single mothers spend more time with teen daughters than teen sons. There is also evidence of the presence of same-sex role models outside the family: for instance, Bettinger and Long (2005) find that the presence of faculty members of the same gender impacts student interest in a subject, which supports a possible role-model effect.

In light of this evidence, we believe it is of interest to investigate whether there are relevant same-sex role model effects in the context of the intergenerational transmission of smoking behaviour. Our results suggest that this is actually the case for teenagers living in two-parent households. After controlling for the potential endogeneity of parental smoking participation, we find that the intergenerational transmission mechanism is not significant across genders. Instead, the smoking behaviour of the parent of the same sex as the teenager has a significantly significant impact on his/her smoking participation. This same-sex parent-child link, not

surprisingly, is no longer at play for teenagers living in single-parent households, for whom the influence of their only cohabiting parent turns out to be predominant independently of gender.

The remainder of the paper is organized as follows. Section 2 describes the data and presents summary statistics of the relevant variables used in the statistical analyses. Section 3 describes the empirical model and the identification strategy used to estimate the effects of interest, and section 4 discusses the estimation results. Section 5 offers some concluding comments.

2 Data

The data used in this paper are taken from the waves 4-12 of the British Household Panel Survey, covering the period 1994-2002. The BHPS, which was first carried out in 1991, is an annual survey of each adult (16+) member of a nationally representative sample of more than 5,000 households across Great Britain, making a total of approximately 10,000 individual interviews. The same individuals are re-interviewed in successive waves and, if they split-off from their original households, all adult members of their new households are also interviewed. Major topics in the BHPS are household organization, labor market participation, income and wealth, housing conditions, health and socioeconomic values.[4]

Until 1993, children were only interviewed once they reached the age of 16; however, a special survey of household members 11-15 years old, the British Youth Panel (BYP), was introduced in 1994 (wave 4). As stated earlier, our main interest in this paper is to evaluate the impact of parental smoking behaviour on children's smoking habits. Therefore, we restrict our analysis to the period 1994-2002, when information on 11-15 years old household members was also collected. When these young children turned 16 years old, they were still trackable as part of the adult survey in the BHPS itself.

The core of our analyses focuses on those households in which both parents are present, so that we can account for the differential role of each parent in youth smoking. In total, our two-parent sample consists of 9,835 individual-year observations, 4,968 of which correspond

[4]For further details of this survey see http://www.iser.essex.ac.uk/bhps.

to male teens and 4,867 to female teens, spanning the period from 1994 to 2002.[5] Our panel is unbalanced, with adolescents contributing between once and a maximum of nine times. As an interesting extension, we also look at single-mother households, although in this part of the analysis it is not possible to separately assess the influence of each parent on youth smoking decisions. We do not consider single-father households as well due to small sample size: most single-parent households (around 90%) are actually single-mother households. Our sample of teenagers living with their single mothers consists of 3,928 individual-year observations, of which 1,972 correspond to male teenagers and 1,956 to female teenagers.

Information on smoking participation is available from both the adult (16+) and children (11-15) questionnaires, that is, the BHPS and the BYP. In the BYP, children aged 11-15 years are asked the question "*How many cigarettes did you smoke in the last seven days?*", which we use to construct our smoking indicator: if the child reports to have smoked at least one cigarette in the last week, he/she is classified as a smoker. For children older than 15 years, we use the answer to the direct question on whether or not they categorize themselves as a smoker that is included in the BHPS.[6]

In order to prevent underreporting and to reduce measurement error, questions for BHPS children are tape-recorded and delivered through use of a personal stereo system in order to ensure confidentiality even when family members might be present.[7] To further assess the reliability of our smoking information for children, we have contrasted the prevalence of youth smoking in the BHPS with that from other comparable published data, obtaining very similar results.[8]

[5] We select this age interval because most smokers start smoking when they are between 11-19 years old.

[6] We are aware that our smoking indicator has been constructed from two different questions, the BYP question for children aged 11 to 15 and the BHPS question for children aged 16 or older. However, our results are very similar when using slightly different definitions of the smoking indicator.

[7] This is further assisted by printing only response categories, that is without the questions themselves, on the questionnaire form. Any household member scanning the child's responses would therefore not be able to link these with the original questions.

[8] In particular, we have relied on statistics reported by the NHS Information Centre (2008), which are based on a survey of 11-15 students carried out by the National Centre for Social Research and the National Foundation for Educational Research. Not only information was gathered in classrooms rather than at home and confidentiality was repeatedly reassured, but for several years the survey also collected saliva samples from half of the students. The samples were tested for the presence of cotinine, a major metabolite of nicotine that indicates recent exposure to tobacco smoke, and results from these tests indicated that children were largely honest about their smoking; validating the estimates of the prevalence of smoking derived from the survey. We have computed smoking statistics by age and gender for a comparable sample of 11-15 year old children from the BHPS in order to contrast them with those reported by the NHS Information Centre (2008). These two

The household nature of the BHPS allows us to link teenagers' smoking behaviour to their household socioeconomic characteristics and their parental smoking habits. Additionally, all adult (16+) household members are also asked about their parents' socioeconomic status when they were 14. This is a relevant piece of information that we employ to construct a set of reliable instrumental variables, as we discuss in further depth in the following section.

Youth smoking rates by parental smoking habits for the two-parent sample are presented in Table 1. As expected, smoking rates generally rise with age, with the biggest increase taking place between the 11-13 and the 14-15 age segments. The highest smoking rates for all age groups are observed when both parents smoke (22.6%) while the lowest incidence of teenage smoking arises when neither the father nor the mother smokes (11.4%). Parental smoking habits seem to be a strong predictor of youth smoking behaviour for both boys and girls. Furthermore, the differences in smoking rates between children of smoking and non-smoking parents is particularly remarkable for those in the age brackets above 13 years. For example, 36.7% (28.5%) of girls (boys) aged 14-15 smoke when both parents smoke, while only 16.8% (13.5%) are smokers when living in a smoke-free family. Youth smoking rates when only one parent smokes are somewhat smaller than those observed when both parents smoke but clearly higher than the smoking rates of youth living with two non-smoking parents.

Table 2 displays youth smoking rates by maternal smoking status for the sample of single-mother households. The comparison between Table 1 and Table 2 suggests that the smoking rates of teens living in single-mother households are clearly higher than those of their counterparts living in two-parent households, independently of the smoking behaviour of their parents. As for the role of parental smoking decisions, these are also strong predictors of youth smoking behaviour when living with a single mother: 33.5% (31.1%) of boys (girls) living with a smoking single mother are smokers, against only 15.3% (13.9%) of their counterparts living with a non-smoking single mother.

The BHPS also provides a wide range of socioeconomic information on children's and their parents' characteristics. For example, it contains questions regarding whether the teenager works for pay or not and it includes information on both parents' age, education and occupation, as well as on real household income, household size, and area of residence.[9]

sets of statistics were remarkably similar.

[9]The education variable denotes the highest degree obtained and is grouped into three categories: more than

Table 3 displays summary statistics for most of these characteristics by parental smoking behaviour in the two-parent sample. In families with non-smoking parents, fathers and mothers have a higher level of education than their counterparts in families where either one or both parents smoke. For instance, 49% (35%) of fathers (mothers) in non-smoking households have more than a high school degree, compared to approximately 27% (17%) in households where either one or both parents smoke. Not surprisingly given the difference in education, the occupational category and real household income[10] of parents in smoke-free households are higher than those of smoking parents. This is consistent with the existence of relevant socioeconomic inequalities in smoking which have been documented by extensive research into the factors influencing adult smoking behaviour. This unequal distribution of tobacco consumption has been observed in all countries where the smoking epidemic is mature, especially in Northern European countries like the UK (see for instance, Cavelaars et al., 2000 and Kunst, Giskes and Mackenbach, 2004).

Descriptive statistics for the sample of single mothers are displayed in Table 4 and reproduce the main features of the two-parent sample, confirming the existence of a socioeconomic gradient in smoking in single-mother households as well: smoking single mothers are younger, less educated and have a lower occupational status than non-smoking single mothers.

3 Empirical Model

In order to empirically assess whether parental smoking affects youth smoking behaviour, the following three-equation model is estimated using the sample of two-parent households:

$$YS_i = \begin{cases} 1 & \text{if } \alpha * MS_i + \beta * FS_i + \gamma * X_i + \varepsilon_{i1} > 0 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

high school (higher degree 1st degree, Teaching and other higher qualification), high school degree (Nursing, A levels, O levels or equivalents) and less than high school (CSE, Apprenticeship and None). Parents' occupational categories have been divided into four groups: high (managers, administrators and professionals), medium (associate professional and technical, clerical and secretarial, craft and related occupations), low (personal and protective service occupations, sales, plant and machine operators and other occupations) and not working. There are six geographical areas: London, Wales, Scotland, rest of South East, rest of England and Northern Ireland.

[10]Household income is expressed in 1996 pounds.

$$MS_i = \begin{cases} 1 & \text{if } \delta_1 * ZM_i + \gamma_1 * X_i + \varepsilon_{i2} > 0 \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

$$FS_i = \begin{cases} 1 & \text{if } \delta_2 * ZF_i + \gamma_2 * X_i + \varepsilon_{i3} > 0 \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

where YS_i, MS_i and FS_i are smoking indicators for teenager i, her mother and her father, respectively.[11]

Single equation estimation of (1) would yield inconsistent estimates of α and β because it would disregard the correlations between the errors of the models determining youth and parental smoking choices (i.e. the correlation between ε_{i1}, ε_{i2}, and ε_{i3}). In particular, if teens' unobserved propensity to smoke was correlated with their parents' smoking behaviour, then the single-equation estimates would not reflect the causal impact of paternal and maternal smoking choices. This is likely to be the case if unobserved factors potentially shared by teens and their parents such as attitudes towards risk, rates of time preference, degree of health consciousness and, ultimately, genetic traits, are relevant determinants of smoking behaviour. In order to deal with this issue, we estimate equations 1-3 jointly, treating fathers' and mothers' smoking choices (FS and MS) as potentially endogenous variables.

Identification of the causal effects of maternal and paternal smoking requires valid instruments, i.e. variables that affect parental smoking behaviour but have no direct residual impact on teenagers' smoking decisions.[12] One would be tempted to rely on grandparents' smoking

[11] Admittedly, the static nature of our model prevents us from drawing conclusions regarding smoking dynamics. Some examples of studies that focus on the dynamics of smoking behaviour by modeling current smoking as a function of past smoking are Gilleskie and Strumpf (2005) and Christelis and Sanz-de-Galdeano (2009). Given the econometric complications associated with having a lagged dependent variable, there is an obvious trade-off: these papers do deal with them, but no other independent variable is considered as potentially endogenous. Since our main goal is to analyse the impact of parental smoking behaviour (which is potentially endogenous), we have decided not to include a lagged dependent variable.

[12] Alternative empirical strategies relying on the panel dimension of the BHPS have been discarded because there is not enough time variation in parental smoking status during the time-span (1994-2002) of our estimation samples to identify the effects of interest. For example, in our estimation sample for two parent households, mothers (fathers) start smoking between t and t+1 in just 1.5% (1.7%) of the cases. The corresponding statistics for quits are 1.4% for mothers and 2.5% for fathers. This is probably due to the high persistence in smoking behaviour among our sample of middle age parents, who are probably too old to start smoking (part of the identified inflows are likely to be relapses) but still too young to quit.

The actual number of cigarettes smoked by parents may exhibit more variation over time than smoking status. However, in practice, variation in the self-reported number of cigarettes smoked over time is measured with considerable error because of heaping.

behaviour. However, this information is not available in our data and, more importantly, grandparents' smoking status may have a residual impact on youth smoking behaviour, even after controlling for parental smoking, if individuals' propensity to smoke were, to some extent, genetically transmitted, and this genetic influence went beyond one generation. Instead, based on data availability and on the strong correlation between social class, occupation and smoking behaviour previously uncovered (tobacco smoking is currently more common among adults from more disadvantaged backgrounds), the set of instruments used are social class and occupational indicators for the teenagers' grandparents.[13] These are denoted by ZM and ZF in the maternal and paternal smoking equations, respectively,[14] and the existing literature on the socioeconomic inequalities in smoking habits as well as the socioeconomic differences between adult smokers and non-smokers highlighted in Section 2 suggest that assuming that $\delta_1 \neq 0$ and $\delta_2 \neq 0$ is plausible. Moreover, we will provide statistical evidence on our instruments' relevance in Section 4.

It is worth noting that similar instrumental variables have been successfully employed by Maurin (2002), who analyses the impact of parental income on the probability of being held back in elementary school in France. Maurin (2002) uses information on grandparents' socioeconomic status and parents' education level to sort out the income effects from the effects of unmeasured factors that are correlated with income. Along these lines, our identification

[13] The past two decades have seen the increasing association of smoking with markers of social disadvantages. The European Commission has recently acknowledged this problem in the "Reflection process on the future EU health policy" launched by European Commissioner for Health and Consumer Protection David Byrne, and on the "Community Action on the Field of Public Healh (2003-2008)". For a recent review of the socioeconomic inequalities in smoking habits in the European Union, see Kunst, Giskes and Mackenbach (2004).

[14] The occupational indicators for the teenagers' grandparents have been divided into seven groups: professional occupation, managerial and technical occupation, skilled non manual occupation, skilled manual occupation, partly skilled occupation, armed forces (only for grandfathers) and not working. Moreover, we include the Hope-Goldthorpe scale variable and dummies for grandparents not being alive. Note that the Hope-Goldthorpe scale has 36 categories ranked in order of "social desirability" of male occupations. The categories are assumed to provide a high degree of differentiation in terms of both occupational function and employment status. It is important to highlight that this class schema was devised for men, but the scores are commonly used for both men and women.

In sum, for each grandmother, we have a total of 8 socioeconomic status variables that serve as exclusion restrictions: 6 occupational dummy variables, the Hope-Goldthorpe scale variable and an indicator for the grandmother being dead when the parent was 14 years old. For each grandfather we have one more exlusion restriction because there is an additional category in the set of occupational dummies (armed forces), which yields a total of 9 exclusion restrictions. Hence, there are 17 variables in ZF (those referred to the grandparents' socieconomic status on the father's side) and another 17 variables in ZM (those referred to the grandparents' socieconomic status on the mother's side).

strategy relies on the assumption that, after controlling for the relevant explanatory variables, the impact of parental socioeconomic status on smoking behaviour does not go beyond one generation. Formally, we assume that ZM and ZF are exogenous in equation 1 or that $Cov(ZM_i, \varepsilon_{i1}) = 0$ and $Cov(ZF_i, \varepsilon_{i1}) = 0$. This may be a too strong assumption in countries where families ties are very strong and children often grow up together with their parents and grandparents (as in Southern European countries). However, it is likely to fit Northern European countries, like the UK, reasonably well, since family ties in those countries are clearly not so strong as in the Mediterranean.[15] Moreover, there are three additional reasons supporting the validity of our instrumental variables. First, information collected on grandparents' socioeconomic status refers to when the teenagers' parents were 14 years old, not to the present. Second, we have replicated all the analyses that follow excluding from the sample the teenagers who were actually cohabiting with their grandparents, obtaining very similar results. This is not surprising because the number of teenage-year observations excluded in this case is small: 0.90% and 0.85% in two-parent and single-mother families, respectively. Third, we do control for a set of parental characteristics which is wide enough to believe that the impact of socioeconomic status on smoking behaviour does not go beyond one generation. The explanatory variables contained in the X vector, which are similar to those included in other studies of the determinants of youth smoking behaviour, such as Blow, Leicester and Windmeijer (2005), do not only refer to teenagers' individual characteristics but they also include a rich set of parental characteristics like age, education and occupational indicators for each parent.[16] Hence, overall we believe that our identifying assumptions are reasonable.

One possible concern with our model could be that the smoking behaviour of the teenagers, which we do not observe, might be correlated with their socioeconomic status. This, however, is unlikely to be the case if the socioeconomic gradient in smoking was not relevant at the first stages of the smoking epidemic and appeared with the diffusion of information about smoking risks.[17] This is actually what the existing literature suggests.[18] Additionally, we

[15] Reher (1998) distinguishes between Western countries where family ties are weak (Scandinavia, the British Isles, the Low Countries, Germany, Austria, and the United States) from those where they are strong, namely the Mediterranean. Bentolila and Ichino (2008) adopt a similar classification.

[16] As there is no spatial variation in prices because there are no regional-level cigarette taxes in the UK, we control for price changes using time dummies.

[17] We are very grateful to an anonymous referee for pointing this out to us.

[18] According to Huisman, Kunst and Machenbach (2005), who use homogeneous data for several European

have confirmed that while the socioeconomic gradient in smoking is sizeable and significant for the parents of teenagers in our dataset, it is actually not there for individuals belonging to their grandparents' generation.[19]

In order to account for the dichotomous nature of YS, MS and FS we use a trivariate probit model. It is assumed that ε_{i1}, ε_{i2} and ε_{i3} are error terms distributed as multivariate normal, each with a mean of zero and a variance-covariance matrix V, which has unit diagonal elements and off-diagonal elements equal to $\rho_{jk} = \rho_{kj}$. The evaluation of the likelihood function requires the computation of trivariate normal integrals, which are approximated via the Geweke-Hajivassiliou-Keane smooth recursive simulator, denoted as GHK in what follows. The GHK simulator belongs to the class of importance sampling simulators where one draws from some distribution other than the considered joint distribution, and then re-weights to obtain an unbiased simulator. In this way the importance sampling can reduce the simulation error by oversampling parts of the error distribution that are most informative. In the case of a multinomial probit model, the main characteristic of the GHK simulator here employed is that it splits the joint normal probability density function into a series of conveniently simulated conditional probabilities from a truncated normal distribution, where the joint probability can be written as the product of each of the conditional simulated probabilities coming from the truncated normal. Hajivassiliou, McFadden and Ruud (1996) found the GHK simulator to generally outperform 12 other simulators.[20] Estimation results are presented in the following section.

countries, the smoking epidemic is divided into four stages. In the very first stage, smoking prevalence is low, but then it rises rapidly as smoking becomes more fashionable. In the third stage the prevalence of smoking has peaked and starts declining and in the fourth stage it continues to decline, slowly approaching a stable minimum level. This decline starts earlier among the higher educated than among the lower educated, who are the "first to adopt innovations", which means that when the smoking epidemic reaches more advanced stages, as it has in Northern European countries, the socioeconomic gradient in smoking becomes larger. This suggests that the socioeconomic gradient shall be larger among younger individuals (who started smoking at later stages of the smoking epidemic) than among older individuals (who are more likely to have started smoking when it was still fashionable and on the rise).

[19] These results, not reported for the sake of brevity, are available upon request from the authors.

[20] In order to perform our empirical estimation we employ the mvprobit program in STATA written by Cappellari and Jenkins (2003).

4 Estimation and Results

4.1 Two-Parent Households

As a benchmark for later comparisons, we use a probit model to estimate equation 1 separately by gender, neglecting for the time being the potential endogeneity of parental smoking choices. Probit coefficient estimates and their corresponding standard errors as well as pseudo R-squared statistics[21] are reported in Table 5. Apart from the smoking indicators for the father and the mother, we also control for the set of socioeconomic characteristics displayed in Table 3 and commented in the previous section.

The results for boys indicate that having both a smoking mother and a smoking father increases the probability of smoking. These effects are statistically significant at the 1% level. For girls, coefficient estimates on the smoking father and the smoking mother indicator variables are also positive and statistically significant. These results are broadly in line with those of Powell and Chaloupka (2004), who use single-equation models to explore the determinants of youth smoking behaviour in the US, without separately analyzing the influence of mothers and fathers, and find that both female and male teenagers who live in households where either one or both parents smoke are significantly more likely to be smokers.

A useful framework to assess the magnitude of these effects is provided by the matrix of smoking rates by parental smoking participation reported in Table 6, which displays $\hat{p}$, the probability of youth smoking in each cell, the marginal effects of each parent's smoking behaviour given the smoking participation of the other parent, and their corresponding standard errors, which have been obtained by simulated asymptotic sampling techniques.[22] Empirically, each value of $\hat{p}$ has been computed as the probability of youth smoking when the dummy variables MS and FS are turned "on" and "off", depending on the smoking status of each parent we consider, and conditional on given values of all other covariates. Marginal effects have been calculated as the difference in the probabilities of interest.

The results for boys displayed in Panel A of Table 6 indicate, not surprisingly, that the

[21] The pseudo R-squared is analogous to the R-squared for OLS regression. Several pseudo R-squared measures, reviewed in Wooldridge (2002, Chapter 15), have been proposed for binary response. We have relied on the measure suggested by McFadden (1974), $1 - \frac{L_{ur}}{L_0}$, where L_{ur} is the log-likelihood function for the estimated model and L_0 is the log-likelihood function in the model with only an intercept.

[22] Alternatively, one can use the Delta method. Nearly identical results were obtained from the two approaches.

highest smoking probability corresponds to the case when both parents smoke (24.3%) while the lowest one corresponds to households where neither the father nor the mother smokes (11.8%). The difference between these two extreme cases amounts to 12.4 percentage points and it is statistically significant at the 1% level. The evidence also suggests that conditioning on the smoking status of each parent, the smoking decision of the other parent increases the likelihood of boys' smoking participation. For instance, given that the mother smokes, having a smoking father increases the probability of youth smoking for boys by 7.1 percentage points with respect to having a non-smoking father. If instead we condition on having a smoking father, the impact of maternal smoking on the probability of boys' smoking participation is a 6.5 percentage points increase. These effects are also statistically significant at the 1% level.

The results for girls, reported in Panel B of Table 6, convey a very similar message for the extreme cases where either both or neither of the parents are smokers. The predicted probability of smoking for girls with two smoking parents is 23.3% while the smoking rate for their counterparts living in families where neither parent smokes is 11.9%.

An interesting finding is that for girls' smoking behaviour, conditioning on fathers' smoking behaviour, the effects of having a smoking mother (8.0 and 7.0 percentage points when the father smokes and when he does not smoke, respectively) are bigger than the estimated effects of fathers' smoking choices given the maternal smoking status (4.5 and 3.4 percentage points when the mother smokes and when she does not smoke, respectively). The evidence for boys, instead, indicates that paternal smoking participation has only a slightly stronger impact on male teenagers' smoking status than maternal smoking participation. In sum, according to these single equation estimates, there seems to be a stronger intergenerational link between parents and children of the same sex, although the same-sex link is more evident for girls. However, as discussed in Section 3, these results may not reflect the causal impact of parental smoking choices in the presence of unobserved heterogeneity associated with both parents' and their children's smoking decisions.

In order to account for the potential endogeneity of parental smoking decisions we now jointly estimate equations 1-3 using a trivariate probit model and include information on grandparents' socioeconomic status and occupation as exclusion restrictions. Coefficient estimates of the dummy variables MS and FS and their associated standard errors are presented

in Table 7, while Tables 13 and 14 in the Appendix display the full set of results for all covariates for male and female teenagers, respectively. The results from the joint likelihood ratio test on the correlation coefficients of the error terms of equations 1-3, reported in Table 7, show statistical evidence that parental and youth smoking behaviours are indeed correlated for both female and male teenagers.

According to Table 7 and in contrast with the probit results, the indicator denoting that the father is a smoker is no longer statistically significant for girls, and the same happens with the maternal smoking indicator for boys. That is, mothers' and fathers' smoking habits play a statistically significant role for girls and boys, respectively, while maternal (paternal) smoking status does not significantly affect boys' (girls') smoking behaviour. In sum, in the context of smoking behaviour, girls seem to imitate their mothers, while boys seem to imitate their fathers. To the extent of our knowledge, this sort of phenomenon has not previously been documented in the youth smoking literature, although there is evidence of mother-daughter and father-son links between parental education and children's labor status (Emerson and Portela-Souza, 2002), educational attainment (Ortega and Tanaka, 2007) and health as measured by height for age (Thomas, 1994).

Pseudo R-squared statistics, measures of instrument relevance and tests of overidentifying variables are reported at the bottom of Table 7. Regarding instrument relevance, we test the hypotheses that the grandparents' socioeconomic indicators on the mother's side (ZM) do not enter the MS equation, that the grandparents' socioeconomic indicators on the father's side (ZF) do not enter the FS equation and, additionally, we perform a joint test of exclusion of our instruments from *both* the father and the mother smoking equations.[23]The results of all these tests strongly reject the null hypotheses that the coefficients associated with the grandparents' socioeconomic status indicators are jointly equal to zero at standard levels of testing.

[23]Stock and Yogo (2002) develop quantitative definitions of weak instruments for the general case of n endogenous regressors in linear IV regression. However, we cannot rely on their proposal because our setup differs from a 2SLS model in important aspects. Not only our model is nonlinear, but, instead of having the same set of exclusion restrictions in each auxiliary equation, we have a simultaneous equation model in which the set of exclusion restrictions is different in the father smoking equation and in the mother smoking equation. To the best of our knowledge, a test equivalent to that proposed by Stock and Yogo (2001) for this type of set up does not exist. As an alternative, we try to deduce the relevance of our instruments in *both* the father and the mother smoking equations by performing a joint test of their exclusion.

Given that we have more exclusion restrictions than endogenous regressors, we can perform several tests of our overidentifying variables as well. After the multivariate probit estimation, we test our full model against alternative models in which different sets of instruments have been excluded.[24] These tests are also displayed at the bottom of Table 7 and detailed lists of the overidentifying variables considered in each of them are included in the note below the table. The results from these tests are always supportive of our overidentifying variables.

Table 8 replicates Table 6 and illustrates the magnitude of the effects of interest when using the trivariate probit model. Our results confirm the non-significant role of the mother-son and father-daughter links already suggested by the coefficient estimates displayed in Table 7. Conditioning on paternal smoking behaviour, the impact of maternal smoking participation is not statistically significant at standard levels for boys. As for girls, the role of paternal smoking decisions is not significant when conditioning on maternal smoking choices. Instead, the mother-daughter and father-son effects are always statistically significant at the 5% level, independently of the other parent's smoking status. Regarding the magnitude of these same-sex significant effects, conditioning on having a (non-) smoking father, having a smoking mother increases the probability of girls' smoking by (7.6) 8.0 percentage points. For boys, if we condition on having a (non-) smoking mother, the smoking habit of fathers increases their probability of being smokers by (5.7) 6.4 percentage points. In sum, after correcting for the potential endogeneity of parental smoking decisions, we find evidence of significant same-sex parent-child links: mothers play a significant role for their daughters, while fathers appear to be imitated by their sons.

We now briefly turn to the impact of the rest of the variables considered in the analysis. In Tables 13 and 14 (reported in the Appendix) we display all trivariate probit coefficient estimates from equations 1-3 for male and female teenagers, respectively. In addition to parental smoking status, other factors affecting the probability of youth smoking in a positive and statistically significant way are, for instance, teenagers' age and if they are working for pay. Young males are significantly less likely to smoke if their mothers have at least a high school diploma and the higher occupational status their fathers have; these variables have the same sign but do not achieve standard levels of statistical significance in the youth

[24] We thank Stephen Jenkins for suggesting this procedure to us.

smoking equation for female teenagers.[25] As for the maternal and paternal smoking equations (equations 2 and 3), our instrumental variables also display the expected sign: mothers and fathers of our sample of teenagers are significantly less likely to be smokers if their own parents (the teenagers' grandparents) had a high occupational status when they were 14.

4.2 Single-Mother Households

We now extend our previous analyses to the case of teens living in single-mother families. Table 9 displays probit coefficient estimates on the single-mother smoking indicator for male and female teenagers. Additional regressors included are the single-mother analogous of those listed in Table 4.

Table 9 clearly indicates that both male and female teens living with a smoking mother in a single-parent household are significantly more likely to smoke if she smokes. In order to easily assess how relevant these effects are, Table 10 reports the predicted probabilities of teenagers' smoking when they live with a smoking and a non-smoking single mother and the associated marginal effects of maternal smoking behaviour. The smoking probability of boys (girls) living with a non-smoking single mother is 19.4% (16.5%) and it is increased for both groups by 13 percentage points in the presence of a smoking single mother, being this effect statistically significant at standard levels of testing.

As in the two-parent case, single mothers' smoking behaviour is likely to be endogenous in the youth smoking equation if there are unobserved factors shared by single mothers and their children that jointly explain the smoking behaviour of both. In order to overcome this issue, we use instrumental variable techniques as we have done for the two-parent case, our instruments being indicators of the socioeconomic status of maternal grandparents. The only difference is that our system has now two equations rather than three as in the previous analysis of two-parent households and, logically, it is no longer possible to separately assess the impact of each parent's smoking status on youth smoking decisions.

Bivariate probit coefficient estimates of the impact of parental smoking in single-mother families are reported in Table 11 and the full set of results for male and female teens living with a single mother are displayed in Appendix Tables 15 and 16, respectively. The evidence

[25] See Blow, Leicester and Windmeijer (2005) for a study focusing on the impact of socioeconomic status on the smoking behaviour of teenagers.

reported in Table 11 indicates that, once we correct for the potential endogeneity of single mothers' smoking behaviour (denoted by MS), it keeps on having a statistically significant impact on the smoking choices of both boys and girls. As with the analysis of two-parent households, we also find that our instruments are satisfactory in terms of relevance and provide evidence supportive of our overidentifying variables. The results of these tests are reported at the bottom of Table 11.

The predicted probabilities of youth smoking, displayed in Table 12, indicate that boys (girls) living in a single-mother household have a 32.7% (28%) probability of smoking if their mother smokes, while their smoking probability is significantly lower (there is a 13.1 and 10.5 percentage points decrease for boys and girls, respectively) when living with a non-smoking single mother. Therefore, our results suggest that the same-sex parent-child link in smoking behaviour is no longer relevant when there is only one paternal figure present in the household, since male teenagers' smoking behaviour who live in a single-mother family are significantly affected by that of their mothers, just as female teenagers are.

5 Conclusions

We use individual data on teenagers from the BHPS to study the intergenerational transmission of smoking habits. This is particularly relevant because research evaluating the effectiveness of both prices and other traditional anti-smoking policies in reducing youth smoking has reached mixed conclusions. The question whether the relationship between parents and their children's smoking habits is a causal one is not merely a technical one but it is relevant from a policy perspective because if the impact of parental smoking on youth smoking behaviour is causal, policies that succeed in reducing adults' smoking may in turn have an impact on youth smoking participation.

Our contribution with respect to previous studies is two-fold. First, we take into account that parental smoking choices are likely to be endogenous. In other words, there may be unobserved family factors, common to parents and their children, that jointly determine parents' and teens' smoking behaviour. Actually, previous research indicates that intergenerational transmission of risk attitudes is important and that children's and their parents' rates of time preference might be correlated. Second, we attempt to separately assess how mothers' and

fathers' smoking choices affect their female and male teenagers' smoking behaviour. This part of the analysis has been motivated by previous studies exploring outcomes and behaviours other than smoking that uncover significant same-sex parent-child links.

Our results for two-parent households show clear evidence that there is an important degree of intergenerational transmission of smoking behaviour between parents and children of the same sex. After controlling for the potential endogeneity of parental smoking status, we find that mothers' and fathers' smoking habits play a statistically significant role in girls' and boys' smoking behaviour, respectively. On the other hand, maternal smoking status does not significantly affect boys' smoking behaviour and paternal smoking status does not have a statistically significant impact on girls' smoking decisions. In other words, as far as smoking behaviour is concerned, we find evidence of the presence of same-sex role models in two-parent families: girls imitate their mothers and boys imitate their fathers. The results for teenagers living with a single mother indicate that, independently of their gender, their smoking behaviour is significantly affected by that of their only cohabiting parent.

Throughout this paper, we have suggested several unobserved factors that may play a relevant role in determining smoking behaviour within households and used instrumental variable techniques to isolate the causal impact of parental smoking. However, we have not directly analysed such factors mainly because of the lack of suitable data. An interesting avenue for future research would be to empirically identify the underlying mechanisms that jointly determine parents' and their children's smoking choices and assess their relative importance. Distinguishing genetic transmission from transmission of time preferences or risk attitudes, among other potential mechanisms, would require detailed data on household members' smoking habits, socioeconomic background, risk attitudes and time preferences combined with rich information on the nature of within household relationships that would allow us to identify biological twins and/or distinguish adopted from biological children. Future research may try to account for such factors.

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Table 1: Youth Smoking Rates of Two-Parent Households. All sample and by Parental Smoking Behaviour

	All	**by Parental Smoking Participation**			
Youth Smoking Rates		Only Father (1)	Only Mother (2)	Both (3)	None (4)
		A. Full Sample, N=9801			
11-13	4.3	4.8	6.4	5.4	3.5
14-15	19.3	25.1	30.3	32.1	15.2
16-17	19.0	29.4	34.2	38.8	13.3
18-19	27.4	35.0	43.2	42.6	21.8
All	14.5	18.8	22.4	22.6	11.4
		B. Boys, N=4953			
11-13	3.1	3.9	4.9	4.4	2.2
14-15	16.8	21.2	25.8	28.5	13.5
16-17	20.2	36.3	36.8	42.9	12.4
18-19	30.8	43.0	45.8	46.5	24.1
All	14.5	19.7	21.6	22.2	10.9
		C. Girls, N=4848			
11-13	5.6	5.8	8.3	6.6	4.6
14-15	21.8	29.4	36.4	36.7	16.8
16-17	17.6	23.2	31.1	34.6	14.1
18-19	23.4	26.5	40.1	38.3	19.2
All	14.6	17.9	23.5	23.0	11.8

Note: Statistics based on the sample of individual-year observations corresponding to teenagers living in two-parent households. All statistics are weighted.

Table 2: Youth Smoking Rates of Single-Mother Households. All Sample and by Mother's Smoking Behaviour

	All	**by Maternal Smoking Participation**	
		Smoking Single Mother	Non-smoking Single Mother
Youth Smoking Rates		(1)	(2)
		A. Full Sample, N=3895	
11-13	6.4	11.8	2.6
14-15	28.0	37.1	21.3
16-17	27.5	43.2	16.6
18-19	37.6	56.9	27.0
All	21.7	32.3	14.6
		B. Boys, N=1957	
11-13	7.1	14.8	2.2
14-15	26.1	35.2	19.5
16-17	29.1	42.3	19.3
18-19	43.2	58.0	33.7
All	22.7	33.5	15.3
		C. Girls, N=1938	
11-13	5.6	8.8	3.2
14-15	30.0	39.2	23.3
16-17	25.7	44.4	14.0
18-19	32.0	55.7	21.2
All	20.7	31.1	13.9

Note: Statistics based on the sample of individual-year observations corresponding to teenagers living in single-mother households. All statistics are weighted.

Table 3: Main Sample Characteristics of Two-Parent Households. All Sample and by Parental Smoking Behaviour

	All	**by Parental Smoking Participation**			
		Only Father	Only Mother	Both	None
Variable		(1)	(2)	(3)	(4)
Age	14.5	14.3	14.3	14.2	14.6
Male	0.51	0.51	0.55	0.53	0.50
White	0.95	0.91	0.99	0.98	0.96
Work for Pay	0.40	0.40	0.43	0.43	0.40
Household size	4.5	4.8	4.5	4.7	4.4
Monthly HH income	2981.2	2555.0	2527.3	2397.5	3215.9
Father's age	44.2	42.4	42.6	41.4	45.0
Mother's age	42.0	40.2	40.5	39.8	42.9
Father's education:					
More than high school	0.41	0.28	0.25	0.27	0.49
High school	0.29	0.29	0.35	0.31	0.28
Less than high school	0.30	0.43	0.39	0.42	0.23
Mother's education:					
More than high school	0.28	0.17	0.17	0.17	0.35
High school	0.40	0.37	0.41	0.32	0.39
Less than high school	0.32	0.45	0.43	0.51	0.27
Father's occupational category:					
High	0.31	0.16	0.17	0.15	0.38
Medium	0.30	0.34	0.34	0.35	0.28
Low	0.27	0.30	0.29	0.29	0.26
Not working	0.12	0.20	0.19	0.22	0.08
Mother's occupational category:					
High	0.15	0.10	0.10	0.09	0.17
Medium	0.28	0.23	0.25	0.22	0.31
Low	0.33	0.36	0.41	0.41	0.31
Not working	0.24	0.31	0.24	0.28	0.21

Note: N=9271. Statistics based on the sample of individual-year observations for whom non missing information is available for all the variables used. Macro area of residence and year dummies are also included in the statistical analyses. All statistics are weighted.

Table 4: Main Sample Characteristics of Single-Mother Households. All Sample and by Mother's Smoking Behaviour

	All	**by Maternal Smoking Participation**	
		Smoking Single Mother	Non-smoking Single Mother
Variable		(1)	(2)
Age	14.7	14.7	14.8
Male	0.52	0.53	0.51
White	0.92	0.96	0.90
Work for Pay	0.38	0.37	0.38
Household size	3.7	3.7	3.7
Monthly HH income	1779.1	1633.8	1877.5
Single parent's age	41.0	39.9	41.8
Single parent's education:			
Low	0.37	0.52	0.28
Medium	0.37	0.31	0.40
High	0.26	0.17	0.32
Single mother's occupation:			
High	0.12	0.09	0.14
Medium	0.23	0.22	0.24
Low	0.30	0.29	0.31
Not working	0.35	0.40	0.31

Note: N=3762. Statistics based on the sample of individual-year observations for whom non missing information is available for all the variables used. Macro area of residence and year dummies are also included in the statistical analyses. All statistics are weighted.

Table 5: Youth Smoking Probit Coefficient Estimates. Two-Parent Households

	Boys	Girls
Mother Smokes (MS)	0.287	0.311
	(0.093)	(0.086)
Father Smokes (FS)	0.286	0.182
	(0.094)	(0.085)
Pseudo R^2	0.152	0.105
N	4,698	4,573

Note: Standard errors, displayed in round brackets, are clustered by individual. Additional control variables included in the estimation are those listed in Table 3.

Table 6: Predicted Probabilities of Youth Smoking by Parental Smoking Behaviour in Two-Parent Households. Results Based on Probit Estimation.

A. Boys			
	$FS = 1$	$FS = 0$	
$MS = 1$	$\hat{p}_{11}$ =0.243 (0.020)	$\hat{p}_{12}$ = 0.171(0.018)	$(\hat{p}_{11} - \hat{p}_{12})$ =0.071 (0.022)
$MS = 0$	$\hat{p}_{21}$ =0.1774 (0.020)	$\hat{p}_{22}$ =0.118 (0.010)	$(\hat{p}_{21} - \hat{p}_{22})$ =0.059 (0.019)
	$(\hat{p}_{11} - \hat{p}_{21})$ = 0.065 (0.022)	$(\hat{p}_{12} - \hat{p}_{22})$ =0.052 (0.019)	$(\hat{p}_{11} - \hat{p}_{22})$ =0.124 (0.024)
B. Girls			
	$FS = 1$	$FS = 0$	
$MS = 1$	$\hat{p}_{11}$ =0.233 (0.022)	$\hat{p}_{12}$ =0.188 (0.020)	$(\hat{p}_{11} - \hat{p}_{12})$ =0.045 (0.021)
$MS = 0$	$\hat{p}_{21}$ =0.153 (0.017)	$\hat{p}_{22}$ =0.119 (0.009)	$(\hat{p}_{21} - \hat{p}_{22})$ =0.034 (0.017)
	$(\hat{p}_{11} - \hat{p}_{21})$ =0.080 (0.021)	$(\hat{p}_{12} - \hat{p}_{22})$ =0.070 (0.020)	$(\hat{p}_{11} - \hat{p}_{22})$ =0.115 (0.024)

Note: Standard errors, in round brackets, have been computed by simulation.

Table 7: Youth Smoking Trivariate Probit Coefficient Estimates. Two-Parent Households

	Boys	Girls
Mother Smokes (MS)	0.166	0.319
	(0.151)	(0.123)
Father Smokes (FS)	0.262	0.083
	(0.139)	(0.118)
N	4698	4573
Pseudo R^2	0.1135	0.0886
Likelihood ratio test of $\rho(YS) = \rho(MS) = \rho(FS) = 0$	376.16[3]	418.32[3]
Instrument relevance:		
Instruments excluded from MS	341.80 [17]	30.99 [17]
Instruments excluded from FS	60.09 [17]	27.78 [17]
Instruments excluded from both MS and FS	411.00 [34]	54.29 [34]
Tests of overidentifying variables:		
Full model vs. restricted model 1	87.78 [17]	101.22 [17]
Full model vs. restricted model 2	61.73 [17]	74.35 [17]
Full model vs. restricted model 3	120.17 [26]	133.23 [26]
Full model vs. restricted model 4	54.56[13]	46.05[13]
Full model vs. restricted model 5	66.90[13]	88.53[13]

Note: Standard errors, displayed in round brackets, are clustered by individual. Degrees of freedom in square brackets. Additional control variables included in the estimation are those listed in Table 3. The different sets of overidentifying variables are the following: all the instruments from the MS equation (model 1), all the instruments from the FS equation, all the grandparents' occupational dummies from both the FS and the MS equations (model 3), all the grandparents' occupational dummies from the MS equation (model 4) and all the grandparents' occupational dummies from the FS equation (model 5).

Table 8: Predicted Probabilities of Youth Smoking by Parental Smoking Behaviour in Two-Parent Households. Results Based on Trivariate Probit Estimation

A. Boys			
	$FS = 1$	$FS = 0$	
$MS = 1$	$\hat{p}_{11}$ =0.217 (0.035)	$\hat{p}_{12}$ =0.154 (0.023)	$(\hat{p}_{11} - \hat{p}_{12})$ =0.064 (0.033)
$MS = 0$	$\hat{p}_{21}$ =0.184 (0.027)	$\hat{p}_{22}$ = 0.126 (0.014)	$(\hat{p}_{21} - \hat{p}_{22})$ =0.057 (0.029)
	$(\hat{p}_{11} - \hat{p}_{21})$ =0.033 (0.036)	$(\hat{p}_{12} - \hat{p}_{22})$ =0.027 (0.029)	$(\hat{p}_{11} - \hat{p}_{22})$ =0.091 (0.045)
B. Girls			
	$FS = 1$	$FS = 0$	
$MS = 1$	$\hat{p}_{11}$ =0.218 (0.032)	$\hat{p}_{12}$ =0.199 (0.027)	$(\hat{p}_{11} - \hat{p}_{12})$ =0.019 (0.030)
$MS = 0$	$\hat{p}_{21}$ =0.138 (0.020)	$\hat{p}_{22}$ =0.123 (0.011)	$(\hat{p}_{21} - \hat{p}_{22})$ =0.014(0.022)
	$(\hat{p}_{11} - \hat{p}_{21})$ =0.080 (0.030)	$(\hat{p}_{12} - \hat{p}_{22})$ =0.076 (0.030)	$(\hat{p}_{11} - \hat{p}_{22})$ =0.095 (0.039)

Note: See note to Table 6.

Table 9: Youth Smoking Probit Coefficient Estimates. Single-Mother Households

	Boys	Girls
Single Mother Smokes	0.478	0.521
	(0.109)	(0.111)
Pseudo R^2	0.1589	0.1447
N	1,889	1,873

Note: Standard errors, displayed in round brackets, are clustered by individual. Additional control variables included in the estimation are those listed in Table 4.

Table 10: Predicted Probabilities of Youth Smoking by Parental Smoking Behaviour in Single-MotherHouseholds. Results Based on Probit Estimation

	Boys	Girls
$MS = 1$	$\hat{p}_1$ =0.328 (0.026)	$\hat{p}_1 = 0.297$ (0.025)
$MS = 0$	$\hat{p}_2 = 0.194$ (0.016)	$\hat{p}_2 = 0.165$ (0.015)
	$(\hat{p}_1 - \hat{p}_2) = 0.133$ (0.029)	$(\hat{p}_1 - \hat{p}_2) = 0.132$ (0.029)

Note: Standard errors, in round brackets, have been computed by simulation. MS is the smoking indicator for single mothers.

Table 11: Youth Smoking Bivariate Probit Coefficient Estimates. Single-Mother Households

	Boys	Girls
Single Mother Smokes	0.459	0.428
	(0.198)	(0.209)
N	1889	1873
Pseudo R^2	0.1151	0.1266
Likelihood ratio test of $\rho(YS) = \rho(MS) = 0$	0.022[1]	0.446[1]
Instrument relevance:		
Instruments excluded from MS	307.02 [17]	35.46 [17]
Test of overidentifying variables	95.21 [13]	74.08 [13]

Note: Standard errors, displayed in round brackets, are clustered by individual. Degrees of freedom are reported in square brackets. Additional control variables included in the estimation are those listed in Table 4. The overidentifying variables are all the grandparents' occupational dummies.

Table 12: Predicted Probabilities of Youth Smoking by Parental Smoking Behaviour in Single-Mother Households. Results Based on Bivariate Probit Estimation

	Boys	Girls
$MS = 1$	$\hat{p}_1$ =0.327 (0.039)	$\hat{p}_1$ = 0.280 (0.037)
$MS = 0$	$\hat{p}_2$ =0.196 (0.023)	$\hat{p}_2$ = 0.175 (0.022)
	$(\hat{p}_1 - \hat{p}_2) = 0.131$ (0.054)	$(\hat{p}_1 - \hat{p}_2)$ =0.105 (0.053)

Note: See note to Table 10.

APPENDIX

Table 13: Trivariate Probit Coefficients Estimates for Male Teenagers in Two-Parent Households (4689 obs)

Two parent households	**Males**		**Father**		**Mother**	
Variable	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*
Father smoking	0.262	0.139				
Mother smoking	0.166	0.151				
Kid's age	0.188	0.015				
Kid works for pay	0.159	0.062				
Log(monthly HH income)	0.109	0.071	0.014	0.063	−0.032	0.066
Kid is white	0.443	0.226				
Household size	−0.027	0.037	0.068	0.037	−0.031	0.038
Parents different race			−0.107	0.234	0.165	0.306
Area of residence						
Rest of South East	0.493	0.228	−0.177	0.243	0.405	0.250
Scotland	0.202	0.225	0.042	0.236	0.508	0.245
Wales	0.410	0.226	0.072	0.242	0.399	0.260
Rest of England	0.404	0.211	−0.249	0.225	0.439	0.240
London	0.501	0.255	0.271	0.271	0.459	0.275
Parent's age						
Father's age	−0.009	0.009	−0.018	0.009	−0.021	0.010
Mother's age	0.001	0.011	−0.031	0.011	−0.010	0.011
Father's education						
More than high school	−0.095	0.103	−0.384	0.104	−0.410	0.107
High school	−0.157	0.104	−0.235	0.101	−0.070	0.102
Mother's education						
More than high school	−0.247	0.115	−0.481	0.110	−0.418	0.121
High school	−0.165	0.094	−0.317	0.091	−0.141	0.096

Table 13: Trivariate Probit Coefficients Estimates for Male Teenagers in Two-Parent Households (cont.)

Two parent households	**Males**		**Father**		**Mother**	
Variable	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*
Father's occ. category						
High	-0.356	0.146	-0.64	0.132	-0.588	0.141
Medium	-0.275	0.128	-0.252	0.125	-0.346	0.122
Low	-0.246	0.126	-0.455	0.123	-0.368	0.121
Mother's occ. category:						
High	0.086	0.128	0.086	0.126	0.012	0.133
Medium	0.023	0.105	-0.054	0.010	0.131	0.104
Low	0.120	0.096	0.068	0.090	0.188	0.090
Grandfather's occupation						
Professional			-1.167	0.406	0.286	0.408
Managerial and technincal			-0.789	0.295	0.122	0.299
Skilled non manual			-0.844	0.285	-0.009	0.281
Skilled manual			0.488	0.218	0.198	0.223
Partly skilled			-0.579	0.213	0.371	0.210
Unskilled			-0.605	0.234	0.139	0.228
Armed forces			-0.227	0.339	-0.459	0.520
Grandmother's occupation						
Professional occ.			-3.784	0.685	-3.930	0.503
Managerial and technincal			0.188	0.379	0.259	0.361
Skilled non manual			0.090	0.281	0.237	0.251
Skilled manual			0.091	0.279	0.167	0.270
Partly skilled			0.109	0.215	-0.013	0.214
Unskilled			0.008	0.185	0.264	0.174
Hope-Goldthorpe Scale						
Grandfather			0.012	0.004	-0.001	0.004
Grandmother			-0.002	0.006	-0.001	0.005
Grandfather not alive			0.113	0.214	0.402	0.194
Grandmother not alive			0.023	0.259	0.383	0.458

Note: Standard errors are clustered by individual. Omitted categories are less than high school for parental education, not working for parental and grandparental occupational category indicators and Northern Ireland for regional indicators. Additional variables included in the estimation are year dummies.

Table 14: Trivariate Probit Coefficients Estimates for Female Teenagers in Two-Parent Households (4573 obs).

Two parents	**Females**		**Father**		**Mother**	
Variable	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*
Father smoking	0.083	0.118				
Mother smoking	0.319	0.123				
Kid's age	0.151	0.015				
Kid works for pay	0.136	0.061				
Log(monthly HH income)	−0.024	0.067	−0.126	0.062	0.035	0.069
Kid is white	0.784	0.274				
Household size	−0.327	0.037	0.886	0.034	−0.090	0.035
Parents different race			0.941	0.358	0.700	0.306
Area of residence						
Rest of South East	0.698	0.219	−0.049	0.246	0.741	0.246
Scotland	0.293	0.226	0.118	0.235	0.968	0.239
Wales	0.415	0.215	−0.061	0.245	0.807	0.246
Rest of England	0.609	0.205	−0.142	0.226	0.729	0.229
London	0.649	0.249	0.028	0.271	0.745	0.280
Parent's age						
Father's age	−0.005	0.008	−0.021	0.008	−0.014	0.009
Mother's age	−0.009	0.009	0.001	0.010	−0.014	0.011
Father's education						
More than high school	0.001	0.101	−0.248	0.108	−0.178	0.110
High school	−0.157	0.101	−0.260	0.103	−0.134	0.105
Mother´s education						
More than high school	−0.184	0.115	−0.294	0.089	−0.302	0.124
High school	−0.005	0.091	−0.051	0.058	−0.200	0.100

Table 14: Trivariate Probit Coefficients Estimates for Female Teenagers in Two-Parent Households (cont.)

Two parents	**Females**		**Father**		**Mother**	
Variable	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*
Father's occ. category						
High	−0.035	0.135	−0.623	0.125	−0.824	0.140
Medium	−0.081	0.116	−0.159	0.116	−0.340	0.125
Low	−0.070	0.120	−0.251	0.114	−0.523	0.126
Mother's occ. category:						
High	−0.156	0.143	−0.055	0.125	−0.120	0.154
Medium	−0.025	0.107	−0.060	0.103	−0.007	0.111
Low	−0.023	0.097	−0.048	0.089	0.252	0.096
Grandfather's occupation						
Professional			−0.307	0.370	0.721	0.398
Managerial and technincal			−0.251	0.282	0.613	0.297
Skilled non manual			−0.135	0.247	0.402	0.291
Skilled manual			−0.107	0.208	0.343	0.223
Partly skilled			0.058	0.205	0.569	0.216
Unskilled			−0.548	0.217	0.504	0.234
Armed forces			−0.394	0.330	−0.020	0.332
Grandmother's occupation						
Professional occ.			0.142	0.689	−0.989	0.691
Managerial and technincal			0.056	0.358	0.211	0.384
Skilled non manual			0.035	0.26	0.098	0.252
Skilled manual			−0.065	0.264	−0.015	0.979
Partly skilled			−0.043	0.202	−0.219	0.220
Unskilled			0.123	0.172	0.125	0.189
Hope-Goldthorpe Scale						
Grandfather			0.006	0.004	−0.009	0.004
Grandmother			0.001	0.006	0.001	0.006
Grandfather not alive			0.291	0.201	0.275	0.200
Grandmother not alive			−0.585	0.257	0.062	0.223

Note: Standard errors are clustered by individual. Omitted categories are less than high school for parental education, not working for parental and grandparental occupational category indicators and Northern Ireland for regional indicators. Additional variables included in the estimation are year dummies.

Table 15: Bivariate Probit Coefficients Estimates for Male Teenagers in Single-Mother Households (1,889 obs).

Single Mother	**Males**		**Mother**	
Variable	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*
Mother smokes	0.459	0.198		
Kid's age	0.200	0.021		
Kid works for pay	0.158	0.089		
Log(monthly HH income)	−0.059	0.079	0.042	0.074
Kid is white	0.569	0.236		
Household size	−0.005	0.046	−0.111	0.043
Area of residence				
Rest of South East	0.023	0.273	0.361	0.365
Scotland	−0.357	0.265	0.429	0.345
Wales	−0.312	0.280	0.586	0.356
Rest of England	−0.386	0.243	0.201	0.341
London	−0.011	0.339	0.495	0.403
Mother's characteristics:				
Age	−0.012	0.011	−0.014	0.010
Mother's education				
More than high school	−0.351	0.160	−0.514	0.162
High school	−0.176	0.130	−0.434	0.136
Mother's Occ. category:				
High	0.015	0.177	−0.314	0.168
Medium	−0.204	0.148	−0.221	0.142
Low	0.026	0.134	−0.286	0.131

Table 15: Bivariate Probit Coefficients Estimates for Male Teenagers in Single-Mother Households (cont.)

Single Mother	**Males**		**Mother**	
Variable	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*
Grandfather's occupation				
Professional			−0.561	0.627
Managerial and technincal			−0.191	0.474
Skilled non manual			0.240	0.426
Skilled manual			0.137	0.339
Partly skilled			0.070	0.334
Unskilled			0.596	0.359
Armed forces			1.351	0.521
Grandmother's occupation				
Professional occ.			−3.391	0.759
Managerial and technincal			0.418	0.594
Skilled non manual			0.043	0.431
Skilled manual			0.250	0.416
Partly skilled			−0.091	0.334
Unskilled			0.512	0.276
Hope-Goldthorpe Scale				
Grandfather			0.001	0.007
Grandmother			−0.003	0.009
Grandfather not alive			0.151	0.293
Grandmother not alive			−0.276	0.413

Note: Standard errors are clustered by individual. Omitted categories are less than high school for maternal education, not working for maternal and grandparental occupational category indicators and Northern Ireland for regional indicators. Additional variables included in the estimation are year dummies.

Table 16: Bivariate Probit Coefficients Estimates for Female Teenagers in Single-Mother Households (1,873 obs.)

Single mother	**Females**		**Mother**	
Variable	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*
Mother smokes	0.428	0.209		
Kid's age	0.171	0.022		
Kid works for pay	0.069	0.091		
Log(monthly HH income)	-0.098	0.063	-0.057	0.069
Kid is white	0.588	0.276		
Household size	0.042	0.040	-0.088	0.042
Area of residence				
Rest of South East	0.460	0.278	-0.609	0.330
Scotland	-0.039	0.251	-0.347	0.299
Wales	0.138	0.258	-0.488	0.311
Rest of England	0.077	0.252	-0.674	0.299
London	0.051	0.298	-0.52	0.352
Mother's characteristics:				
Age	-0.007	0.011	-0.049	0.010
Mother's education				
More than high school	-0.366	0.149	-0.663	0.146
High school	-0.549	0.139	-0.608	0.135
Mother's Occ. category:				
High	0.211	0.176	-0.011	0.183
Medium	0.107	0.138	0.121	0.147
Low	0.021	0.132	-0.025	0.123

Table 16: Bivariate Probit Coefficients Estimates for Female Teenagers in Single-Mother Households (cont.)

Single mother	**Females**		**Mother**	
Variable	*Coeff.*	*Std.Error*	*Coeff.*	*Std.Error*
Grandfather's occupation				
Professional			-1.762	0.589
Managerial and technincal			-0.592	0.442
Skilled non manual			-0.087	0.422
Skilled manual			-0.558	0.322
Partly skilled			-0.566	0.314
Unskilled			0.172	0.339
Armed forces			0.196	0.424
Grandmother's occupation				
Professional occ.			-1.038	0.942
Managerial and technincal			-0.179	0.525
Skilled non manual			-0.360	0.377
Skilled manual			-0.189	0.356
Partly skilled			-0.149	0.290
Unskilled			-0.076	0.257
Hope-Goldthorpe Scale				
Grandfather			0.004	0.007
Grandmother			0.007	0.008
Grandfather not alive			-0.013	0.277
Grandmother not alive			0.376	0.342

Note: Standard errors are clustered by individual. Omitted categories are less than high school for maternal education, not working for maternal and grandparental occupational category indicators and Northern Ireland for regional indicators. Additional variables included in the estimation are year dummies.

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