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ABSTRACT

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

We analyze data from the 1994-2002 waves of the British Household Panel Survey to explore the influence of parental smoking habits on their children's smoking decisions. In order to account for the potential endogeneity of parental smoking habits we use instrumental variable methods. We find that mothers play a crucial role in determining their daughters' smoking decisions, while fathers' smoking habits are transmitted primarily to their sons.

JEL Classification: I1, C5

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

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1 Introduction

Smoking is one of the primary public health concerns in industrialized societies. In the UK, where currently about 28 percent of men and 24 percent of women are smokers, the White Paper on Tobacco "Smoking Kills" has recently been approved, aiming to provide a set of interventions for reducing tobacco consumption. Since the majority of smokers first try cigarettes when they are teenagers and youth smoking often persists into adulthood, teens are the focus of many policy discussions. In 1996, the initiation rate of young smokers in the UK was larger than the cessation rate in the adult population (Foulds, 1999). Current statistics show that by the age of 11 one-third of children in the UK have experienced with smoking, while two-thirds have done so by the age of 16 (ASH, 2005). Similar results are obtained when consulting other data sources. For example, one of the most recent surveys conducted among school children aged 11-16 in England, "The Health Behaviour in School-Aged Children Survey", showed that approximately 19 percent of survey participants were regular smokers in 1997. In 1998, the Office of National Statistics survey found similar results among children aged 11-15 years old who experienced with smoking. In this survey, young regular smokers stated that they were smoking about an average of 65 cigarettes per week, and the majority indicated that it would be difficult to stop smoking, increasing this perception the longer had they been regular smokers. In addition, risk attitudes toward smoking were also worrisome. In particular, about 20-40 percent of young regular smokers endorsed the view that "smoking is not really dangerous, it only harms people who smoke a lot".

A wide range of studies in the economics literature has evaluated the responsiveness of cigarette consumption to different anti-smoking policies. These include the establishment of smoking bans, age restrictions, the implementation of information campaigns on the negative health effects associated with smoking and, most often, the increase in cigarette prices through higher taxes (see, among others, Chaloupka and Grossman, 1996; DeCicca, Gilleskie and Strumpf, 2005; Gruber; 2001; Kenkel and Mathios, 2002; Lewit, Coate and Grossman, 1981; Powell, Tauras and Ross, 2005; Ross and Chaloupka, 2004; Ross et al., 2005; Tauras and Chaloupka, 1999; Tauras, O'Malley, and Johnston, 2001). DeCicca et al. (2002) find that prices and taxes have a non-significant (and sometimes positive) effect on smoking initiation

during high school. They also find that the price elasticity of smoking participation becomes less negative as the cohort ages. In contrast, Gruber (2000) finds that prices have a significant negative effect on smoking participation and that this effect is more remarkable for older teens.

Given these mixed results regarding the effectiveness of tax policies and the alarming youth smoking rates that still prevail, the consideration of other determinants of youth smoking behavior should be a priority for researchers and could be helpful for health policy makers when attempting to design more comprehensive anti-smoking policy tools. In this respect, a growing body of literature in several disciplines has assessed the role played by family and social interactions in determining many youth behavioral outcomes. Several studies (Gaviria and Rapahel, 1997; Smith and Stutts, 1999; Powell, Tauras and Ross, 2005) explore the influence of peers on smoking decisions, while Clark and Etilé (2003) analyze the spousal correlation on smoking behavior. Despite the potential importance of intergenerational influences on consumption habits, most of the previous literature has focused on income and earning transfers. An exception is Waldkirch, Cox and Ng (2004), who show that although income is an important source of the intergenerational correlation, parental choices and experiences also affect children's consumption behavior. As for cigarette consumption and the intergenerational transmission of smoking habits, on which this paper focuses, has been the object of extensive physiological and medical research, the majority of which 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 that focus on the link between parental smoking choices and youth smoking behavior are rare in the economics literature. One exception is Powell and Chalopuka (2004), who jointly examine the relevance of parental influences, prices and tobacco control policies on the smoking behavior of youths using 1996 US data from a nationally representative survey of high school students. They find that parental influences are a key factor on youth smoking, and that the likelihood of youth smoking is significantly increased when either parent smokes.

The observed influence of parental smoking behavior on the smoking decisions of youths may be explained by parents as role models for their children, easier access to tobacco in the household or the diminished credibility of warnings about the dangers of tobacco consumption

that come from parents who smoke. However, it may also be due to other unobserved family factors common to parents and their children, such as shared attitudes towards risk, rates of time preference and, ultimately, genetic traits.

To the extent of our knowledge, no studies to date have yet attempted to overcome the potential endogeneity of parental smoking behavior in order to assess whether the observed relationship between parents' and their children's smoking decisions is a causal one. A goal of our study is to fill in this gap by using instrumental variable techniques. Additionally, we also expand on the previous literature by assessing the different influence of each parent on the prevalence of youth smoking by gender. In other words, we attempt to answer questions like "are smoking mothers (fathers) more likely to be imitated by their daughters (sons) than by their sons (daughters)?"

In order to answer these questions we use data from the 1994-2002 waves of the British Household Panel Survey. The household nature of this survey provides us with useful information on children's grandparents that we use to construct instrumental variables and overcome the potential endogeneity of parental smoking behavior. Thus, our identification strategy relies on the assumption that intergenerational influences do not go beyond one generation.

We find that, after correcting for the potential endogeneity of parental smoking behavior, the smoking transmission link is especially strong between parents and children of the same sex. That is, our evidence suggests that paternal smoking behavior affects youth male smoking in a statistically significant way, while maternal smoking primarily affects youth female smoking decisions.

The reminder of the paper is organized as follows. Section 2 describes the data used 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 (BHPS hereafter), 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.[1]

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 behavior 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 to males and 4,867 to females, spanning the period from 1994 to 2002.[2] Our panel is unbalanced, with adolescents contributing between once and a maximum of nine times. As an interesting extension, we also look at single parent households, although in this part of the analysis we are unable to separately assess the influence of each parent on youth smoking decisions. Our sample of single parents consists of 4,332 observations, of which 2,231 correspond to males and 2,101 to females. It is worth remarking that most single-parent households are actually mother-headed households: 84.6% (89.2%) of boys (girls) living in single-parent households are living with their mothers, while the percentage of teens living with their parents never goes above 16%.

Information on smoking participation is available from both the adult (16+) and children (11-15) questionnaires, that is, the BHPS and the BYP.[3] In the BYP, children aged 11-15

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

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

[3] In order to prevent underreporting and to reduce measurement error, young participants were interviewed separately from their parents.

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.[4] The household nature of the BHPS allows us to link teenagers' smoking behavior 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 (22.9%) while the lowest incidence of teenage smoking arises when neither the father nor the mother smokes (11%). Parental smoking habits seem to be a strong predictor of youth smoking behavior 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, 32.5% (30%) of girls (boys) aged 14-15 smoke when both parents smoke, while only 15.4% (12.6%) 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 parental smoking status for the sample of single parents. The comparison of Table 1 and Table 2 suggests that the smoking rates of teens living in single-parent households are clearly higher than those of teens living in two-parent households, independently of the smoking behavior of their parents. As for the role of parental smoking decisions, these are also strong predictors of youth smoking behavior when living with a single parent: 32.3% (29.6%) of boys (girls) living with a smoking parent smoke, against

[4] 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.

only 18.5% (15.7%) of their counterparts living with a non-smoking parent.

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 household income, household size, and area of residence.[5]

Table 3 displays summary statistics for most of these characteristics by parental smoking behavior in the two-parent sample. Children living with parents who smoke are more likely to be working for pay and to live in bigger households. As for their parents' characteristics, 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, 48% (33%) 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 household income for 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 behavior. 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. and Kunst, Giskes and Mackenbach, 2004).

Descriptive statistics for the single-parent sample are not reported for the sake of brevity but reproduce the main feature of the two-parent sample: non-smoking single parents have a higher socioeconomic status than their smoking counterparts.[6]

[5] The education variable denotes the highest degree obtained and is grouped into three categories: more than 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). 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 North Island.

[6] These results are available upon request from the authors.

3 Empirical Model

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

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

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

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

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

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 is correlated with their parents' smoking behavior, then the single-equation estimates will 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 behavior. 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 behavior but have no direct residual impact on teenagers' smoking decisions. Ideally, one would want to know the grandparents' smoking behavior, but the data employed do not contain this information. However, based on the strong correlation between social class, occupation and smoking behavior previously discussed (tobacco smoking is more common among lower socioeconomic groups), the set of

instruments used are social class and occupational indicators for the teenagers' grandparents.[7] These are denoted by ZM and ZF in the maternal and paternal smoking equations, respectively. Similar instrumental variables have been successfully employed by Maurin (2002), who analyzes 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. Similarly, our identification strategy relies on the assumption that the impact of parental socioeconomic status on smoking behavior does not go beyond one generation. This assumption is likely to fit Northern European countries, like the UK, reasonably well, since family ties there are clearly not so strong as in the Mediterranean.[8] Moreover, the information collected on grandparents' socioeconomic status refers to them when the teenagers' parents were 14 years old. Hence, overall we believe that this is a reasonable assumption.

The explanatory variables contained in the X vector refer to teenagers' socioeconomic characteristics, such as their age, race, whether they work for pay, household size and income and regional indicators. In addition, a set of parental characteristics, containing both parents' age, occupational dummies for each parent, and year dummies were also included.[9] The choice of control variables included in the statistical analyses that follows is in line with those included in other studies of the determinants of youth smoking behavior, such as Blow, Leicester and Windmeijer (2005).

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

[7] 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).

[8] We are aware that our identifying assumption may be restrictive for countries where families ties are very strong and children often grow up together with their parents and grandparents (as in Southern European countries). 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 (2006) adopt a similar classification.

[9] Tobacco prices and regulations in the UK are set at national levels not allowing for regional differences. Therefore, temporal variation in prices or regulations is captured by our year dummies.

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.[10] Estimation results are presented in the following section.

4 Estimation and Results

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 are reported in Table 4. 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 in line with those of Powell and Chaloupka (2004), who explore the determinants of youth smoking behavior 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 or both parents smoke are

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

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 5, where $\hat{p}$ represents the probability of youth smoking in each cell. Empirically, each value of $\hat{p}$ has been computed as the mean of teenagers' predicted probabilities of smoking given their covariate values and their parents' smoking behavior. Standard errors of the mean predicted probabilities have been calculated using the delta method.

The results for boys displayed in Panel A of Table 5 indicate, not surprisingly, that the highest smoking probability corresponds to the case when both parents smoke (20.9%) while the lowest one corresponds to households where neither the father nor the mother smokes (8.3%). The difference between these two extreme cases amounts to 12.6 percentage points and 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 7.2 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 also a 7.2 percentage points increase. These effects are also statistically significant at the 1% level.

The results for girls, reported in Panel B of Table 5, 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 20.8% while the smoking rate for their counterparts living in families where neither parent smokes is 9.5%. An interesting finding encountered when analyzing girls' smoking (and not encountered for boys) is that maternal smoking behavior seems to play a more important role for them than paternal smoking behavior. That is, conditioning on paternal smoking behavior, the impacts of maternal smoking choices (7.7 and 6.4 percentage points when the father smokes and when he does not smoke, respectively) are bigger than the estimated effects of paternal smoking choices given the maternal smoking status (4.8 and 3.8 percentage points when the mother smokes and when she does not smoke, respectively).

However, 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. The resulting coefficient estimates and their associated standard errors are presented in Table 6. In contrast with the probit results, the paternal smoking indicator 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 smoking does not significantly affect boys' smoking behavior, paternal smoking does not have a statistically significant impact on girl's smoking decisions. In sum, in the context of smoking behavior, girls seem to imitate their mothers, while boys seem to imitate their fathers. To the extent of our knowledge, this sort of phenomenon had not previously been documented in the youth smoking literature, although there is evidence of mother-daughter and father-son links in the context of other health outcomes. For instance, Thomas (1994) examines the relationship between parental education and child height in several countries. He finds that the education of the mother has a bigger effect on her daughter's height while paternal education, in contrast, has a bigger impact on his son's height.

First-stage F-statistics and partial R^2 measures on all the instruments used are also reported as a diagnostic tool in the bottom part of Table 6 to evaluate the seriousness of the finite-sample bias. It turns out that the value of the F-statistic on the excluded instruments in equations 2 and 3 is well above the threshold value of 10, and the partial R^2 between the instruments and the endogenous variables is far away from 0, which is suggested by Bound, Jaeger and Baker (1995) as the rule of thumb criterion to establish instrument weakness. We can argue that the instruments' quality appears to be reasonable as suggested by these measures. The results from the joint likelihood ratio test on the correlation coefficients of the error terms of equations 1-3 shows statistical evidence that parental and youth smoking behaviors are actually correlated.

Table 7 replicates Table 5 and illustrates the magnitude of the estimated effects when using the trivariate probit model. The estimated youth smoking probabilities in the extreme

cases where both parents smoke or neither of them smokes are similar to the probit results displayed in Table 5. For instance, the predicted probability of boys' (girls') smoking when both parents smoke is 20.9% (20.8%) in the trivariate probit model, quite similar to those obtained when using a probit model (20.3% for boys and 19% for girls, respectively).

The results in Table 7 confirm the non-significant role of the mother-son and father-daughter links already suggested by the coefficient estimates displayed in Table 6. Conditioning on paternal smoking behavior, the impact of maternal smoking participation is not statistically significant at standard levels for boys. At the same time, the role of paternal smoking decisions is not significant for girls when conditioning on maternal smoking choices. Instead, the mother-daughter and father-son effects are statistically significant at the 5% level. As for the magnitude of these significant effects, conditioning on having a (non) smoking father, having a smoking mother increases the probability of girls' smoking by (6.2) 7.4 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 (6.4) 8.1 percentage points. In sum, after correcting for the potential endogeneity of parental smoking decisions, our findings indicate that there are relevant differences in the role of parental smoking behavior depending on the gender of the child and these differences vary with the gender of the parent.

We now turn to the impact of the remainder of our control variables on youth smoking participation. In Table 12 (reported in the Appendix) we display all trivariate probit coefficient estimates from equation 1.[11] In addition to maternal and paternal smoking habits, other factors affecting the probability of youth smoking in a positive and statistically significant way are the adolescents' age, if they are working for pay or if they are of white race and if they live in the South East region, London, Wales or in the rest of England. On the other hand, after having controlled for parental smoking behavior, household size and income, parents' age, mother's occupation and father's education do not have a statistically significant effect neither for males nor for females. Moreover, young males are less likely to smoke if their mothers have at least a high school diploma and the higher occupational category their fathers have, whereas the same variables have no statistically significant effect on female smoking behavior.[12]

[11] For the sake of brevity, we do not to report the coefficient estimates from equations 2 and 3, which are used in order to correct for the endogeneity of mother's and father's smoking indicators in equation 1.

[12] See Blow, Leicester and Windmeijer (2005) for a study focusing on the impact of socioeconomic status on

Finally, we extend our previous analyses to the case of teens living in single-parent families. Table 8 displays probit coefficient estimates on the single-parent smoking indicator for male and female teenagers. Additional regressors included are the single-parent analogous of those listed in Table 3 plus a dummy variable indicating whether the teen lives in a mother-headed or a father-headed household. As pointed out earlier, most single-parent households in our sample are mother-headed households: 84.6% (89.2) of boys (girls) living in a single-parent household are living with their mothers. Table 8 clearly indicates that both male and female teens living with a smoking parent in a single-parent household are significantly more likely to smoke if he/she smokes.

In order to easily assess how relevant these effects are, Table 9 displays the predicted probabilities of teenagers' smoking when they live in a smoking and a non-smoking environment and the associated marginal effects of parental smoking behavior. The smoking probability of boys (girls) living with non-smoking single parents is 15.8% (13.4%) and it is increased by 11.6 (12.8) percentage points in the presence of a smoking single parent, being this effect statistically significant at standard levels of testing. As in the two-parent case, single-parent smoking behavior is likely to be endogenous in the youth smoking equation if there are unobserved factors shared by parents and their children that jointly explain the smoking behavior of both. In order to overcome this issue, we use instrumental variable techniques as we have done for the two-parent case; the only difference is that now our system only has two equations rather than three as in the previous two-parent case, and 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-parent families are reported in Table 10, which indicates that, once we correct for the potential endogeneity of single parents' smoking behavior, this no longer affects boys in a statistically significant way.[13] This is consistent with the previous trivariate probit results for two-parent families because most teens living in single-parent households are actually living with their mothers. Tests for the validity of the instruments are reported at the bottom of Table 10 and show that our instruments are not weak in a statistical sense. The predicted probabilities of youth smok-

the smoking behaviour of teenagers.

[13] Coefficient estimates on the other regressors included in the estimation, not reported for the sake of brevity, are available upon request from the authors.

ing displayed in Table 11 indicate that both boys and girls living in single-parent household have a 25% probability of smoking if their parents smoke, while their smoking probability is lower (although the reduction is bigger for girls) when living with non-smoking single parents. However, this difference is only statistically significant at standard levels of testing for female teenagers, whose smoking probability is decreased by 11.4 percentage points when they live with non-smoking single parents, representing almost a 50% reduction.

5 Conclusions

We use individual data on teenagers from the BHPS (1994-2002) to analyze the intergenerational transmission of smoking habits in the UK. Our added value 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 behavior. Second, we attempt to separately assess how mothers' and fathers' smoking choices affect their female and male teenagers' smoking behavior.

Our results for two-parent families show clear evidence that there is an important degree of intergenerational transmission of smoking behavior between parents and children of the same sex. After controlling for the potential endogeneity of parental smoking, we find that mothers' and fathers' smoking habits play a statistically significant role for girls and boys, respectively. While maternal smoking does not significantly affect boys' smoking behavior, paternal smoking does not have a statistically significant impact on girls' smoking decisions. To sum up, as far as smoking behavior is concerned, girls imitate their mothers and boys imitate their fathers. The results for single-parent households indicate that single parents' smoking choices significantly affect the smoking behavior of their female teenagers, while this is no longer the case for male teenagers. Given that most single parents in our sample are actually single mothers, these findings are consistent with the results for the two-parent sample. All our results are backed up by statistical tests for the validity of the instrumental variables used to identify the model.

We believe that our findings could be useful for health policymakers. Most applied tobacco-control policies in Europe attempt to decrease youth access to smoking by increasing cigarette

prices, enacting bans on advertising or banning tobacco sales to underage children. However, youth smoking rates remain alarmingly high. Thus, given the limited success that traditional anti-smoking policies have had in reducing youth smoking, it seems reasonable to take into consideration the intergenerational parents-children link. Consequently, the success of tobacco-control policies may be increased if parental smoking behavior is considered in their design. Our main finding, that is, the existence of a cause-effect relationship between parental smoking choices and teens' smoking behavior (mainly between parents and children of the same sex), suggests that parents should be made aware of this intergenerational transmission mechanism, while future educational programs and information campaigns should actively include them.

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Table 1: Youth Smoking Rates by Parental Smoking Behaviour. Two-Parent Households

	Parental Smoking Participation			
	Only Father	Only Mother	Both	None
Youth Smoking Rates	(1)	(2)	(3)	(4)
	A. Full Sample, N=9835			
11-13	5.8	6.1	6.2	3.4
14-15	26.5	28.8	31.1	14.0
16-17	30.9	32.2	37.6	13.0
18-19	37.3	42.3	44.7	22.0
All	20.0	21.6	22.9	11.0
	B. Boys, N=4968			
11-13	5.7	5.7	6.6	2.1
14-15	25.5	26.7	30.0	12.6
16-17	35.4	34.7	38.1	12.1
18-19	42.1	43.4	44.8	24.4
All	21.1	21.5	22.7	10.6
	C. Girls, N=4867			
11-13	6.0	6.5	5.8	4.6
14-15	27.8	31.5	32.5	15.4
16-17	26.5	29.5	37.0	13.9
18-19	32.3	41.0	44.7	19.2
All	18.9	21.7	23.2	11.4

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

Table 2: Youth Smoking Rates by Parental Smoking Behaviour. Single-Parent Families

	Parental Smoking Participation	
	Single parent smokes	Single parent does not smoke
Youth Smoking Rates	(1)	(2)
	A. Full Sample, N=4,332	
11-13	9.7	4.0
14-15	34.5	23.2
16-17	43.0	20.3
18-19	52.0	26.8
All	31.04	17.1
	B. Boys, N=2,231	
11-13	11.8	4.8
14-15	34.3	20.4
16-17	41.7	26.0
18-19	54.8	30.1
All	32.3	18.5
	C. Girls, N=2,101	
11-13	7.6	3.5
14-15	34.6	26.0
16-17	44.5	15.0
18-19	48.4	23.5
All	29.6	15.7

Note: Statistics based on the sample of individual-year observations corresponding to teenagers living in single-parent households.

Table 3: Main Sample Characteristics by Parental Smoking Behaviour. Two-Parent Sample

	Parental Smoking Participation			
	Only Father	Only Mother	Both	None
Variable	(1)	(2)	(3)	(4)
Age	14.3	14.3	14.2	14.6
Male	0.51	0.53	0.53	0.50
White	0.94	0.99	0.99	0.97
Work for Pay	0.40	0.43	0.43	0.40
Household size	4.8	4.6	4.7	4.5
Log(monthly HH income)	7.6	7.7	7.6	7.9
Father's age	42.2	42.4	41.5	44.7
Mother's age	40.1	40.3	39.7	42.5
Father's education:				
More than high school	0.28	0.26	0.27	0.48
High school	0.28	0.32	0.29	0.29
Less than high school	0.44	0.42	0.45	0.24
Mother's education:				
More than high school	0.17	0.17	0.17	0.33
High school	0.38	0.39	0.33	0.39
Less than high school	0.46	0.45	0.50	0.28
Father's occupational category:				
High	0.15	0.15	0.12	0.36
Medium	0.32	0.32	0.32	0.27
Low	0.30	0.30	0.30	0.26
Not working	0.24	0.24	0.26	0.11
Mother's occupation:				
High	0.10	0.08	0.08	0.17
Medium	0.22	0.23	0.21	0.29
Low	0.36	0.40	0.40	0.30
Not working	0.33	0.29	0.32	0.24

Note: N=9,271. 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.

Table 4: Youth Smoking Probit Coefficient Estimates. Two-Parent Households

	Boys	Girls
Mother Smokes	0.287	0.311
	(0.093)	(0.086)
Father Smokes	0.286	0.182
	(0.094)	(0.085)
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 5: Predicted Probabilities of Youth Smoking by Parental Smoking Behaviour in Two-Parent Households. Results Based on Probit Estimation

A. Boys			
	$SF = 1$	$SF = 0$	
$SM = 1$	$\hat{p}_{11}$ =0.209 (0.024)	$\hat{p}_{12}$ = 0.137 (0.022)	$(\hat{p}_{11} - \hat{p}_{12})$ =0.072 (0.022)
$SM = 0$	$\hat{p}_{21}$ =0.136 (0.019)	$\hat{p}_{22}$ =0.083 (0.010)	$(\hat{p}_{21} - \hat{p}_{22})$ =0.050 (0.017)
	$(\hat{p}_{11} - \hat{p}_{21})$ = 0.072 (0.024)	$(\hat{p}_{12} - \hat{p}_{22})$ =0.053 (0.020)	$(\hat{p}_{11} - \hat{p}_{22})$ =0.126 (0.018)
B. Girls			
	$SF = 1$	$SF = 0$	
$SM = 1$	$\hat{p}_{11}$ =0.208 (0.024)	$\hat{p}_{12}$ =0.159 (0.023)	$(\hat{p}_{11} - \hat{p}_{12})$ =0.048 (0.022)
$SM = 0$	$\hat{p}_{21}$ =0.130 (0.018)	$\hat{p}_{22}$ =0.095 (0.011)	$(\hat{p}_{21} - \hat{p}_{22})$ =0.034 (0.017)
	$(\hat{p}_{11} - \hat{p}_{21})$ =0.077 (0.022)	$(\hat{p}_{12} - \hat{p}_{22})$ =0.064 (0.020)	$(\hat{p}_{11} - \hat{p}_{22})$ =0.112(0.025)

Note: Standard errors, in round brackets, have been computed using the delta method. $\hat{p}_{11} = \frac{\sum_{i=1}^{N} \Pr(SY_i=1|SM_i=1,SF_i=1,Xi)}{N}$, $\hat{p}_{12} = \frac{\sum_{i=1}^{N} \Pr(SY_i=1|SM_i=1,SF_i=0,Xi)}{N}$, $\hat{p}_{21} = \frac{\sum_{i=1}^{N} \Pr(SY_i=1|SM_i=0,SF_i=1,Xi)}{N}$, $\hat{p}_{22} = \frac{\sum_{i=1}^{N} \Pr(SY_i=1|SM_i=0,SF_i=0,Xi)}{N}$

Table 6: Youth Smoking Trivariate Probit Coefficient Estimates. Two-Parent Households

	Boys	Girls
Mother Smokes	0.209	0.319
	(0.161)	(0.123)
Father Smokes	0.334	0.083
	(0.156)	(0.118)
N	4698	4573
Likelihood ratio test of $\rho(YS) = \rho(MS) = \rho(FS) = 0$	394.694	418.324
F- test of Instruments in MS	334.74[17]	27.78 [17]
F- test of Instruments in FS	22.25[17]	30.99 [17]
Partial R^2 (excluded instruments) in MS	0.018	0.074
Partial R^2 (excluded instruments) in FS	0.045	0.223

Note: Standard errors, displayed in round brackets, are clustered by individual. Degrees of freedom are reported in square brackets.

Table 7: Predicted Probabilities of Youth Smoking by Parental Smoking Behaviour in Two-Parent Households. Results Based on Trivariate Probit Estimation

A. Boys			
	$SF = 1$	$SF = 0$	
$SM = 1$	$\hat{p}_{11}$ =0.203 (0.045)	$\hat{p}_{12}$ =0.122 (0.028)	$(\hat{p}_{11} - \hat{p}_{12})$ =0.081 (0.041)
$SM = 0$	$\hat{p}_{21}$ = 0.149 (0.029)	$\hat{p}_{22}$ =0.085 (0.013)	$(\hat{p}_{21} - \hat{p}_{22})$ =0.064 (0.032)
	$(\hat{p}_{11} - \hat{p}_{21})$ =0.054 (0.043)	$(\hat{p}_{12} - \hat{p}_{22})$ =0.037 (0.031)	$(\hat{p}_{11} - \hat{p}_{22})$ =0.118 (0.053)
B. Girls			
	$SF = 1$	$SF = 0$	
$SM = 1$	$\hat{p}_{11}$ =0.190 (0.033)	$\hat{p}_{12}$ =0.168 (0.029)	$(\hat{p}_{11} - \hat{p}_{12})$ =0.022 (0.031)
$SM = 0$	$\hat{p}_{21}$ =0.115 (0.020)	$\hat{p}_{22}$ =0.100 (0.013)	$(\hat{p}_{21} - \hat{p}_{22})$ =0.015 (0.022)
	$(\hat{p}_{11} - \hat{p}_{21})$ =0.074 (0.031)	$(\hat{p}_{12} - \hat{p}_{22})$ =0.062 (0.029)	$(\hat{p}_{11} - \hat{p}_{22})$ =0.090(0.039)

Note: See note to Table 5

Table 8: Youth Smoking Probit Coefficient Estimates. Single-Parent Households

	Boys	Girls
Single Parent Smokes	0.4019	0.47180
	(0.098)	(0.102)
N	2,231	2,101

Note: Standard errors, displayed in round brackets, are clustered by individual. Additional control variables included in the estimation are the single-parent analogous of those listed in Table 3 plus a dummy variable indicating whether the teen lives in a mother-headed or a father-headed household

Table 9: Predicted Probabilities of Youth Smoking by Parental Smoking Behaviour in Single-Parent Households. Results Based on Probit Estimation

	Boys	Girls
$SP = 1$	$\hat{p}_1 = 0.275$ (0.024)	$\hat{p}_1 = 0.263$ (0.025)
$SP = 0$	$\hat{p}_2 = 0.159$ (0.016)	$\hat{p}_2 = 0.134$ (0.015)
	$(\hat{p}_1 - \hat{p}_2) = 0.116$ (0.029)	$(\hat{p}_1 - \hat{p}_2) = 0.129$ (0.029)

Note: Standard errors, in round brackets, have been computed using the delta method. $\hat{p}_1 = \frac{\sum_{i=1}^{N} \Pr(SY_i=1|SP_i=1,Xi)}{N}$, $\hat{p}_2 = \frac{\sum_{i=1}^{N} \Pr(SY_i=1|SP_i=0,Xi)}{N}$,where SP is the single-parent smoking indicator.

Table 10: Youth Smoking Bivariate Probit Coefficient Estimates. Single-Parent Households

	Boys	Girls
Single Parent Smokes	0.291	0.419
	(0.198)	(0.203)
N	2231	2101
Likelihood ratio test of $\rho(YS) = \rho(MS) = \rho(FS) = 0$	0.698	0.152
F- test of Instruments in PS	318.80 [17]	30.63 [17]
Partial R^2 (excluded instruments) in PS	0.518	0.306

Note: Standard errors, displayed in round brackets, are clustered by individual. Degrees of freedom are reported in square brackets.

Table 11: Predicted Probabilities of Youth Smoking by Parental Smoking Behaviour in Single-Parent Households. Results Based on Bivariate Probit Estimation

	Boys	Girls
$SP = 1$	$\hat{p}_1$ =0.254 (0.1977)	$\hat{p}_1 = 0.253$ (0.040)
$SP = 0$	$\hat{p}_2$ =0.171 (0.025)	$\hat{p}_2 = 0.139$ (0.022)
	$(\hat{p}_1 - \hat{p}_2) = 0.084$ (0.057)	$(\hat{p}_1 - \hat{p}_2)$ =0.114 (0.056)

Note: See note to Table 9.

APPENDIX

Table 12: Trivariate Probit Coefficients Estimates. Two-Parent Sample

	Females		**Males**	
Variable	*Coeff.*	*Std. Error*	*Coeff.*	*Std. Error*
Father smokes	0.083	0.118	0.334	0.156
Mother smokes	0.319	0.123	0.209	0.161
Teenager's age	0.151	0.015	0.189	0.015
Teenager works for pay	0.136	0.061	0.159	0.063
Log(monthly HH income)	-0.024	0.067	0.110	0.071
White	0.784	0.275	0.443	0.227
Household size	-0.033	0.037	-0.028	0.037
Area of residence				
Rest of South East	0.697	0.220	0.480	0.227
Scotland	0.293	0.226	0.185	0.224
Wales	0.415	0.216	0.393	0.225
Rest of England	0.609	0.205	0.393	0.210
London	0.649	0.249	0.482	0.253
Parents' age				
Father's age	-0.005	0.008	-0.008	0.009
Mother's age	-0.009	0.010	0.002	0.011
Father's education				
More than high school	0.001	0.100	-0.081	0.104
High school	-0.158	0.101	-0.150	0.105
Mother's education:				
More than high school	-0.183	0.116	-0.231	0.115
High school	-0.005	0.091	-0.156	0.093
Father's occ. category:				
High	-0.035	0.135	-0.335	0.147
Medium	-0.081	0.117	-0.265	0.129
Low	-0.070	0.120	-0.230	0.126
Mother's occ. category:				
High	-0.156	0.143	0.083	0.128
Medium	-0.025	0.107	0.023	0.105
Low	-0.024	0.097	0.117	0.096
N. Obs.	4,573		4,698	

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