Home Computer Use and the Development of Human Capital

Ofer Malamud
University of Chicago and NBER

Cristian Pop-Eleches*
Columbia University, BREAD, NBER

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Abstract

This paper uses a regression discontinuity design to estimate the effect of home computers on child and adolescent outcomes. We collected survey data from households who participated in a unique government program in Romania which allocated vouchers for the purchase of a home computer to low-income children based on a simple ranking of family income. We show that children in households who received a voucher were substantially more likely to own and use a computer than their counterparts who did not receive a voucher. Our main results indicate that that home computer use has both positive and negative effects on the development of human capital. Children who won a voucher had significantly lower school grades in Math, English and Romanian but significantly higher scores in a test of computer skills and in self-reported measures of computer fluency. There is also evidence that winning a voucher increased cognitive ability, as measured by Raven's Progressive Matrices. We do not find much evidence for an effect on non-cognitive outcomes. Finally, the presence of parental rules regarding computer use and homework appear to mitigate the effects of computer ownership, suggesting that parental monitoring and supervision may be important mediating factors.

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1 Introduction

The development of the personal computer in the late 1970s enabled households to purchase a computer for the home, and children to gain access to an important new technology. At present, over three-quarters of all American children aged 3 to 17 years live in a household with a computer. (U.S. Census Bureau, 2005) However, large disparities in computer ownership by race and family income remain. Data from the 2003 Current Population Survey (CPS) indicate that less than half of children with family incomes under $25,000 lived in a household with a computer, compared to 92 percent of those with family incomes over $100,000. Furthermore, access to computer technology is far less common among children in developing countries, and the disparities between the rich and poor are often much greater. Estimates from the OECD's 2003 Programme for International Student Assessment (PISA) show that most 15 year old students in developed countries have access to a computer at home (91 percent in the United States). In contrast, only about half of 15 year old students have access to a home computer in emerging Eastern European countries such as Poland, Latvia and Serbia.[1] Among 15 year olds in the bottom SES quartile within these countries, fewer than a quarter have access to a home computer.[2] (OECD, 2005)

Many government and non-governmental organizations are trying to bridge this "digital divide" across nations and between households. For example, Brazil embarked on some of the earliest government-run initiatives to bring inexpensive computers to its citizens. In 2003, the government announced a plan to encourage domestic manufacturers to develop inexpensive consumer PCs for Brazilians with incomes between $140 and $1,400 USD. (Rebelo, 2005) The One Laptop per Child (OLPC) program has received substantial publicity in its efforts to develop a cheap laptop computer suitable for children in developing countries. Uruguay has already completed its *Plan Ceibal* by providing a free OLPC laptop to every primary school child, while other countries, such as Peru and Columbia, have placed orders for hundreds of thousands of computers. (de Russe, 2009) Even

[1] This is probably an understatement of cross-country disparities in access since 15 year olds who remain enrolled in school in developing countries are more likely to come from advantaged family backgrounds.

[2] This fraction is substantially lower for less-developed countries such as Thailand, Tunisia, and Turkey, and essentially zero for countries in sub-Saharan Africa and parts of south Asia.

in cases where these computers are provided for school use, they are also intended to serve as home computers.[3] However, these major efforts to increase computer access among children are happening despite relatively little credible evidence regarding the effect of home computers on children's educational and behavioral outcomes.

The risks and benefits of increased computers use among children have been a matter of substantial public debate. As with concerns about television, many have expressed the worry that children might become "addicted" to interactive computer products.[4] Some negative physical consequences are clearly associated with long periods of computer use, such as repetitive strain injuries, eye strain, and increased risk of obesity. Excessive computer use is also hypothesized to lead to decreased social involvement and isolation. If computers are used for playing games or for accessing the Internet, children may be exposed to adult content that can have detrimental effects on social and behavioral outcomes. More generally, it is possible that time spent on a computer displaces other activities more valuable from a developmental perspective. On the other hand, computers may help introduce children to an important new technology. This may foster the development of computer skills which lead to better labor market outcomes as adult.[5] Computers may also facilitate learning through the use of educational software. Indeed, in contrast to television, the interactive nature of computer technology has often been viewed with great promise.[6] Since computers represent such a versatile technology, the potential risks and benefits are highly dependent on the availability of different types of software and the patterns of actual use. Indeed, evidence from the 2003 CPS indicates that 83 percent of American children aged 3 to 17 with a computer at home used it to play games, the most common single use. (U.S. Census Bureau, 2005) Moreover, in considering the effect of *home* computers on child and adolescent outcomes, parental involvement

[3] The chairman of OPLC, Nicholas Negroponte, explains that "mobility is important, especially with regard to taking the computer home at night.....bringing the laptop home engages the family." http://laptop.org/faq.en_US.html

[4] Nevertheless, recent evidence on the effect of early exposure to television on test scores suggests that (1950s) television did not lead to lower cognitive achievement. (Gentzkow and Shapiro, 2008) In related studies, Olken (2009) finds that television and radio reduces social participation in Indonesia while Jensen and Oster (2009) show that access to cable TV improves women's status in India.

[5] Krueger (1993) estimated a large wage premium among Americans who use a computer at work. However, DiNardo and Pishke (1997) have cast some doubt on whether these represent causal estimates for the effect of computer use by taking advantage of more detailed information on work activities from Germany.

[6] See Wartella and Jennings (2000) for comparisons between computers and more traditional media.

and monitoring may be especially important mediating factors.[7]

This paper seeks to provide a credible estimate for the effect of access to a home computer on the development of human capital for children and adolescents from disadvantaged households. We analyze a government program administered by the Romanian Ministry of Education which subsidized the purchase of home computers. The program awarded approximately 35,000 vouchers worth 200 Euros (about $300) in 2008 towards the purchase of a personal computer for low-income students enrolled in Romania's public schools. Similar to programs in other countries, the Euro 200 program was intended to increase home computer use among disadvantaged families and promote computer skills for school-aged children. Since the fixed number of vouchers were allocated based on a simple ranking of family income, we employ a regression discontinuity design that allows comparisons across students very similar in family income and other respects, but markedly different in their access to a computer at home. Using data that we collected through in-person household interviews, we estimate the impact of winning a program voucher on computer ownership and use, academic achievement, cognitive assessments, computer skills, and various behavioral outcomes.

Our findings indicate that home computer use has both positive and negative effects on child outcomes. We find that winning a voucher increased the likelihood of households owning a home computer by over 50 percentage points, making them almost twice as likely to own a computer as compared to households who had incomes above the program threshold. As expected, higher rates of computer ownership also led to increased computer use, with children in households who won a voucher using computers about 3 to 4 hours a week more than their counterparts who did not win a voucher. We find strong evidence that children in households who won a voucher had significantly lower school grades in Math, English and Romanian, with most estimates clustered around an effect size of 1/3 of a standard deviation. On the other hand, we estimate that children in household who won a voucher had significantly higher scores in a test of computer skills and in self-reported measures of computer fluency, with effect sizes of about 1/3 of a standard deviation.

[7] In their qualitative study of home computer use, Giacquinta et. al. (1993) find that children engaged in educational computing only if parents took a very active role in selecting software and spending time with the children at the computer. When left on their own, most of the children in their sample only used home computers for games and regarded educational programs as boring.

There is also some evidence that winning a voucher increased cognitive ability, as measured by a Raven's Progressive Matrices test. We do not find much evidence that winning a computer voucher affects behavioral outcomes. In summary, home computers use has an important impact on the development of human capital. Although less precise, the same pattern of results holds for a smaller sample of households who received a computer voucher four years earlier, suggesting that our main findings persist over time.

These results may not be so surprising given that few parents or children report having educational software installed on their computer, and few children report using the computer for homework or other educational purposes. Instead, most computers had games installed and children reported that most of the computer time was spent playing games. There is also some evidence that winning a computer voucher reduced the time spent doing homework, watching TV, and reading. Interestingly, we find evidence that the presence of parental rules regarding homework mitigate some of the negative effects of winning a computer voucher without affecting the gains to computer skills and cognitive ability. On the other hand, the presence of rules regarding computer use reduce the positive impacts on computer skills without improving academic achievement. Although these results are merely suggestive since such rules are not randomly assigned, they may indicate that encouraging homework is more effective than restricting computer use.

The paper is organized as follows: Section 2 discusses the related literature regarding the effect of home (and school) computers on child and adolescent outcomes. Section 3 provides background on the Euro 200 program. Section 4 describes the data collection effort and the resulting data. Section 5 explains the empirical strategy which underlies the analysis. Section 6 presents the results and Section 7 concludes.

2 Related Literature

There is a small but growing literature examining the effect of home computer use on educational outcomes using readily available survey data. Attewell and Battle (1999) use the 1988 National Educational Longitudinal Survey (NELS-88) to show that having a home computer is associated

with higher test scores in Math and reading. Fairlie (2005) use data from the Computer and Internet Use Supplement to the 2001 CPS to show that having access to a home computer is also associated with a higher likelihood of being enrolled in school. While the raw difference in school enrollment between teenagers with and without home computers is over 10 percentage points, the differential is only 1.4 percentage points after controlling for family income, parental education, parental occupation and other background characteristics. This indicates that selection on observable characteristics is quite substantial in this setting, and suggests that selection on unobserved characteristics may lead to even further bias. Beltran, Das, and Fairlie (2010) extend this work using the 2000-2003 CPS Supplements and National Longitudinal Survey of Youth (NLYS) 1997 to find that teenagers with home computers are 6 to 8 percentage points more likely to graduate from high school.[8] Although they attempt to address the possibility of omitted variables by using parental use of the Internet at work and the presence of another teenager in the household as instruments, the resulting estimates are statistically insignificant and there are plausible reasons why the exclusion restrictions may be violated.

Fuchs and Woessmann (2004) estimate the relationship between the availability of home computers and student achievement in Math and reading tests using PISA data. They observe that the positive correlation between home computers and student performance actually becomes negative once they control for detailed student, family and school characteristics. While they recognize that this analysis remains "descriptive rather than causal," they maintain that these estimates should be closer to the true causal effect from an exogenous variation in computer availability. Several recent papers exploit randomized experiments in order to address some of the concerns regarding causal inference. Fairlie and London (2009) conduct a field experiment in which financial aid students attending a large college in Northern California were randomly selected to receive free home computers. While they find some positive effects of providing computers on educational outcomes and self-reported computer skills, their estimates lack sufficient precision to enable strong inferences. Servon and Kaestner (2008) examine the impact of providing a home computer and Internet service

[8] Schmitt and Wadsworth (2004) also provide evidence of a positive relationship between home computer ownership and subsequent academic achievement in Britain using the British Household Panel Survey (BHPS).

to low- and moderate-income families on their use of financial services but find little evidence of program effects.

Evidence concerning the effect of computer use in school on educational attainment is also mixed. Angrist and Lavy (2002) find that the quasi-random installation of computers in Israeli schools did not lead to improvements in Math test scores. Barrera-Osorio and Linden (2009) conduct a randomized evaluation of a Colombian program to integrate computers into public schools but find little effect on student test scores and other outcomes. In related work, Goolsbee and Guryan (2006) show that Internet and communications subsidies in US schools (through the E-rate program) led to increased Internet investment but did not lead to improved student test scores. Rouse and Krueger (2004) present evidence from a randomized experiment showing that an instructional reading computer program improved certain limited aspects of students language skills but did not improve broader language abilities. In contrast, a recent study by Barrow, Markman and Rouse (2010) evaluated a randomized experiment which provided computer instruction in algebra and found significant effects on Mathematics achievement. Finally, Banerjee et. al. (2007) examine the effect of an computer-assisted learning program in India which offered children two hours of computer time per week to play games that involve solving Math problems. They find a positive effect of computer use on Math test scores, suggesting that closely targeted computer instruction may be beneficial.

Closely related to research on educational outcomes, the psychological literature has explored the effect of computer and internet use on children's time-use, as well as cognitive and behavioral outcomes. Subrahmanyam et. al. (2000, 2001) review some findings from recent US-based studies: children with a computer at home spend more time using it and substitute away from watching television (Kraut et al., 2001; Stanger, 1998); children playing computer based games display higher levels of spatial ability (Subrahmanyam and Greenfield, 1994); effects on social and behavioral outcomes are quite mixed. Again, the possibility of omitted variables implies that these findings are merely suggestive. However, these cognitive and non-cognitive (social and behavioral) outcomes may play an important role in enhancing educational outcomes.

3 The Euro 200 Program

The voucher program, widely known as the Euro 200 program in Romania, was proposed by the Prime Minister's office and adopted by unanimous vote in Parliament in June 2004 as Law 269/2004. According to the law, the official purpose of the program was to establish a mechanism to increase the purchase of computers through financial incentives based on social criteria, in order to promote competence in computing knowledge. Over time, the government expanded the resources allocated to the voucher program: thus, whereas 25,051 families received vouchers in 2004, the number of awards increased to 27,555 in 2005, 28,005 in 2006, 38,379 in 2007, and 35,484 in 2008. The proportion of applicants who received computers also changed over time with about 20% in 2004, 53% in 2005, 96% in 2006, 100% in 2007, and 68% in 2008.[9] The rules of the program specified the minimum specifications of computers purchased using the vouchers. In 2008, computers had to be new and equipped with at least a 2 GHz processor, 1GB RAM memory, 160 GB hard-disk with a keyboard, mouse and monitor, as well as some pre-installed software.

In the early rounds of the Euro 200 program, the 200 Euro (roughly $300) subsidy already covered a large fraction of the cost a new computer that met the minimum specifications. For example, in 2005, the voucher covered about 75 percent of the price of a system at Romania's largest computer retailer, who sold almost 40 percent of the program computers. (Comunicatii Mobile, 2005) However, with the gradual reduction of computer prices over time, the voucher was able to cover even higher fraction of the cost. Indeed, by 2007, two of the largest computer retailers were able to offer computers that met the minimum specifications for 200 Euro. (Ministry of Education, 2007). Thus, it is not surprising that according to data from the Ministry of Education, 99 percent of the issued vouchers in the regions included in our study were converted into computer purchases by the recipients.

The program was targeted towards children from low income families.[10] To be eligible to apply

[9] Conseequently, we are not able to examine the 2006 and 2007 rounds of the Euro 200 program using a similar research design.

[10] There is evidence that among children who took the national exam at the end of grade 8, those who participated in the Euro 200 program scored about 0.3 standard deviations below the national average.

for the program, a household was required to have at least one child under the age of 26 enrolled in grades 1 to 12 of a private or public school or attending university. At the same time only households with monthly family income per household member of less than 150 RON (around $65) were eligible to apply. The calculation of income included all permanent sources of income of family members in the month prior to the application, with the exception of unemployment benefits, state support for children, merit scholarships and social scholarships.[11] In 2008, 52,212 households applied for the program and met the threshold. Following the application deadline, all the applicants were ranked based on their family income per household member. Since the government had a limited budget, it restricted the number of vouchers to 35,484 in the 2008 program round, which corresponded to a maximum income of 62.58 RON (about $27).[12] Neither the number of winners nor the income threshold was known to the applicants in advance. This feature of the program is essential for implementing the regression discontinuity design which enables us to compare students with incomes close to the 62.58 RON threshold who experienced a discontinuity in access to a home computer.

In order to encourage the use of these computers for educational purposes, the Ministry of Education also offered 530 multimedia educational lessons to voucher winners. The lessons included subjects such as Math, biology, physics, geography, computer science, history and chemistry for different grades and were developed under the guidelines of the Ministry of Education in accordance with the national teaching curriculum. Computer retailers who participated in the Euro 200 program were encouraged to install these lessons at no charge on the computers of program winners. However, as revealed by our household survey, relatively few parents report having educational software installed on their computer, and few children report using the computer for educational purposes.

[11] The application form included several explicit warnings against reporting false incomes and families needed to provide supporting documentation along with the application.

[12] Vouchers were issued in the name of the child, and therefore not transferable. While it is possible that families, in turn, sold their computer to other buyers, we show that most voucher winners actually kept their computers.

4 Data

The data used in this paper come from a 2009 household survey that we conducted with families who applied to the 2008 round of the Euro 200 program.[13] In order to conduct the survey, we obtained a list of 6,418 families who participated in the Romanian regions of Arad, Bistrita-Nasaud, Braila, Cluj, Maramures, Mures and Sibiu.[14] This list contained the names of the parents and child who applied to the program, the place of residence and the name of the child's school. It also included information on the income per family member in the month prior to the application deadline, which is essential for implementing our regression discontinuity design. With the help of Gallup Romania, we attempted to locate and interview each of these families in person. We succeeded in interviewing 3,354 families for a response rate of 52%, which is in line with Gallup's interview rate for this population.[15] While the resulting sample is not completely representative of the program applicant pool or the population of these counties more generally, we found no evidence that response rates differed between households who won vouchers and their counterparts who did not receive vouchers.

The household survey had three separate components. First, we interviewed the family in order to obtain demographic information about each member of the household and basic household characteristics, including information about computer ownership. Second, we surveyed the primary caregiver to elicit information on child outcomes for each child in the family. Third, we conducted a separate interview with each child present at home on the day of the survey. Both the parental and the child questionnaires included questions about our main variables of interest, such as computer ownership and use, time-use patterns, academic achievement, and the presence of behavioral problems. In addition, we administered a cognitive ability test, a computer test, and a battery of computer fluency questions to the children present at home on the day of the survey.

[13] The survey was conduct in the spring of 2009, between May and June, while most children were still in school.

[14] These regions are quite representative of Romania. We did not find a difference between the regions in our study as compared to the rest of the country in terms of area, population, income per capita as well as program characteristics such as number of applicants and percent winners.

[15] At the same time, we also conducted identical interviews with applicants to the 2005 round of the Euro 200 from the regions of Covasna and Valcea. For this sample, the original list included 1,554 families and we managed to conduct 647 interview, yielding a somewhat lower response rate of 42%.

Panel A of Table 1 presents summary statistics for the main household variables. Average monthly income per household member is about 48 RON, which translates into approximately $20. Since the program was targeted towards low income families, it is not surprising that the sample population is predominantly rural and has comparatively low levels of educational attainment.[16] Among our 3,356 applicant families, 64.7 percent received a voucher in the 2008 round of the Euro 200 program and 98.6 percent of the awarded vouchers were cashed according to records by the Ministry of Education. About 73 percent of all households own a computer, indicating that about one third of households who did not qualify for a voucher in the 2008 round had a computer in the spring of 2009. Computers are reported to be turned on for an average of 1.5 hours each day, or about 2 hours conditional on having a computer. Interestingly, 65 percent of households have games installed on their home computer, or 87 percent of those who own a computer. In contrast, only about 9 percent of households have educational software installed on their home computer, despite the fact that educational software was made available from the Ministry of Education at no cost. Access to the Internet is limited to just 14 percent of households. Thus, when interpreting our results, it is important to keep in mind that the voucher program increased computer access without much of an effect on Internet access.

Panel B of Table 1 presents parental reports on time-use, academic, and behavioral outcomes for about 5,900 children.[17] The sample of children is pretty evenly split between boys and girls and ranges from 7 to 22 years of age (with only 3 percent above the age 19). On average, parents report that children use a computer about 5 hours a week, or over 6 hours a week conditional on having a home computer. For measures of time spent doing homework, watching TV, and reading, we focus on a binary variable indicating daily use: whether children spent more than 1 hour a week engaged in that activity. Academic outcomes consist of average school grades during the 2008-09 academic year in the subjects of Math, Romanian, and English, as well as a school behavior grade. All subjects are graded out of 10, with grades in Math, Romanian, and English averaging about 7.5, and with

[16] Compared to national averages, our sample contains a somewhat larger fraction of Hungarians reflecting the fact that one of the counties (Mures) has a large Hungarian majority.

[17] We allowed the head of household to report on up to 5 children. This sample censoring affects only 29 families who report having between 6 and 11 children.

the vast majority of students receiving a 10 in behavior. We also asked parents if their children had exhibited various behavior problems during the past three months. We created an index for the fraction of the problems that were reported to be "sometimes" or "often" true of the child, as opposed to "not true" for the following behaviors: trouble getting along with teachers, disobedience at home, disobedience at school, hanging around with troublemakers, bullying others, inability to sit still, and whether the child prefers to be alone.[18] Finally, we elicited information about children's height and weight to form measures of BMI, as well as information about participation in sports and service.

Table 2 presents summary statistics based on 4,600 child interviews for time-use, academic, and behavioral outcomes, as well as cognitive and computer assessments. Average age and child gender in the child surveys are very similar to those in the parent surveys. Children also report doing homework and watching TV at similar frequencies to those reported by parents. In addition, we asked children about the daily use of their computers for games, homework, and educational activities. Almost 20 percent of children report that they play games every day. In contrast, only 1.5 percent of children report that they use the computer for homework every day and less than 1 percent report using educational software every day. Average grades in Math, Romanian, and English are also comparable to parent reports. In a later section, we examine the degree of correspondence between child and parent reports for different questions in greater detail.

We also administered an un-timed cognitive ability test based on Raven's Progressive Matrices, which is standardized with a mean of 0 and standard deviation of 1.[19] This test is designed to assess general intelligence by measuring the ability to form perceptual relations and to reason by analogy independent of language and formal schooling. (Raven, 1939, 1956) However, a number of scholars have argued that the test also measures an important spatial component of ability.[20] We also

[18] The questions are based on items used in the National Health Interview Survey and the National Longitudinal Survey of Youth Children's Supplement (NLSY-CS). As in recent MTO evaluations (Katz, Kling, and Leibman, 2001), we focus on seven questions that asked about behaviors which the mothers could observe directly, as opposed to generic questions about behavior or questions requiring intuition about how their child was feeling.

[19] This is comprised of two different sets of test questions: one given to children aged 5-12 and another given to children aged 13 and over. The test instrument is based on the one administered to respondents of the Mexican Family Lifestyle Survey (MxFLS) (http://www.mxfls.cide.edu/).

[20] See, for example, Burke (1958) and Hunt (1975). Some more recent work in psychology tries to explain the small

administered a computer test and elicited self-reported computer fluency. The computer literacy test contained 12 multiple-choice questions intended to capture a measure of computer skills (the Data Appendix contains a full description of the computer test). Self-reported computer fluency was obtained by asking children to report on their knowledge of different tasks related to operating a computer, using applications, as well as email and the internet use (again, the Data Appendix contains the full set of computer fluency questions). These questions are based on a computer-email-web (CEW) fluency scale by Bunz (2004) and validated by Bunz et. al. (2007) with their actual abilities performing related tasks in an applied computer-lab session.[21] We report the raw fluency scores ranging from 1-4 but we normalize the scales to a mean of 0 and standard deviation of 1 in the regression analysis. We also conducted a 10 item Rosenberg Self-Esteem Scale in order to provide a self-reported measure of non-cognitive skills.[22] Finally, we asked children about their health status, problems with pain in the hands, perception of overweight or underweight, and the frequency of smoking and drinking of alcohol.

5 Empirical strategy

We employ a regression discontinuity (RD) design to estimate the effect of providing a computer voucher to low-income students enrolled in Romania's public schools in 2008. Since these computer vouchers were allocated according to a simple income cutoff, we are able to compare outcomes across families with similar income and other characteristics, but very different levels of computer ownership. This corresponds to a "sharp" RD design and the basic regression model used through the analysis is as follows:

$$outcome_i = \beta' \mathbf{X}_i + \delta winner_i + f\left(income_i\right) + \varepsilon_i \tag{1}$$

but consistent sex differences in Raven's Progressive Matrices test in terms of a spatial component of ability; for example Colom et. al. (2004) and Lynn et. al. (2004).

[21] These questions were based in large part on work by Bunz (2004) to develop and validate a computer-email-web (CEW) literacy scale. Bunz et. al. (2007) show that computer fluency

[22] The Rosenberg test consists of 10 statements related to overall feelings of self-worth or self-acceptance. The items are answered on a four-point scale which ranges from "strongly agree" (1) to "strongly disagree" (4). Summing the ratings after reverse scoring the negatively worded items, scores range from 10 to 40, with higher scores indicating lower self-esteem.

where $outcome_i$ represents a particular child outcome such as computer use or GPA by child i. $\mathbf{X}_i$ includes a set of control variables: age, ethnicity, gender, and educational attainment of the head of household, as well as child gender and age dummies. In practice, these control variables have very little effect on our estimates of the discontinuity and serve mainly to increase precision. $winner_i$ is an indicator variable equal to 1 if monthly household income per capita is less than the cut-off of 62.58 RON, and 0 otherwise. The coefficient δ, our main coefficient of interest, indicates the effect of receiving a Euro 200 computer voucher on the relevant outcome. Finally, $f(income_i)$ is a smooth function of income, which is the forcing variable in the context of this regression discontinuity design.

The central question for implementing this empirical strategy is how to model $f(income_i)$. We consider both parametric and non-parametric functions of income to explore the robustness of our findings to a variety of functional form assumptions. For our parametric specifications, we focus on linear, quadratic, and cubic models, allowing the slope of these functions to vary on each side of the cutoff (i.e. linear, quadratic and cubic splines). For our non-parametric specifications, we follow Hahn, Todd, and van der Klaauw (2001) and Porter (2003) by using local linear regressions to estimate the left and right limits of the discontinuity, where the difference between the two is the estimated treatment effect. We estimate this in one step using a simple rectangular kernel. Although a triangular kernel, by putting more weight on observations closer to the cutoff point, has been shown to be boundary optimal (Chang, Fan, and Marron, 1997), Lee and Lemuiex (2009) argue that a more transparent way of putting more weight on observations close to the cutoff is to re-estimate a model with a rectangular kernel using smaller bandwidths. We follow Lee and Lemuiex and implement a simple rectangular kernel. However, as in much of the earlier research, our results are not very sensitive to the choice of kernel (Fan and Gijbels, 1996).

A more consequential decision is the choice of bandwidth. Given the absence of a widely agreed-upon method for the selection of optimal bandwidths in the non-parametric RD context, we follow Ludwig and Miller (2007) and present results for a broad range of candidate bandwidths. Our preferred estimates are based on a bandwidth of 30 which appears to balance the goal of staying

relatively local to the cutoff while providing enough data to yield informative estimates. However, we also consider bandwidths that are twice (60), half (15) and one fourth (7.5) the size of our preferred bandwidth. In addition, we present two alternative approaches for estimating the optimal bandwidth: (i) a modified cross-validation (CV) procedure, as described by Ludwig and Miller (2005) and Imbens and Lemuiex (2007);[23] and (ii) the Imbens-Kalyanarman (IK) optimal bandwidth, as described by Imbens and Kalyanarman (2009).[24] The specific bandwidths determined according to these procedures differ for each outcome, but most IK bandwidths range from 5-10 whereas most CV bandwidths range from 20-40.[25] Finally, we follow Imbens and Lemuiex (2007) and Lee and Lemuiex (2009) by presenting standard robust errors, but cluster by household when running regressions at the child level to allow for within-household correlations.[26]

The central assumption underlying the RD design is that we have correctly specified the function of income (the forcing variable) which determines assignment of the computer voucher. However, another important assumption is that households were not able to manipulate the forcing variable, by reporting a lower income. While it is possible that some families under-reported their income level, we do not believe that cheating represents a serious concern.[27] The minimum cut-off of 62.58 RON for the voucher program was not known ex-ante; it was determined by the amount of funds available and by the number of households who applied and their corresponding income, none of which were known prior to the start of the program. Moreover, in the previous rounds of 2006 and 2007, essentially all household who applied ended up receiving vouchers. Consequently, there was a strong reason for families to believe that they would receive a voucher even if they reported income close to the upper limit for eligibility. We offer an explicit test for manipulation of the

[23] The cross-validiation (CV) procedure is implemented by examining prediction errors for each data point within 10 RON of the income cutoff. Specifically, we generate a loss function of the average boundary prediction error, where the predicted values of datapoints to the left (right) of the cutoff are based on local linear regressions using data only to the left (right) of these points. We create this loss function for bandwidths ranging from 1 to 50 and select the one which minimizes loss. This procedure is implemented separately for each outcome variable.

[24] The IK bandwidth selection procedure is implemented using the Stata ado file named rdob.ado (available on Imbens' website).

[25] Having plotted graphs of our dependent variables by income, it appears that the IK bandwidths are undersmoothing the data due to the extremely small bandwidths.

[26] Using analytic standard errors derived based on the formula provided by Porter (2003) does little to alter our inferences. However, these do not account for the possibility of correlated observations within-household.

[27] As mentioned previously, the Euro 200 application form included stern warnings against any attempt to falsify information on income.

forcing variable along the lines of McCrary (2007) in a subsequent section.

Note that we restrict most of our analysis to the reduced-form effects of winning a voucher. Some families who did not win a voucher in 2008 may have already owned a computer or decided to buy a computer after finding out that they would not receive one as part of the government program. However, we do not know exactly when these computers were purchased so there may be variation in the exposure to computer ownership that isn't captured by observed ownership in 2009 at the time of the survey. Households who did not win a voucher but purchased a computer just prior to the time of the survey will have had a much shorter exposure to computers than the households who won a voucher and received computers in the summer of 2008. So instrumenting for computer ownership with having received a voucher would not "scale up" our estimates in the appropriate fashion. Nevertheless, although we focus on the reduced-form effects, we will also present (naive) two-stage least squares (2SLS) estimates for our main outcomes in a subsequent section.

6 Main Results

We present our main results by showing 6 different non-parametric specifications (bandwidths of 60, 30, 15, 7.5, as well as the Imbens-Kalyanaraman (IK) and cross-validation (CV) optimal bandwidths) and 3 different parametric specifications (linear, quadratic and cubic splines) for each outcome.[28] All our regressions include age, ethnicity, gender, and educational attainment of the head of household, as well as child gender and age dummies. As mentioned earlier, our preferred estimates are based on a non-parametric bandwidth of 30 which appears to balance the goal of staying relatively local to the cutoff while providing enough data to yield informative estimates. Consequently, we also display graphs of our main outcomes using local linear regressions with a bandwidth of 30. These plot fitted values of residuals from local linear regressions of the main outcomes on our standard set of controls (where income is always normalized to be 0 at the 62.58

[28] In the interest of displaying a broad range of different specifications, our tables do not report some basic statistics (number of observations, R^2, complier means, etc.). These are available from the authors.

RON cutoff).[29]

6.1 Effect on Computer Ownership

We begin by displaying the dramatic effect of winning a voucher on computer ownership in Table 3 and Figure 1. Panel A of Figure 1 illustrates the sharp regression discontinuity design that underlies our empirical strategy, wherein all households with income below the cutoff are awarded a Euro 200 voucher. Using data from the Ministry of Education, Panel B documents that an extremely high proportion of awarded vouchers are actually cashed in to buy computers. Thus, to a first approximation, we can interpret the effect of winning a voucher as the receipt of a free computer. Columns 1 and 6 of Table 3 indicate that households who won a voucher were over 50 percentage points more likely to have a computer at home at the discontinuity, representing at least a 170 percent increase over the likelihood of owning a computer among those who did not win a voucher. Panel C of Figure 1 reveals a sharp discontinuity and confirms that families around the cutoff with very similar incomes experienced a very different likelihood of owning a computer at home. Panel D shows that winning a voucher also increases actual computer use for children. The corresponding estimates from columns 2 and 7 indicate that children in households who received a voucher report spending around 2-4 additional hours per week as compared to children who did not receive a voucher with similar income; our preferred estimates are clustered around 3 hours based on both parent and child reports. Finally, the estimates in columns 3 and 8 confirm that winning a voucher did not lead to differences in internet access.

We also examine the presence of computer software that may influence whether the computer is used for productive (or unproductive) activities. Thus, Panels E and F of Figure 1 display the likelihood that households who won a voucher have a computer installed with educational software and games respectively. While the effect of winning on having a computer with educational software is generally significant in columns 4 and 9, it is substantially smaller than the effect of winning on having a computer with games installed in columns 5 and 10. Indeed, Panel E of Figure 1

[29] Plotting the residuals yields similar graphs to those based on raw values but helps eliminates some of the noise. See Lee and Lemuiex (2009) for a discussion of residualized outcomes.

confirms that almost all children in households who won a voucher use a home computer with games installed on it. The absence of education software is somewhat surprising given that the Ministry of Education made such software freely available to winners of the Euro 200 program. However, this software was not pre-installed and required additional effort for installation by computer vendors and voucher winners. The next section examines the types of computer use reported by children in more detail, as well as time use for other types of daily activities.

6.2 Effect on Computer and Time Use

Table 4 and Figure 2 present estimates for the effect of winning a voucher on children's computer use and time use based on binary variables indicating daily use.[30] Information about different types of computer use was elicited from the child survey only. Column 1 shows that children who won a voucher were 14 percentage points more likely to use a computer for games on a daily basis. In columns 2 and 3, we observe that winning a voucher does not translate into increased computer use for doing homework or for using educational software. Apart from the fact that computers are not used for strictly educational purposes, time spent in front of a computer also appears to crowd out other important activities. Columns 5 and 7 suggest that the probability of doing at least 1 hour of homework a day is lower for voucher winners, although this finding is not very precisely estimated or robust across all the specifications. Columns 6 and 8 indicate that winning a computer voucher also decreases the time spent watching TV. Finally, parental reports of reading in column 9 (which was included only in the parent survey) indicate that children in households who won a voucher are significant less likely to reading for pleasure on a daily basis. The results from Table 4 are mirrored in Figure 2 which present graphs based on the child reports. They suggest that the increase in computer use among winners of the Euro 200 program is mostly spent playing games, and associated with reductions in time spent watching TV, doing homework and reading for pleasure.[31]

[30] As explained in Section 4, we asked children about whether they used their computer for games, homework, and educational activities every day. For homework, watching TV, and reading, we measure daily use with a binary variable indicating whether children spent more than 1 hour a week engaged in that activity.

[31] It is important to note that we generally do not find significant effects for average measures of time-use for homework and TV, although the estimates are mostly similar in sign and magnitude. This suggest that most of the

6.3 Effect on Academic Achievement

In Table 5 and Figure 3, we explore the impact of winning a computer voucher on measures of academic achievement. In particular, we focus on average school grades for the 2008-2009 academic year in Math, Romanian, and English, as well as a grade for school behavior. These are the main subjects that are studied in Romanian schools and serve as important indicators of school performance. As for previous outcomes, we present results based on both child and parent reports, which serve as an important check on the validity of our measures. Columns 1 and 5 of Table 5 indicate that children in households who won a voucher have a significantly lower Math GPA than their counterparts who did not win a voucher across most specifications. The coefficients tend to range from about 0.3 to 0.7 representing an effect size of 1/5 to 1/2 of a standard deviation, with a preferred estimate of approximately 1/3 of a standard deviation.[32] Panels A and B of Figure 3 display the corresponding discontinuity in the non-parametric plots of Math GPA on our normalized measure of income. Columns 2 and 6 indicate a slightly larger magnitude for the negative effect of winning a voucher on GPA in Romanian language across most specifications, with a similar discontinuity observed in panels C and D. Again, the effect size for our preferred estimates is about 1/3 of a standard deviation. Finally, columns 3 and 7 together with panels E and F show very similar results for the effect of winning a voucher on GPA in English.[33] We find no significant difference in the effect of winning a voucher on the grades received for school behavior. Overall, these results suggest that winning a voucher and receiving a free computer through the Euro 200 program led to a lower academic performance in school.

effect on time use is on the margin of daily use. The results for time spent reading are much more robust across different specifications.

[32] Interestingly, the magnitudes are substantially larger for smaller bandwidths. When we graph Figure 3 using these smaller bandwidths, the resulting plots appear to be somewhat undersmoothed with a few points near the discotinuity driving the larger results.

[33] While there is a downward slope between income and academic outcomes for winners in these graphs, the slopes on either side of the discontinuity are not statistically significant from one another.

6.4 Effect on Cognitive Ability and Computer Skills

Table 6 and Figure 4 present estimates for the effect of winning a computer voucher on a number of different assessments that we administered directly to children. To begin with, we administered an un-timed cognitive ability test based on Raven's Progressive Matrices. As explained earlier, this test is designed to assess general intelligence independent of formal schooling so it is likely to differ from the measures of academic achievement described in the previous section. Moreover, insofar as the test requires matching different shapes and patterns to a series of spatial configurations, it may also pick up an important spatial component of ability. Column 1 of Table 6 shows that children in households who received a voucher tend to have significantly higher Raven scores than their counterparts who did not win a voucher, with an effect size of 1/3 of a standard deviation according to our preferred specification.[34] Panel A of Figure 4 shows confirms the presence of a visible discontinuity in a graphical analysis.

We also administered two assessments to measure children's computer skills. The first was a computer test which consisted of 12 multiple choice questions intended to measure computer knowledge – see Data Appendix for a full description of the test. Column 2 of Table 6 shows that children in households who received a voucher have significantly higher computer test scores than those who did not win a voucher, with an effect size ranging from 1/5 to 2/5 of a standard deviation in all specifications. The graphical representation of this estimate is shown in Panel B of Figure 4. The second assessment asked children about their fluency with respect to different dimensions of computer use. We find that winning a voucher improves the ability to operate a computer (column 3) and the ability to effectively use a number of applications (column 4). While the coefficients on these outcomes become insignificant for bandwidths smaller than 15, the magnitudes remain as large for these specification. These findings are confirmed by the graphical analyses presented in panels C and D of Figure 4. Given that internet use did not increase with program participation, it is not surprising that we do not find improvements on questions related to web and email fluency,

[34] Note that the magnitude and significant of this effect diminishes substantially with bandwidths smaller than 15 (including the IK bandwidth which is approximately 7 for this outcome).

as seen in columns 5 and 6 and panels E and F of Figure 4.

6.5 Effect on Non-Cognitive Outcomes

We examine the impact of winning a voucher on various non-cognitive outcomes in Table 7. From the child survey, we elicited the Rosenberg Self-Esteem Scale to assess global self-esteem, and asked children about their health status, problems due to pain in their hands and fingers, their perception of being overweight, and the frequency of smoking and drinking of alcohol. In the parent survey, we asked parents to complete the Behavioral Problem Index (BPI) and provide information about child height and weight (to construct BMI) as well as their engagement in sports and community service activities. For almost all of these non-cognitive outcomes, we find no significant effects across our many specifications.[35] To summarize the evidence presented thus far, winning a voucher and receiving a free home computer appears to have both positive and negative effects on child outcomes. While computers certainly seem to improve computer skills, they also affect school performance negatively measured by the average grades in three important academic subjects. There is also evidence that winning a voucher and receiving a free computer leads to higher scores on a test of general intelligence (which may also pick up a spatial component of ability).

7 Further Results

In this section, we examine a number of additional results that build on our main findings. We explore whether the effects of winning a computer voucher are mediated by proxies for parental involvement and supervision, and whether they are affected by child characteristics such as age and gender. We also investigate whether the effects of winning a computer voucher persist over time, and consider a number of specifications checks, Finally, we discuss our findings in light of our OLS and 2SLS estimates. In the interest of saving space and to improve the precision of our estimates, all of the specifications in this sections are based on linear splines using the full

[35] The few instances of significant coefficients across our many specifications suggest negative effects (Rosenberg Scale, BPI, Health). However, given the problems associated with multiple inference, we are hesitant to put much weight on these findings.

sample and the standard set of controls (age, ethnicity, gender, and educational attainment of the head of household, as well as child gender and age dummies). We also focus on nine of our main outcome variables which include computer use, homework, Math GPA, Romanian GPA, English GPA, Raven's Progressive Matrices test, computer test, computer fluency, and application fluency, all derived from the child survey instrument.

7.1 Effects of Parental Rules

In order to better understand the role of parental supervision and monitoring on our main results, we introduce two indicator variables for whether parents have rules regulating computer use and homework activities for each child. Approximately one third of children have parents who impose rules on computer use and a similar fraction of children have parents who impose rules on homework activities.[36] We proceed to estimate equations in which the variable for winning a Euro 200 voucher is interacted respectively with each of these parental rules.[37] Appendix Table 1 presents results from estimating this equation on our main outcome variables. Note that these variables are potentially endogenous, so the results of this analysis need to be interpreted with care.

Panel A of Appendix Table 1 displays the interaction of our program effect, *winner*, with the presence of rules related to computer use. As might be expected, the interaction is negative and significant in column 1, indicating that computer use is substantially lower for children whose parents impose rules on computer use. This also appears to lead to a lower acquisition of computer skills, as demonstrated by the negative and significant interactions for the computer test and measures of computer fluency in columns 7, 8, and 9. On the other hand, the presence of rules on computer use do not seem to impact daily homework activities, or academic achievement in school. In Panel B, we present the analogous results for the interaction of our program effect with the presence of rules related to homework. Again, as might be expected, children whose

[36] About 18 percent of children are subject to rules for both computer use and homework activities (with 13 percent of children are subject only rules on computer use, and another 13 percent of children are subject only to rules on homework activities).

[37] Specifically we estimate the equation: $outcome_i = \beta' \mathbf{X}_i + \delta winner_i + \pi rules_i + \lambda winner_i * rules_i + f(income_i) + \varepsilon_i$ where $rules_i$ is an indicator for whether the parents have rules about computer use or homework activities.

parents impose rules on homework do more homework (the interaction is positive and significant in column 2). Moreover, this also appears to impact school performance. The presence of rules regarding homework activities ameliorates the negative impact of winning a computer voucher on Math, Romanian, and English GPA with the coefficients on the interaction terms in columns 3, 4, and 5 about half the size of the main effects. Interestingly, having rules regulating homework does not have a negative effect on computer use or the accumulation of computer skills. Neither rules regarding computer use or homework appear to impact scores on the Raven test.

We interpret these results as consistent with the view that parental monitoring through rules can be important mediating factors. Furthermore, our results suggest that rules regarding computer use reduce the positive effects of winning a voucher on computer skills without improving academic achievement, while rules regarding homework mitigate some of the negative effects of winning a computer voucher without affecting the gains to computer skills or cognitive ability.

7.2 Heterogeneous Effects

Appendix Table 2 explores the differential impact of child characteristics on the effect of winning a computer voucher for our nine main outcome variables. We estimate equations in which the variable for winning a Euro 200 voucher is interacted with child age and gender.[38] Interestingly, Panel A does not reveal any significant differences in the effect of winning a computer voucher between males and females. There are substantial differences in the mean levels of our outcomes variables by gender. Girls use computers less and do more homework; they also have higher GPA and cognitive ability scores but lower computer skills. Panel B displays the interaction between winning a computer voucher and child age. As with gender, there are substantial differences in the mean levels of our outcomes variables. However, there is also some evidence that younger children display the largest gains in cognitive ability as measured by Raven's Progressive Matrices (column 6), and in computer fluency (columns 8 and 9). The finding that younger children display larger gains in cognitive ability is consistent with work by Cunha and Heckman (2008) showing

[38] Specifically, we estimate the equation: $outcome_i = \beta' \mathbf{X}_i + \delta winner_i + \pi child\_chars_i + \lambda winner_i * child\_chars_i + f(income_i) + \varepsilon_i$ where $child\_chars_i$ includes age, gender and number of siblings.

that cognitive skills are more malleable at early ages.

7.3 Long Term Effects

All of our analysis thus far has examined the impact of winning a computer voucher on outcomes approximately one year after families would have receiving their free computer. In order to address whether this program also had longer term impacts on child outcomes, we implemented an identical survey on a sample of children who participated in the 2005 round of the same Euro 200 program.[39] From an initial list of 1,554 families who applied to the 2005 round from the regions of Covasna and Valcea, we were able to successfully complete 647 household interviews.[40] Appendix Table 3 presents regression results using a linear spline and standard controls for our nine main outcome variables.

Column 1 of Appendix Table 3 indicates that households who won a voucher in the 2005 round of the Euro 200 program had significantly higher levels of computer ownership, even four years after they received a free computer. Nevertheless, the difference of 17 percentage points between households who did and did not receive a voucher is substantially smaller than the differential in the short-term. This is not surprising given that those families who applied for a voucher in 2005 but did not receive one could reapply in subsequent years. Columns 4, 5, and 6 show the long-term effects of receiving a voucher on average grades in Math, Romanian, and English respectively. The coefficients are negative but somewhat imprecise. Furthermore, if one were to re-scale the size of these effects in light of the smaller difference in computer ownership, the magnitude of these estimates suggest long term effects that are similar to the short-term ones. The impact of winning a voucher on cognitive ability as measured by the Raven's Progressive Matrices test is positive but insignificant, again with a similar magnitude if scaled appropriately. Finally, the effect of winning a voucher on computer skills is positive in two out of our three assessments. The lack of power in

[39] In a previous analysis using the same sample of 2005 program participants from Covasna and Valcea, we analyzed the short term impact as part of a smaller scale pilot study. Our main findings from that study are broadly consistent with those in the current study (Malamud and Pop-Eleches, 2008).

[40] In 2007 we completed 858 household interviews. Our lower response rate for the four-year follow-up is not surprising given that more time elapsed between program and the latest follow-up.

most of these estimates is not surprising given the small sample and we do not wish to draw any strong conclusions. Nevertheless, taken as a whole, these results are consistent with the persistence of long term negative effects on academic achievement, and positive long-term effects on cognitive ability and computer skills.

7.4 2SLS and OLS Estimates

Throughout the paper, we have focused on reduced-form estimates of the effect of winning a computer voucher through the Euro 200 program. Given that almost all of the vouchers were actually cashed in to buy computers (recall Panel B of Figure 1), we may be able to interpret the effect of winning a voucher as the receipt of a free computer. But this does not represent the effect of having access to a computer at home because some of the households who did not win a voucher do report having a computer at home. However, we could scale up our reduced-form estimates by the difference in computer ownership between household who won and did not win a voucher.[41] With an estimated difference in computer ownership of approximately 50 percentage points, this suggests the impact of having access to a home computer are about twice the impact of winning a voucher (2δ). A similar scaling would be achieved by estimating 2SLS regressions in which we use our indicator for winning a voucher ($winner_i$) to instrument for computer ownership ($computer_i$).

Note that this approach may not "scale up" our estimates in the appropriate fashion. As explained earlier, some families who did not win a voucher in 2008 may have already owned a computer or decided to buy a computer after finding out that they would not receive one as part of the government program. However, we do not know exactly when these computers were purchased so there may be variation in the exposure to computer ownership that isn't captured by observed ownership in 2009 at the time of the survey. Households who did not win a voucher but purchased a computer just prior to the time of the survey will have had a much shorter exposure to computers than the households who won a voucher and received computers in the summer of

[41] Note that this resembles the standard calculation used in moving from an intention-to-treat (ITT) estimator to a treatment-on-the-treated (TOT) estimator. Such scaling of the reduced form estimate by the proportion of individuals that actually received the treatment was introduced by Bloom (1984).

2008. Nevertheless, the difference in computer ownership of 50 percentage points at the time of the survey does provide a useful benchmark. Consequently, we present (naive) 2SLS estimates of computer ownership on our main nine outcomes in Appendix Table 5. The 2SLS estimates confirm that the effects of computer ownership are approximately twice as large as the reduced-form effects of winning a computer voucher.

Although we have used a regression discontinuity design in order to overcome the problem of omitted variables and selection bias, it would also be interesting to compare our causal estimates with those that would emerge from a conventional OLS analysis. We attempt to implement this comparison by estimating an OLS regression for children in households that did not receive a computer voucher through the Euro 200 program.[42] Approximately 37 percent of the 1,186 household in our sample who did not receive a voucher reported owning a computer at the time of the survey. The OLS estimates for our nine main outcome variables are reported in Appendix Table 4. As with reduced-form and 2SLS estimates, owning a computer is associated with higher scores on the computer test as well as greater fluency in operating a computer and using applications. Indeed, the magnitude of the coefficients in these OLS regressions are strikingly similar to those from 2SLS. On the other hand, owning a computer is also associated with higher average grades in Math, Romanian, and English. Insofar as our causal estimates indicate a negative impact of winning a computer voucher on average grades, this suggests that children in households who purchased computers were more likely to have higher academic achievement. Finally, the OLS estimate for the effect of computer ownership on cognitive ability is positive and significant but only two-thirds the magnitude of the 2SLS estimate.

7.5 Specification Checks

An important assumption underlying our empirical strategy is that all household and child characteristics, other than receipt of a computer voucher through the Euro 200 program, vary continuously around the income cutoff of 62.58 RON. While we cannot verify this assumption for unobserved

[42] Specifically we estimate the equation: $outcome_i = \beta' \mathbf{X}_i + \delta computer_i + f(income_i) + \varepsilon_i$ where $computer_i$ is an indicator variable for computer ownership.

characteristics, we can check whether our main control variables indeed vary continuously around the income cutoff. Appendix Table 6 confirms that the discontinuities for gender, age, ethnicity and education of the head of household as well as age of the child are almost always small and statistically insignificant across our many specifications. In only one of ten control variables (gender of child) do we reject the null hypothesis. The smoothness of these controls around the discontinuity is also readily observed in Appendix Figure 1, which plots a selection of the control variables included in the table.

The other important assumption underlying our RD design is that households were not able to manipulate the forcing variable, by reporting a lower income. As explained earlier, we do not believe that such under-reporting represents a serious concern. The minimum cut-off of 62.58 RON for the voucher program was not known ex-ante (it was determined by the amount of funds available and by the number of households who applied and their corresponding income, none of which were known prior to the start of the program). Moreover, in the 2006 and 2007 rounds of the Euro 200 program, essentially all household who applied ended up receiving vouchers so it was reasonable for families to believe that they would receive a voucher even if they reported income close to the upper limit for eligibility. Nevertheless, we also examine for evidence of manipulation by checking the frequency density along the lines of McCrary (2007). Appendix Figure 2 plots local linear regressions of the density of children over income from the child survey (in panel A) and the parent survey (in panel B). In both cases, the density varies continuously over different income levels with no significant discontinuity around the income cutoff.

Finally, we examine the degree of correspondence between the parent and child reports in their responses to the same survey questions. For questions that represented information about household characteristics such as computer ownership, access to the Internet, and the presence of educational software, the responses of children and their parents were identical 96 to 98 percent of the time. For questions regarding average grades in Math, Romanian and English, the responses of children and their parents were identical 91 to 92 percent of the time. For questions regarding time-use such as daily homework activities and daily watching of TV, the responses of children and their

parents were somewhat less likely to match up, being identical only 86 percent of the time. But overall, we find the relatively high level of correspondence between child and parent reports to be a reassuring finding.[43] In addition, we confirmed that our main results continue to hold when we restrict ourselves to samples where parent and child responses overlap.

8 Conclusion

This paper examines the effect of access to a home computer on the development of human capital among low-income children and adolescents. Using data that we collected through in-depth household interviews during 2009, we implement a regression discontinuity design and estimate the impact of winning a government-funded voucher worth 200 Euros towards the purchase of personal computer in 2008. We find that winning such a voucher substantially increases the likelihood that households own a home computer. As expected, higher rates of computer ownership among winners also led to increased computer use. But computer use was mostly focused on games and appeared to displace the time spent doing homework and reading for pleasure. Moreover, the effect on homework appears to have had real consequences for school performance. We find that children in household who won a voucher had significantly lower school grades in Math, English and Romanian, with most estimates clustered around an effect size of 1/3 of a standard deviation. On the other hand, we estimate that children in household who won a voucher had significantly higher scores in a test of computer skills and in self-reported measures of computer fluency. There is also evidence that winning a voucher increased cognitive ability, as measured by the Raven's Progressive Matrices test.

These findings indicate that providing home computers to low-income children in Romania lowered academic achievement even while it improved their computer skills and cognitive ability. How do we interpret these findings? The Euro 200 program was extremely successful in increasing home computer ownership and use among low-income children. But despite the efforts of the Romanian

[43] We also examined whether the rates of match between parent and child reports varied around the discontinuity. For the most part, there were no significant differences for these outcomes.

Ministry of Education to encourage the use of these computers for educational purposes, relatively few children have educational software installed on their computer, and fewer still report using their computer for educational purposes. This may have contributed to the decline in academic achievement. However, the Euro 200 program also led to increased computer skills and cognitive ability for those children who received a voucher, especially among the young. Thus, our findings suggest that the introduction of home computers have both positive and negative impacts on the development of children's human capital.

Our analysis also brings out the important role of parents in shaping the impact of home computer use on child and adolescent outcomes. We find suggestive evidence that the presence of rules regarding homework help mitigate some of the negative effects of winning a computer voucher. On the other hand, the presence of rules regarding computer use seem to reduce the positive impacts of winning a voucher on computer skills without improving academic achievement. Thus, our findings also raise questions about the implementation of recent large-scale efforts to increase computer access for disadvantaged children around the world without paying sufficient attention to how parental oversight affects a child's computer use.

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A Data Appendix

A.1 Computer test (12 multiple-choice questions)

1. Which file extensions indicate only graphics files?
   a) BMP and DOC
   b) JPEG and TXT
   c) TXT and STK
   d) BMP and GIF
2. If the power suddenly goes out while writing a letter with a word processing program:
   a) everything in memory (RAM) is erased
   b) the letter will definitely not be lost
   c) the word processing program will be lost
   d) it's a sign that you don't need the letter after all
3. Which of the following can be placed in a "folder"?
   a) a file
   b) a folder
   c) an attachment
   d) all of the above
4. If you are entering a paragraph in a word processing program and you get to the end of a line, what is the best way go on to the next line?
   a) press the tab key
   b) press the return key
   c) just keep typing
   d) press the escape key
5. Which of the following special function keys would be used to key the sentence: "Today is Tuesday."?
   a) shift
   b) return
   c) esc
   d) tab
6. Which of these disk types can store the most data?
   a) A CD-ROM
   b) A floppy disk.
   c) A DVD disk
   d) All disks can store the same amount of data.
7. Which represents the largest storage capacity?
   a) 24MB
   b) 2400KB
   c) 24Gig
   d) 240MB
8. All computers must have:
   a) Word processing software
   b) An operating system
   c) A printer attached
   d) A virus checking program
9. What is considered the "brains" of a computer?
   a) The floppy disk drive
   b) The central processing unit
   c) The electrical cord
   d) The monitor
10. When do you use a modem?
   a) When you want to create a presentation
   b) When you want to access email or the Internet
   c) When you start a program

d) All of the above

11. Which one is an email address?
    a) http://vianet.com/index.htm
    b) D:\\Email\Standard
    c) joesmart@billme.com
    d) Chaminade.org/teachers/mailaddresses
12. Which of these is a browser?
    a) Windows
    b) Microsoft Excel
    c) Outlook Express
    d) Internet Explorer

A.2 Computer fluency (self-reported from "very well" (5) to "not at all" (1))

The following questions are about a variety of computer, email and web-related tasks. Please read each question carefully and circle the appropriate number according to the scale below:

Operating a computer

I can restart a computer
I can switch a computer on
I can format a floppy disk
I can rename a floppy disk
I can use the hard drive
I can switch between currently open applications
I can create folders/directories

Using applications

I can print a document
I can use "save as" when appropriate
I can open a previously saved file from any drive/directory
I can begin a new document
I can save a file in a specified drive/directory
I can rename files
I can delete unwanted files
I can copy or move files between drives and directories

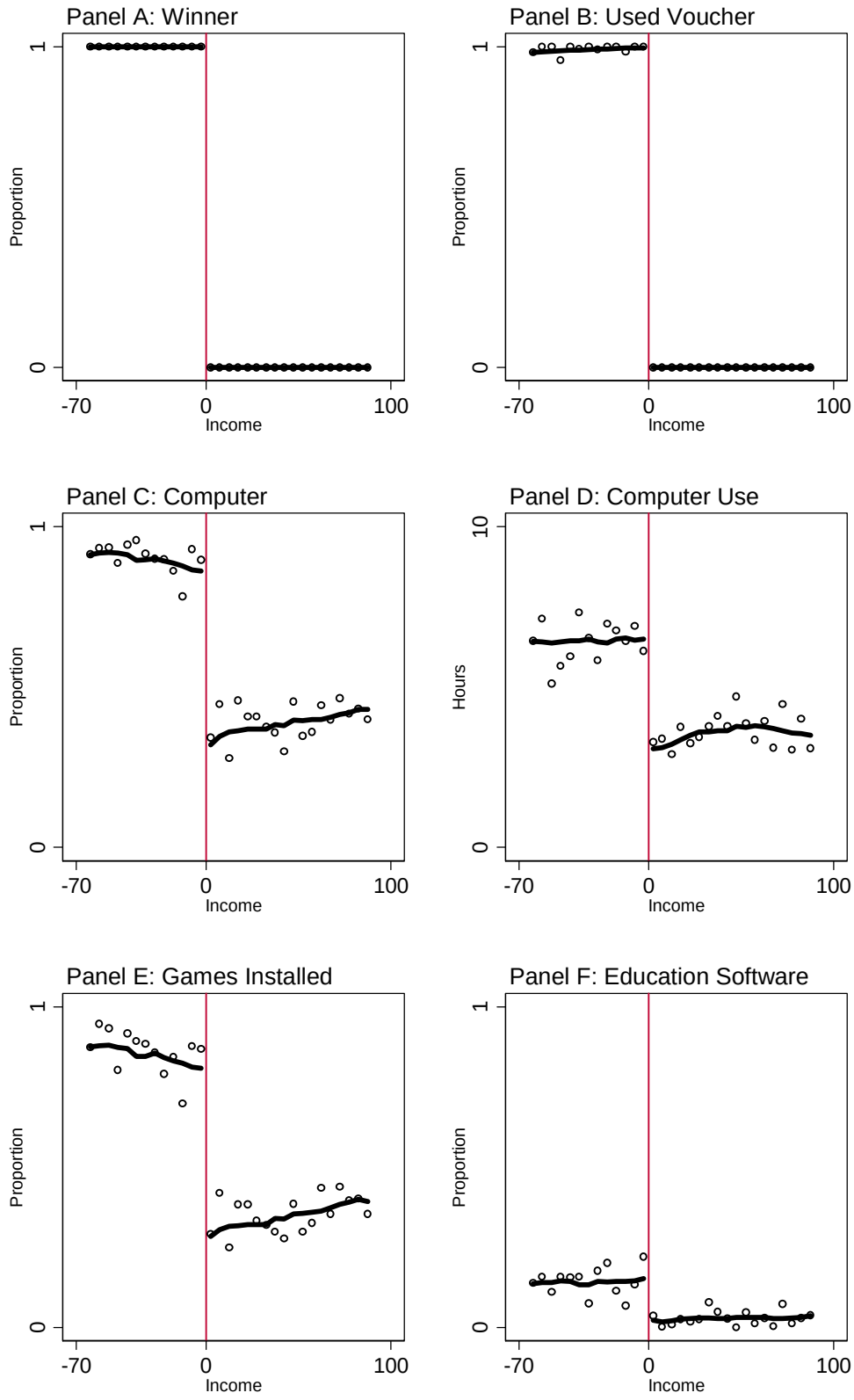
Internet/Web

I can open a web address directly
I can use search engines such as Yahoo or Alta Vista
I can identify the host server from the web address
I can use a Netscape or Explorer to navigate the WWW
I can use "back" and "forward" to move between pages

Email

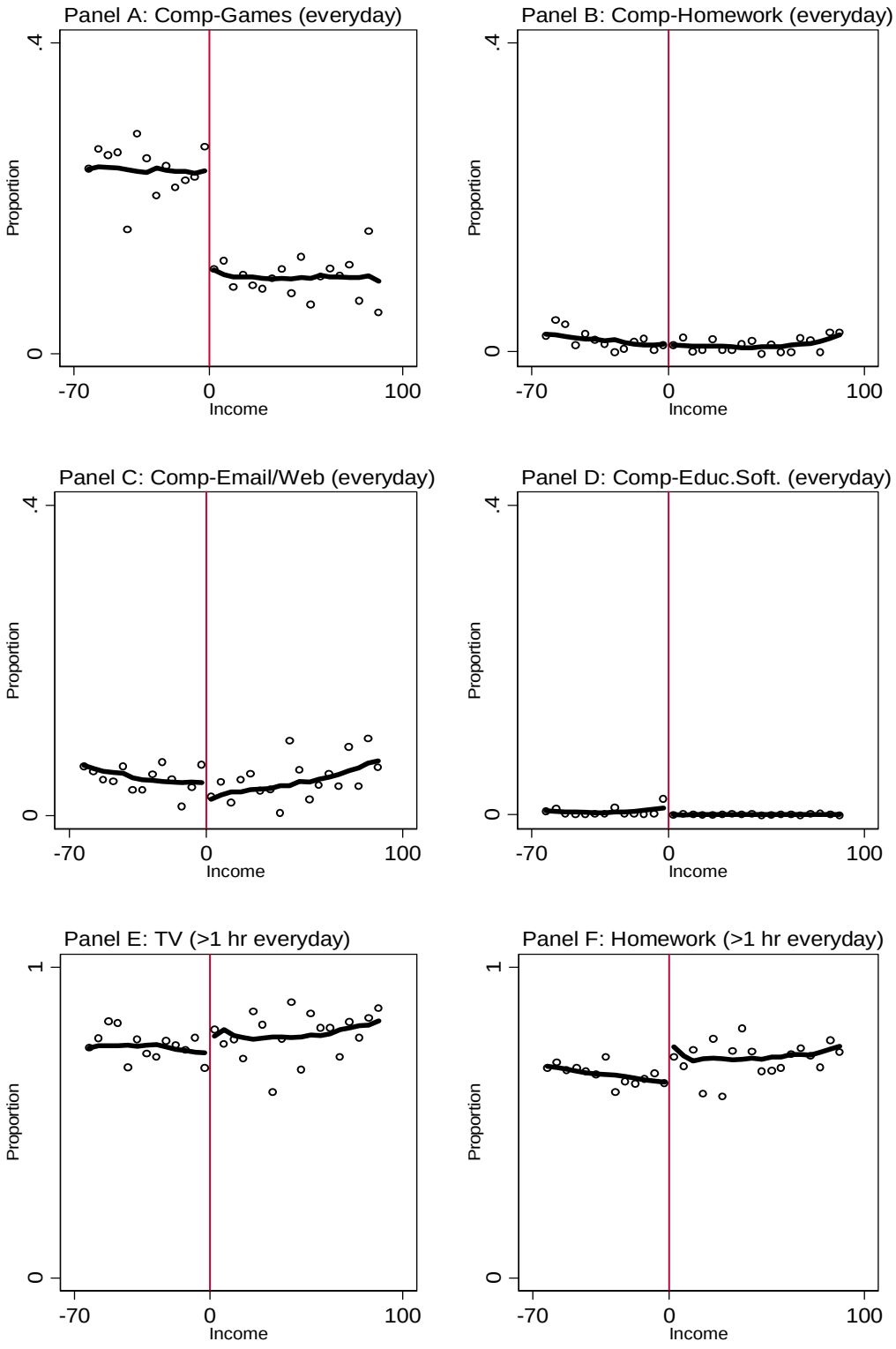
I can use the "reply" and "forward" features for email
I can read new mail messages
I can delete read email
I can send an email message
I can open an email program
I can open a file attached to an email
I can save an attached file
I can attach and send a file with a message

Figure 1: Computer Ownership and Use



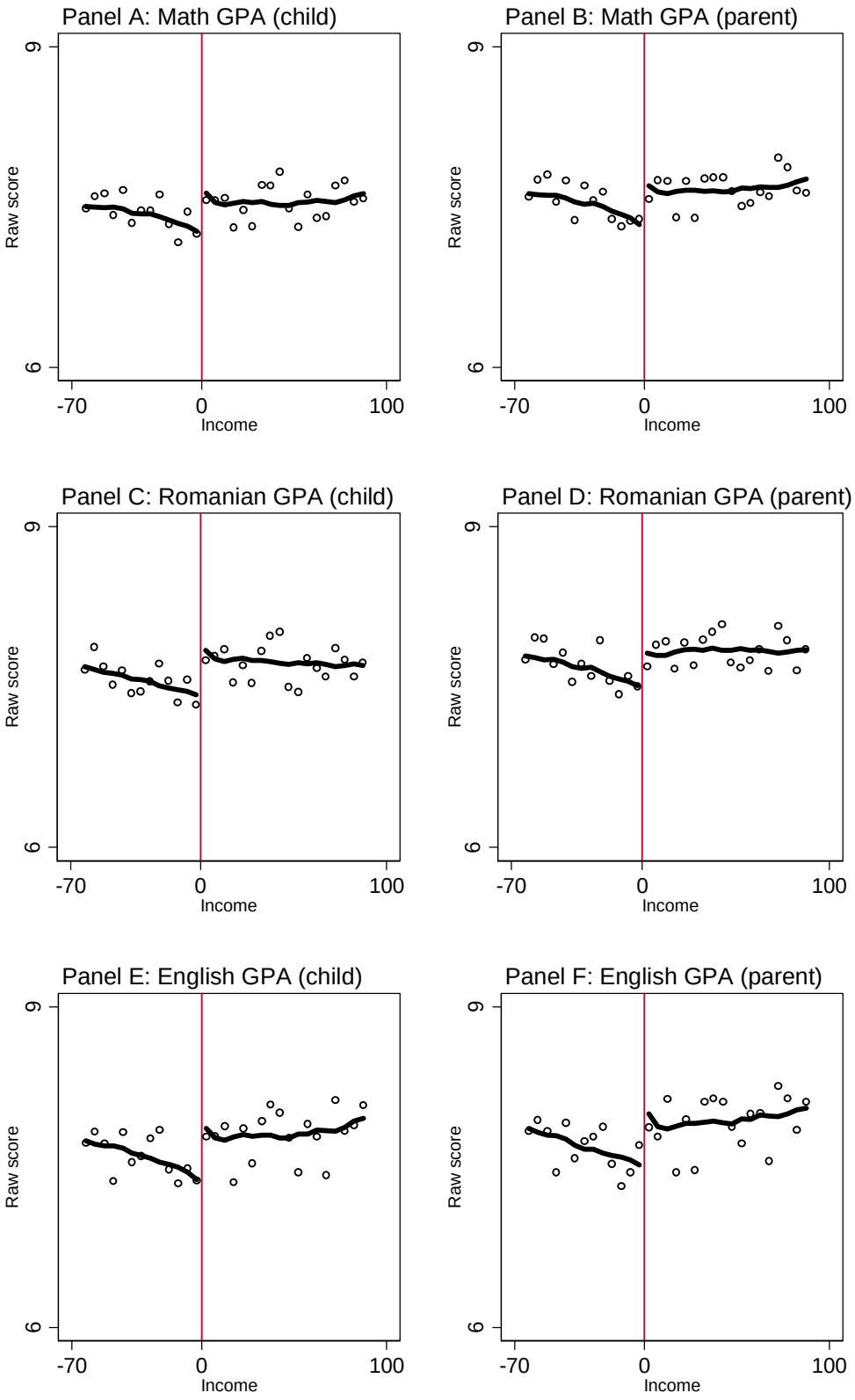
Notes: The dependent variables are defined in Tables 1 and 2. The open circles plot the residuals from regressions of the dependent variables on our standard set of controls for 5 RON intervals. The solid lines are fitted values of residuals from local linear regressions of the dependent variable using a rectangular kernal with a bandwidth of 30. The income variable is the monthly household income per family member used by the Euro 200 program and is normalized to be 0 at the 62.58 RON cutoff. Source: 2009 Euro 200 Survey

Figure 2: Computer and Time Use Outcomes



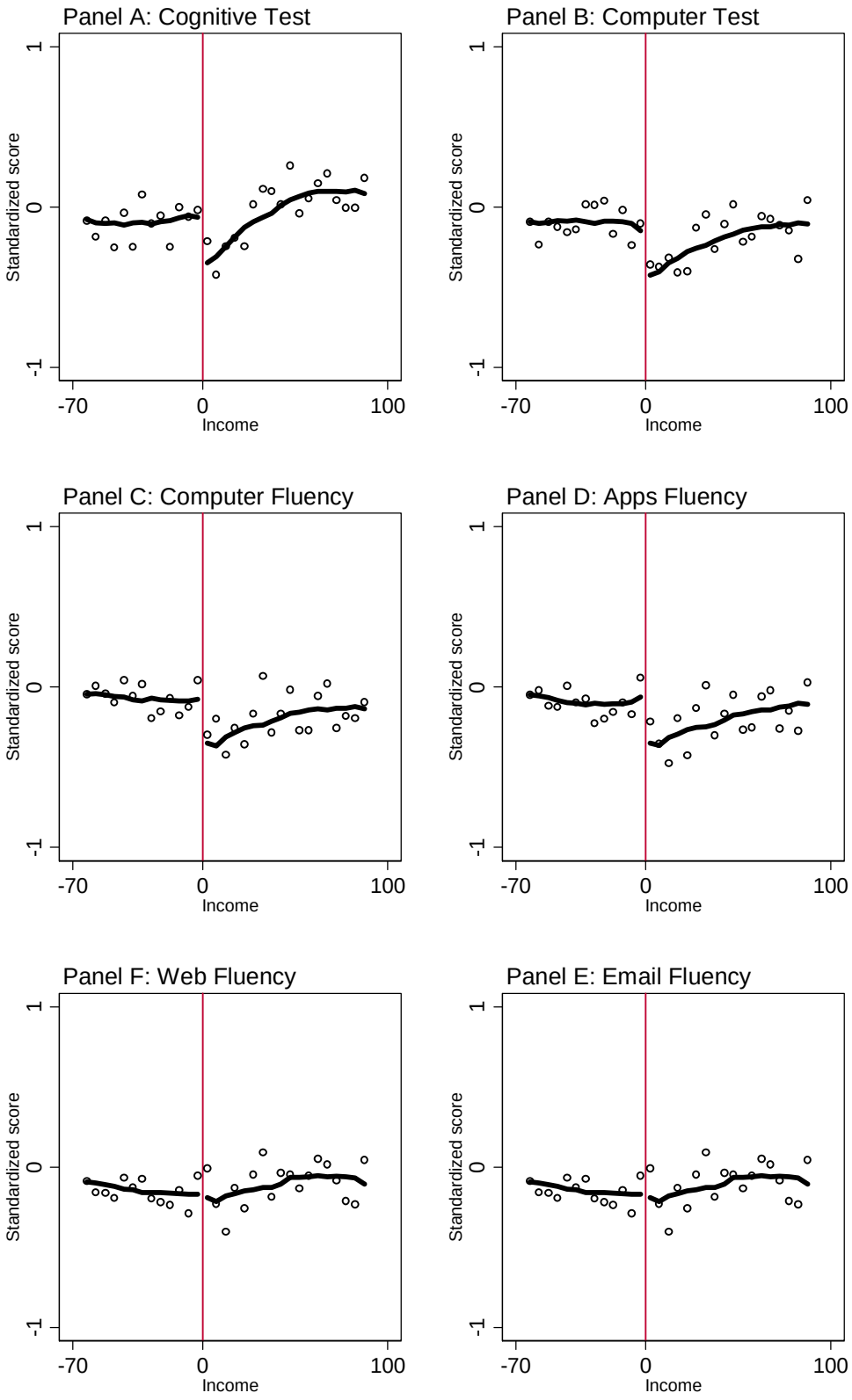
Notes: The dependent variables are defined in Tables 1 and 2. The open circles plot the residuals from regressions of the dependent variables on our standard set of controls for 5 RON intervals. The solid lines are fitted values of residuals from local linear regressions of the dependent variable using a rectangular kernal with a bandwidth of 30. The income variable is the monthly household income per family member used by the Euro 200 program and is normalized to be 0 at the 62.58 RON cutoff. Source: 2009 Euro 200 Survey.

Figure 3: Academic Outcomes



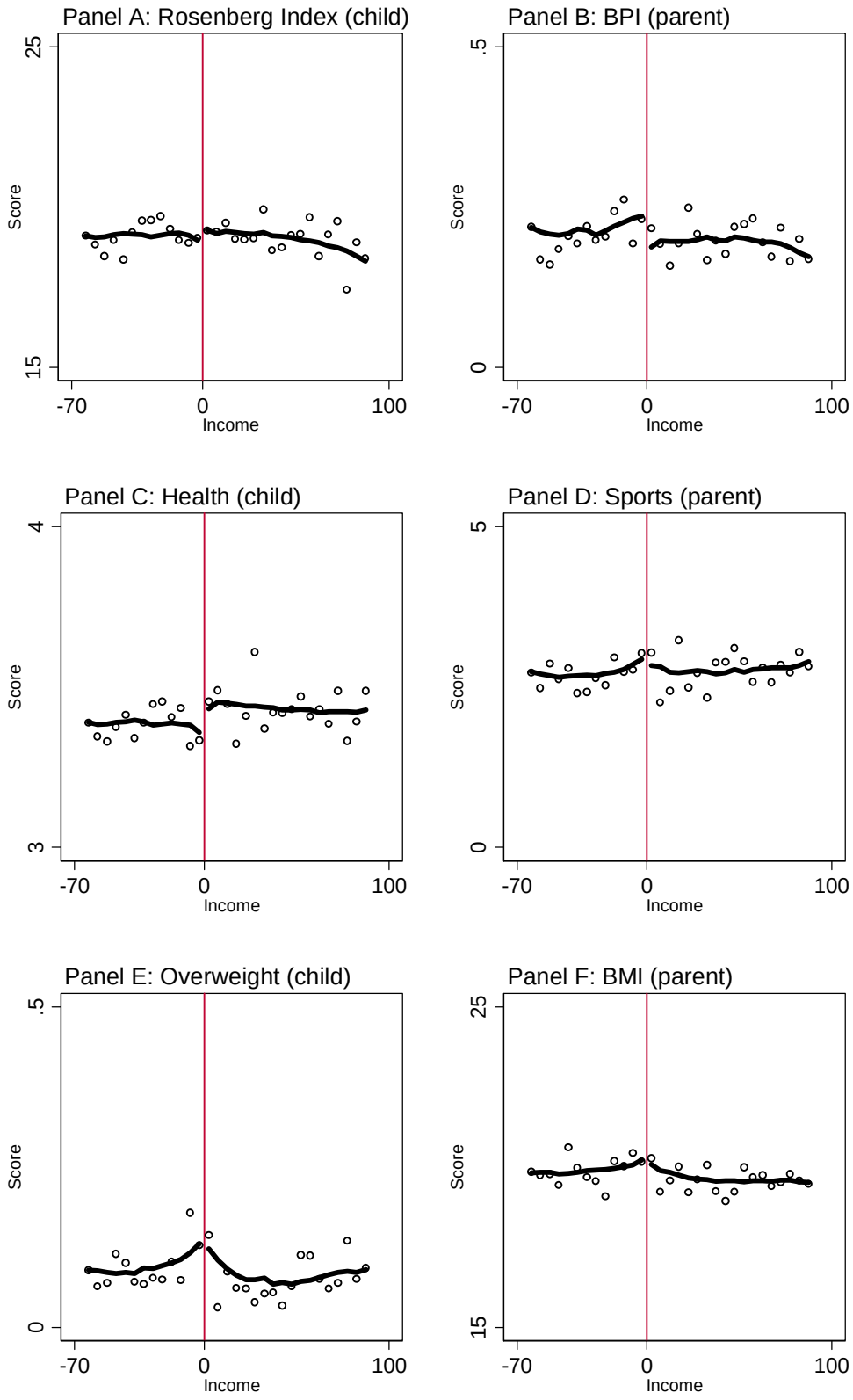
Notes: The dependent variables are defined in Tables 1 and 2. The open circles plot the residuals from regressions of the dependent variables on our standard set of controls for 5 RON intervals. The solid lines are fitted values of residuals from local linear regressions of the dependent variable using a rectangular kernal with a bandwidth of 30. The income variable is the monthly household income per family member used by the Euro 200 program and is normalized to be 0 at the 62.58 RON cutoff. Source: 2009 Euro 200 Survey.

Figure 4: Cognitive and Computer Assessments



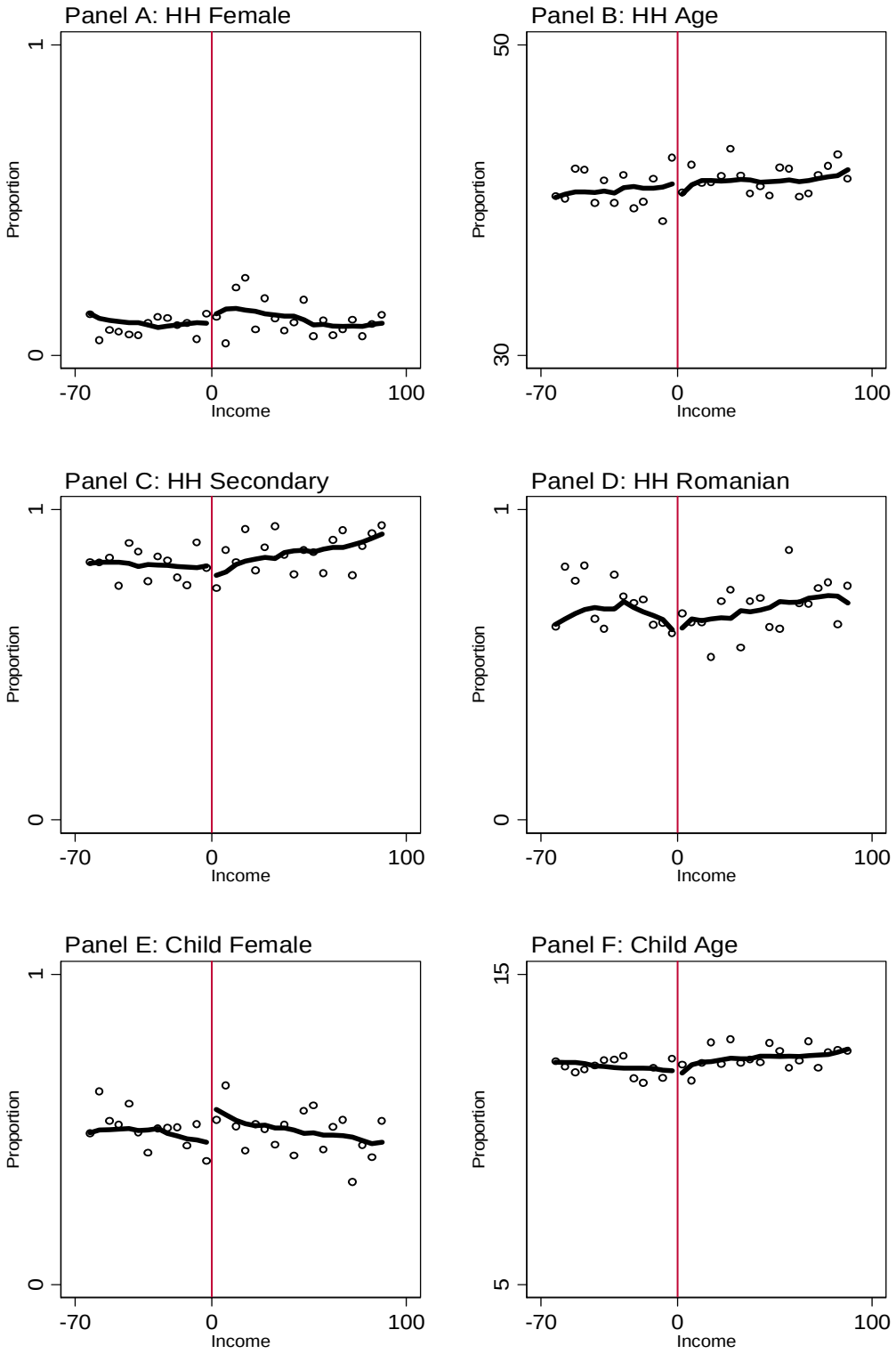
Notes: The dependent variables are defined in Tables 1 and 2. The open circles plot the residuals from regressions of the dependent variables on our standard set of controls for 5 RON intervals. The solid lines are fitted values of residuals from local linear regressions of the dependent variable using a rectangular kernal with a bandwidth of 30. The income variable is the monthly household income per family member used by the Euro 200 program and is normalized to be 0 at the 62.58 RON cutoff. Source: 2009 Euro 200 Survey.

Figure 5: Non-Cognitive Outcomes



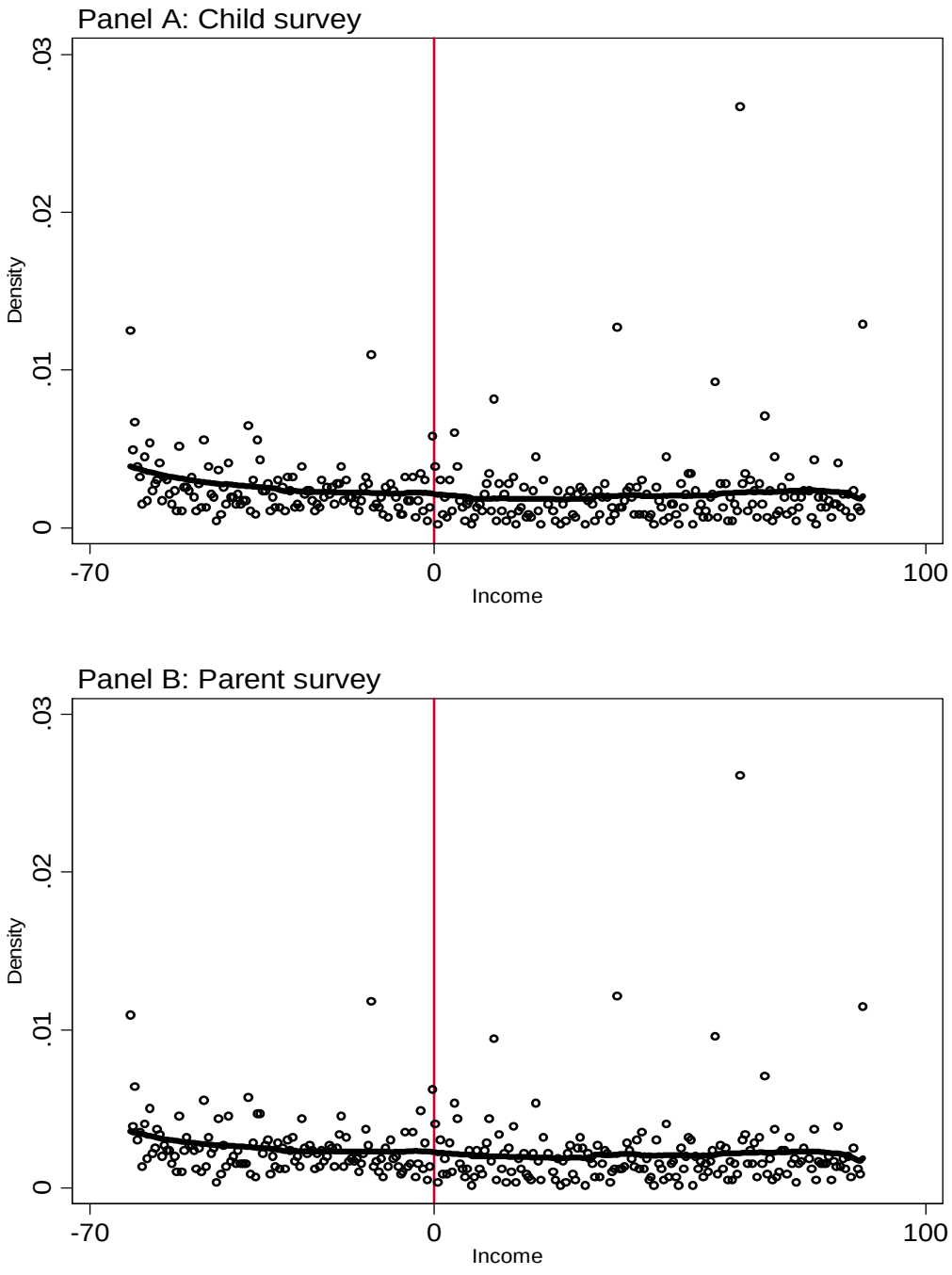
Notes: The dependent variables are defined in Tables 1 and 2. The open circles plot the residuals from regressions of the dependent variables on our standard set of controls for 5 RON intervals. The solid lines are fitted values of residuals from local linear regressions of the dependent variable using a rectangular kernal with a bandwidth of 30. The income variable is the monthly household income per family member used by the Euro 200 program and is normalized to be 0 at the 62.58 RON cutoff. Source: 2009 Euro 200 Survey.

Appendix Figure 1: Household Covariates



Notes: The dependent variables are defined in Tables 1 and 2. The open circles plot the residuals from regressions of the dependent variables on our standard set of controls for 5 RON intervals. The solid lines are fitted values of residuals from local linear regressions of the dependent variable using a rectangular kernal with a bandwidth of 30. The income variable is the monthly household income per family member used by the Euro 200 program and is normalized to be 0 at the 62.58 RON cutoff. Source: 2009 Euro 200 Survey.

Appendix Figure 2: Frequency Densities



Notes: The open circles plot the residuals from regressions of density on our standard set of controls for 5 RON intervals. The solid lines are fitted values of residuals from local linear regressions of density using a rectangular kernal with a bandwidth of 30. The income variable is the monthly household income per family member used by the Euro 200 program and is normalized to be 0 at the 62.58 RON cutoff. Source: 2009 Euro 200 Survey.

Table 1: Summary Statistics of Parental Survey

	Mean	SD	N
Panel A: Household level			
Winner	0.647	0.478	3,356
Income (ven)	47.614	50.683	3,356
Used Voucher	0.638	0.481	3,356
Female HoH	0.119	0.324	3,376
Age of HoH	40.666	8.012	3,358
Ethnicity of HoH			
Romanian	0.676	0.468	3,376
Hungarian	0.149	0.356	3,376
Gypsy	0.107	0.309	3,376
Other	0.068	0.253	3,376
Education of HoH			
Primary	0.126	0.332	3,340
Secondary	0.857	0.350	3,340
Tertiary	0.017	0.128	3,340
Computer ownership			
Have a computer	0.727	0.446	3,350
Have internet	0.144	0.351	3,344
Have a computer w/ games	0.649	0.477	2,856
Have a computer w/ education software	0.091	0.288	2,507
Hours computer is on (per day)	1.453	1.590	3,140
Panel B: Child level			
Gender	0.487	0.500	5,936
Age	12.225	3.334	5,928
Time use			
Computer use hours per week	5.245	6.510	5,283
Homework $\geq$ 1hr everyday	0.661	0.473	5,483
TV $\geq$ 1hr everyday	0.746	0.436	5,498
Reading $\geq$ 1hr everyday	0.053	0.224	5,244
Academic outcomes			
Math GPA	7.602	1.474	4,462
Romanian GPA	7.762	1.422	4,478
English GPA	7.822	1.501	3,536
Behavior GPA	9.931	0.388	4,835
Non-cognitive outcomes			
BPI Index	0.207	0.235	4,791
BMI	19.783	3.814	4,611
Sports (freq)	2.722	1.589	5,392
Service (freq)	1.84	1.00	5,457

Notes: SD is the standard deviation and N is the sample size. Winner is defined as 1 for individuals with an income above the program cutoff of 62.58 RON, 0 otherwise. The income variable is the monthly household income per family member used by the Euro 200 program (normalized to be 0 at the 62.58 RON cutoff in regressions and graphs). Homework, TV, and Reading are indicator variables for daily activites (more than 1 hour per day). GPAs represent raw scores ranging from 1 to 10. BMI is the body-mass index calculated from reported height and weight of the child. BPI index ranges from 0 to 1 with higher scores indicating more behavior problems. Sports and Service are frequencies ranging from 1 to 5. Demographic variables are defined as usual. More details can be found in the Data section of the paper. Source: 2009 Euro 200 survey.

Table 2: Summary Statistics of Child Survey

	Mean	SD	N
Gender	0.495	0.500	4,643
Age	12.187	3.003	4,637
Computer and Time use			
Computer use hours per week	5.465	6.349	4,384
Computer for games ≥ everyday	0.189	0.391	4,606
Computer for homework ≥ everyday	0.015	0.120	4,614
Computer for ed software ≥ everyday	0.003	0.051	4,611
Computer for web/email ≥ everyday	0.052	0.221	4,614
Homework > 1hr everyday	0.682	0.466	4,539
TV > 1hr everyday	0.759	0.428	4,512
Academic outcomes			
Math GPA	7.493	1.512	4,279
Romanian GPA	7.653	1.471	4,302
English GPA	7.717	1.539	3,476
Behavior GPA	9.910	0.427	4,367
Cognitive and Computer Assessments			
Raven's Progressive Matrices Test	-0.060	0.998	4,637
Computer Test (raw)	3.157	2.838	4,646
Computer operation fluency (raw)	2.786	1.231	4,646
Applications fluency (raw)	2.807	1.450	4,646
Web fluency (raw)	2.218	1.454	4,646
Email fluency (raw)	2.385	1.423	4,646
Non-cognitive outcomes			
Rosenberg index (raw)	19.050	3.750	4,085
Health index	3.401	0.659	4,602
Hand pain	0.081	0.273	4,546
Overweight	0.086	0.281	4,483
Underweight	0.177	0.382	4,483
Smoking	0.047	0.211	4,597
Drinking	0.065	0.247	4,611

Notes: SD is the standard deviation and N is the sample size. Computer use for Games, Homework, Education, and Web/email as well as Homework, TV, and Reading are indicator variables for daily activites. The Raven's Progressive Matrices test is standardized with a mean of 0 and standard deviation of 1). The computer test scores shown is a raw score from 1 to 12 but it is normalized to a mean of 0 and standard deviation of 1 in the graphs and regression tables. The fluency scores represent raw responses ranging from 1 (not at all fluent) to 5 (very fluent), again normalized with a mean of 0 and standard deviation of 1 in the graphs and regressiont ables. GPAs represent raw scores ranging from 1 to 10. Rosenberg index is a raw score ranging from from 1 to 30 with higher scores indicating lower self-esteem (also normalized to a mean of 0 and standard deviation of 1 in the graphs and regression tables). Health status is self-reported health status ranging from 1 (poor) to 5 (very well). Hand pain is an indicator variable 1 for any problems with pain in the hands, and 0 otherwise, Overweight/Underweight are indicators variables with 1for a self-reported perception of bei

Table 3: Effect of the Euro200 program on Computer Ownership and Use

	Panel A: Children Survey					Panel B: Parent Survey				
dependent variable	Computer	Internet	Games Installed	Educational software	Computer use (child)	Computer	Internet	Games Installed	Educational software	Computer use (child)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nonparametric	0.507***	0.034	0.466***	0.116***	3.478***	0.527***	0.009	0.524***	0.095***	1.934***
Bandwidth - 60	[0.044]	[0.034]	[0.043]	[0.028]	[0.552]	[0.043]	[0.035]	[0.046]	[0.034]	[0.610]
Nonparametric	0.546***	0.011	0.497***	0.117**	3.407***	0.548***	-0.007	0.594***	0.134**	2.397***
Bandwidth - 30	[0.060]	[0.049]	[0.058]	[0.046]	[0.754]	[0.059]	[0.049]	[0.063]	[0.054]	[0.778]
Nonparametric	0.577***	-0.033	0.566***	0.198***	2.641***	0.615***	-0.008	0.674***	0.238***	1.963*
Bandwidth - 15	[0.080]	[0.064]	[0.077]	[0.062]	[1.003]	[0.075]	[0.062]	[0.084]	[0.075]	[1.043]
Nonparametric	0.675***	0.016	0.707***	0.121	3.797***	0.696***	0.059	0.629***	0.195*	3.199**
Bandwidth - 7.5	[0.116]	[0.074]	[0.113]	[0.077]	[1.347]	[0.102]	[0.075]	[0.117]	[0.118]	[1.328]
Nonparametric	0.699***	0.066	0.751***	0.036	4.093***	0.721***	0.117	0.562***	0.163	2.492**
IK Bandwidth	[0.119]	[0.094]	[0.109]	[0.089]	[1.227]	[0.109]	[0.108]	[0.155]	[0.146]	[1.201]
Nonparametric	0.518***	0.029	0.476***	0.187***	3.352***	0.541***	0.005	0.544***	0.238***	2.219***
CV Bandwidth	[0.048]	[0.060]	[0.056]	[0.066]	[0.725]	[0.048]	[0.052]	[0.053]	[0.075]	[0.640]
Parametric	0.533***	0.006	0.503***	0.122***	3.146***	0.545***	-0.025	0.546***	0.086***	2.220***
Linear Spline	[0.038]	[0.030]	[0.038]	[0.024]	[0.478]	[0.037]	[0.030]	[0.041]	[0.028]	[0.514]
Parametric	0.520***	0.068	0.491***	0.137***	3.851***	0.541***	0.038	0.570***	0.148***	2.313***
Quadratic Spline	[0.054]	[0.044]	[0.054]	[0.040]	[0.709]	[0.053]	[0.045]	[0.058]	[0.051]	[0.771]
Parametric	0.561***	0.01	0.525***	0.179***	2.927***	0.586***	0.015	0.650***	0.003	1.154***
Cubic Spline	[0.071]	[0.058]	[0.070]	[0.058]	[0.907]	[0.068]	[0.052]	[0.076]	[0.061]	[0.324]

Notes: Robust standard errors clustered at the house\hold level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Winner", defined as 1 for individuals with an income below the program cutoff of 62.58 RON, 0 otherwise. All the parametric and non-parametric specifications are described in further detail in Section 5. All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. Source: 2009 Euro 200 survey.

Table 4: Effect of the Euro200 program on Computer and Time Use

	Panel A: Children Survey						Panel B: Parent Survey		
dependent variable	Computer for Games	Computer for Homework	Computer for Ed Software	Computer for Internet	Homework	TV use	Homework	TV use	Reading
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Nonparametric	0.126***	-0.008	0.006	0.011	-0.094**	-0.065	-0.052	-0.061	-0.054**
Bandwidth - 60	[0.037]	[0.008]	[0.006]	[0.018]	[0.042]	[0.043]	[0.042]	[0.046]	[0.023]
Nonparametric	0.136**	0.002	0.01	0.019	-0.096	-0.07	-0.013	-0.092	-0.093***
Bandwidth - 30	[0.054]	[0.009]	[0.012]	[0.027]	[0.059]	[0.064]	[0.059]	[0.065]	[0.034]
Nonparametric	0.145*	-0.009	0.026	0.049	-0.099	-0.164*	-0.006	-0.200**	-0.092**
Bandwidth - 15	[0.076]	[0.015]	[0.021]	[0.035]	[0.083]	[0.090]	[0.078]	[0.095]	[0.046]
Nonparametric	0.173	0.015	0.025	0.081**	-0.194	-0.196*	-0.199*	-0.336***	-0.181***
Bandwidth - 7.5	[0.106]	[0.021]	[0.017]	[0.039]	[0.118]	[0.117]	[0.106]	[0.123]	[0.061]
Nonparametric	0.230*	-0.004	0	0.041	-0.127	-0.230*	-0.201*	-0.341**	-0.135**
IK Bandwidth	[0.117]	[0.011]	[0.000]	[0.058]	[0.137]	[0.124]	[0.116]	[0.136]	[0.064]
Nonparametric	0.134**	0.001	0	0.019	-0.072	-0.084*	-0.049	-0.084*	-0.093*
CV Bandwidth	[0.053]	[0.014]	[0.000]	[0.026]	[0.057]	[0.049]	[0.048]	[0.050]	[0.047]
Parametric	0.136***	0.001	0.005	0.014	-0.071*	-0.024	-0.033	-0.03	-0.034*
Linear Spline	[0.031]	[0.007]	[0.005]	[0.016]	[0.037]	[0.037]	[0.037]	[0.039]	[0.019]
Parametric	0.144***	-0.007	0.014	0.021	-0.085	-0.109*	-0.036	-0.123**	-0.071**
Quadratic Spline	[0.051]	[0.011]	[0.012]	[0.025]	[0.055]	[0.057]	[0.054]	[0.059]	[0.028]
Parametric	0.146**	0.009	0.022	0.031	-0.053	-0.099	0.002	-0.13	-0.092**
Cubic Spline	[0.072]	[0.014]	[0.022]	[0.037]	[0.073]	[0.080]	[0.071]	[0.082]	[0.040]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Winner", defined as 1 for individuals with an income below the program cutoff of 62.58 RON, 0 otherwise. All the parametric and non-parametric specifications are described in further detail in Section 5. All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. Source: 2009 Euro 200 survey.

Table 5: Effect of the Euro200 program on Academic Outcomes

	Panel A: Children Survey				Panel B: Parent Survey			
Dependent variable	Math GPA	Romanian GPA	English GPA	Behavior GPA	Math GPA	Romanian GPA	English GPA	Behavior GPA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nonparametric	-0.276**	-0.424***	-0.362**	0.049	-0.375***	-0.403***	-0.361**	-0.027
Bandwidth - 60	[0.118]	[0.126]	[0.153]	[0.048]	[0.123]	[0.124]	[0.160]	[0.046]
Nonparametric	-0.435**	-0.562***	-0.634***	0.008	-0.415**	-0.370**	-0.534**	-0.059
Bandwidth - 30	[0.171]	[0.181]	[0.225]	[0.070]	[0.180]	[0.176]	[0.231]	[0.072]
Nonparametric	-0.261	-0.361	-0.379	-0.087	-0.252	-0.125	0.061	-0.083
Bandwidth - 15	[0.241]	[0.256]	[0.324]	[0.121]	[0.249]	[0.241]	[0.315]	[0.116]
Nonparametric	-0.758**	-1.118***	-0.778*	-0.117	-0.593*	-0.697**	-0.479	-0.226
Bandwidth - 7.5	[0.327]	[0.332]	[0.452]	[0.170]	[0.337]	[0.322]	[0.449]	[0.182]
Nonparametric	-0.669**	-1.090***	-0.683	-0.229	-0.47	-0.592*	-0.205	-0.360*
IK Bandwidth	[0.329]	[0.320]	[0.449]	[0.188]	[0.332]	[0.324]	[0.491]	[0.206]
Nonparametric	-0.411**	-0.328**	-0.343*	-0.047	-0.418**	-0.311*	-0.306*	-0.063
CV Bandwidth	[0.179]	[0.155]	[0.193]	[0.081]	[0.185]	[0.163]	[0.186]	[0.065]
Parametric	-0.208**	-0.367***	-0.321**	0.092**	-0.241**	-0.325***	-0.356***	0.013
Linear Spline	[0.100]	[0.104]	[0.129]	[0.040]	[0.104]	[0.104]	[0.135]	[0.039]
Parametric	-0.368**	-0.392**	-0.473**	0.014	-0.389**	-0.353**	-0.356*	-0.067
Quadratic Spline	[0.158]	[0.165]	[0.203]	[0.064]	[0.165]	[0.164]	[0.210]	[0.066]
Parametric	-0.265	-0.325	-0.373	0.01	-0.271	-0.141	-0.198	-0.088
Cubic Spline	[0.219]	[0.226]	[0.278]	[0.093]	[0.227]	[0.221]	[0.281]	[0.100]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Winner", defined as 1 for individuals with an income below the program cutoff of 62.58 RON, 0 otherwise. All the parametric and non-parametric specifications are described in further detail in Section 5. All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. Source: 2009 Euro 200 survey.

Table 6: Effect of the Euro200 program on Cognitive Ability and Computer Skills

	Children Survey					
Dependent variable	Raven's Progressive Matrices Test	Computer Test	Computer Fluency	Applications Fluency	Web Fluency	Email Fluency
	(1)	(2)	(3)	(4)	(5)	(6)
Nonparametric	0.275***	0.329***	0.209**	0.215**	0.086	0.035
Bandwidth - 60	[0.092]	[0.076]	[0.098]	[0.094]	[0.093]	[0.094]
Nonparametric	0.320**	0.242**	0.328**	0.346**	0.129	0.053
Bandwidth - 30	[0.133]	[0.108]	[0.165]	[0.153]	[0.155]	[0.156]
Nonparametric	0.214	0.252*	0.409	0.292	0.088	-0.083
Bandwidth - 15	[0.183]	[0.141]	[0.266]	[0.243]	[0.242]	[0.240]
Nonparametric	0.013	0.385*	0.654	0.462	0.186	0.06
Bandwidth - 7.5	[0.291]	[0.197]	[0.471]	[0.413]	[0.417]	[0.417]
Nonparametric	0.027	0.403**	0.738	0.478	0.248	0.12
IK Bandwidth	[0.299]	[0.204]	[0.483]	[0.418]	[0.424]	[0.419]
Nonparametric	0.319***	0.232**	0.329*	0.337*	0.145	0.004
CV Bandwidth	[0.121]	[0.110]	[0.170]	[0.173]	[0.178]	[0.178]
Parametric	0.146*	0.265***	0.208**	0.201**	0.061	-0.016
Linear Spline	[0.079]	[0.066]	[0.081]	[0.079]	[0.079]	[0.080]
Parametric	0.377***	0.321***	0.319**	0.338**	0.174	0.098
Quadratic Spline	[0.119]	[0.096]	[0.148]	[0.138]	[0.140]	[0.141]
Parametric	0.343**	0.224*	0.445*	0.445**	0.229	0.063
Cubic Spline	[0.164]	[0.133]	[0.238]	[0.219]	[0.224]	[0.225]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Winner", defined as 1 for individuals with an income below the program cutoff of 62.58 RON, 0 otherwise. All the parametric and non-parametric specifications are described in further detail in Section 5. All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. Source: 2009 Euro 200 survey.

Table 7: Effect of the Euro200 program on Non-Cognitive Outcomes

	Panel A: Children Survey						Panel B: Parent Survey			
Dependent variable	Rosenberg Index	Overweight	Smoking	Drinking	Health	Hands	BPI Index	BMI	Sports	Service
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nonparametric	0.084	0.039	0.007	0.026	-0.058	0.033	0.059**	0.32	0.13	-0.121
Bandwidth - 60	[0.105]	[0.026]	[0.016]	[0.021]	[0.059]	[0.024]	[0.025]	[0.332]	[0.165]	[0.116]
Nonparametric	-0.026	0.022	0.022	-0.009	-0.134	0.057*	0.047	0.409	0.056	-0.212
Bandwidth - 30	[0.151]	[0.039]	[0.022]	[0.028]	[0.083]	[0.034]	[0.034]	[0.492]	[0.225]	[0.166]
Nonparametric	0.153	0.018	0.045*	-0.003	-0.199*	0.047	-0.006	0.135	-0.387	-0.317
Bandwidth - 15	[0.208]	[0.059]	[0.026]	[0.037]	[0.113]	[0.048]	[0.045]	[0.683]	[0.298]	[0.229]
Nonparametric	0.491*	-0.096	0.009	0.027	-0.09	0.022	0.039	-0.78	-1.044**	-0.515*
Bandwidth - 7.5	[0.254]	[0.087]	[0.035]	[0.053]	[0.172]	[0.069]	[0.054]	[0.976]	[0.458]	[0.278]
Nonparametric	0.623**	-0.028	-0.019	0.053	-0.184	-0.006	0.073	-0.823	-0.725	-0.206
IK Bandwidth	[0.260]	[0.111]	[0.069]	[0.065]	[0.185]	[0.092]	[0.066]	[0.953]	[0.500]	[0.361]
Nonparametric	0.045	0.013	0.007	-0.012	-0.096	0.067*	0.044	0.092	0.194	-0.162
CV Bandwidth	[0.118]	[0.040]	[0.018]	[0.023]	[0.066]	[0.039]	[0.027]	[0.382]	[0.183]	[0.156]
Parametric	0.013	0.033	0.002	0.009	-0.064	0.018	0.02	0.305	0.055	-0.059
Linear Spline	[0.088]	[0.022]	[0.014]	[0.017]	[0.051]	[0.019]	[0.022]	[0.291]	[0.141]	[0.098]
Parametric	0.067	0.041	0.017	0.006	-0.102	0.060*	0.071**	0.359	0.244	-0.208
Quadratic Spline	[0.133]	[0.035]	[0.021]	[0.026]	[0.078]	[0.031]	[0.031]	[0.466]	[0.208]	[0.152]
Parametric	-0.065	0.025	0.034	-0.022	-0.191*	0.048	0.006	0.289	0.153	-0.148
Cubic Spline	[0.178]	[0.048]	[0.026]	[0.035]	[0.106]	[0.041]	[0.039]	[0.653]	[0.271]	[0.203]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Winner", defined as 1 for individuals with an income below the program cutoff of 62.58 RON, 0 otherwise. All the parametric and non-parametric specifications are described in further detail in Section 5. All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. Source: 2009 Euro 200 survey.

Appendix Table 1: Interactions with Parental Rules

Dependent variable	Computer use	Homework	Math GPA	Romanian GPA	English GPA	Raven's Progressive Matrices	Computer Test	Computer Fluency	Applications Fluency
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A									
Winner	3.525***	-0.097**	-0.258**	-0.418***	-0.358***	0.124	0.262***	0.205**	0.174**
	[0.481]	[0.038]	[0.104]	[0.109]	[0.133]	[0.081]	[0.067]	[0.085]	[0.082]
Parent Has Rules for Computer	4.071***	0.044	0.250***	0.294***	0.320***	0.115*	0.323***	0.359***	0.264***
	[0.389]	[0.028]	[0.083]	[0.080]	[0.092]	[0.069]	[0.057]	[0.057]	[0.057]
Winner*Computer Rules	-3.231***	0.046	0.003	-0.027	-0.064	-0.032	-0.158**	-0.161**	-0.052
	[0.471]	[0.034]	[0.097]	[0.095]	[0.113]	[0.080]	[0.067]	[0.066]	[0.067]
Panel B									
Winner	3.055***	-0.104***	-0.251**	-0.443***	-0.418***	0.149*	0.247***	0.229***	0.196**
	[0.507]	[0.039]	[0.107]	[0.111]	[0.137]	[0.082]	[0.069]	[0.086]	[0.082]
Parent Has Rules for Homework	0.644*	0.061**	0.061	-0.014	-0.09	0.071	0.078	0.158***	0.103*
	[0.340]	[0.027]	[0.075]	[0.077]	[0.092]	[0.059]	[0.051]	[0.058]	[0.056]
Winner*Homework Rules	0.204	0.085***	0.13	0.215**	0.340***	-0.018	0.035	-0.042	0.005
	[0.434]	[0.032]	[0.090]	[0.093]	[0.113]	[0.072]	[0.063]	[0.068]	[0.067]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Winner", defined as 1 for individuals with an income below the program cutoff of 62.58 RON, 0 otherwise. All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. The estimation is based on the linear spline specification using the full sample. Source: 2009 Euro 200 survey.

Appendix Table 2: Heterogenous Effects

Dependent variable	Computer use	Homework	Math GPA	Romanian GPA	English GPA	Raven's Progressive Matrices	Computer Test	Computer Fluency	Applications Fluency
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A									
Winner	3.348***	-0.055	-0.15	-0.355***	-0.279**	0.183**	0.238***	0.178**	0.175**
	[0.529]	[0.040]	[0.107]	[0.113]	[0.138]	[0.083]	[0.071]	[0.082]	[0.079]
Female	-1.066***	0.117***	0.357***	0.436***	0.512***	0.143***	-0.140***	-0.110**	-0.046
	[0.284]	[0.022]	[0.067]	[0.065]	[0.078]	[0.048]	[0.043]	[0.047]	[0.046]
Winner*Female	-0.391	-0.032	-0.11	-0.024	-0.082	-0.072	0.052	0.059	0.049
	[0.371]	[0.028]	[0.082]	[0.082]	[0.098]	[0.059]	[0.053]	[0.058]	[0.056]
Panel B									
Winner	2.239**	-0.076	-0.007	-0.271	-0.055	0.432***	0.444***	0.488***	0.514***
	[0.890]	[0.072]	[0.191]	[0.184]	[0.235]	[0.152]	[0.125]	[0.141]	[0.135]
Age	0.344***	-0.016***	-0.253***	-0.211***	-0.166***	0.018**	0.155***	0.147***	0.157***
	[0.052]	[0.004]	[0.011]	[0.011]	[0.014]	[0.009]	[0.008]	[0.008]	[0.008]
Winner*Age	0.075	0.001	-0.016	-0.008	-0.022	-0.023**	-0.015	-0.024**	-0.026***
	[0.068]	[0.005]	[0.014]	[0.014]	[0.017]	[0.011]	[0.009]	[0.010]	[0.009]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Winner", defined as 1 for individuals with an income below the program cutoff of 62.58 RON, 0 otherwise. All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. The estimation is based on the linear spline specification using the full sample. Source: 2009 Euro 200 survey.

Appendix Table 3: Long Run Effects

Dependent variable	Computer	Computer use	Homework	Math GPA	Romanian GPA	English GPA	Raven's Progressive Matrices Test	Computer Test	Computer Fluency	Applications Fluency
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Winner	0.168**	0.238	-0.115	-0.198	-0.1	-0.128	0.065	-0.04	0.13	0.067
	[0.073]	[1.517]	[0.079]	[0.240]	[0.239]	[0.293]	[0.161]	[0.146]	[0.135]	[0.128]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The reported coefficients are for the variable "Winner", defined as 1 for individuals with an income below the program cutoff of 62.58 RON, 0 otherwise. All regressions include controls for income, age, gender, ethnicity and education of the head of household, age and gender of the child. These regressions are restricted to applicants from Covasna and Valcea county who particpated in the 2005 Euro 200 program. The estimation is based on the linear spline specification using the full sample. Source: 2009 Euro 200 survey.

Appendix Table 4: OLS Results

Dependent variable	Computer use	Homework	Math GPA	Romanian GPA	English GPA	Raven's Progressive Matrices Test	Computer Test	Computer Fluency	Applications Fluency
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Computer	6.139***	0.012	0.369***	0.345***	0.329***	0.187***	0.480***	0.517***	0.464***
	[0.313]	[0.027]	[0.075]	[0.075]	[0.088]	[0.058]	[0.050]	[0.051]	[0.050]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Computer", defined as 1 for individuals with a computer at the time of the survey, 0 otherwise. All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. The estimation is based on the linear spline specification, restricted to individuals with an income above the program cutoff of 62.58 RON. Source: 2009 Euro 200 survey.

Appendix Table 5: Naïve 2SLS Results

Dependent variable	Computer use	Homework	Math GPA	Romanian GPA	English GPA	Raven's Progressive Matrices Test	Computer Test	Computer Fluency	Applications Fluency
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Computer	6.157***	-0.120*	-0.411**	-0.715***	-0.658**	0.278*	0.476***	0.397***	0.384***
	[0.826]	[0.071]	[0.202]	[0.216]	[0.295]	[0.148]	[0.120]	[0.152]	[0.147]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Computer" (defined as 1 for individuals with a computer at the time of the survey, 0 otherwise) instrumented with the variable "Winner (defined as 1 for individuals with an income above the program cutoff of 62.58 RON, 0 otherwise). All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. The estimation is based on the linear spline specification using the full sample. Source: 2009 Euro 200 survey.

Appendix Table 6: Specification Tests (Effect of the Euro200 program on covariates)

Dependent variable	Gender	Age	Romanian	Hungarian	Roma	Primary	Secondary	Tertiary	Child Gender	Child Age
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nonparametric	-0.052	-0.541	-0.014	-0.044	0.043	0.021	-0.032	0.011	-0.106**	-0.256
Bandwidth - 60	[0.038]	[0.890]	[0.044]	[0.037]	[0.039]	[0.043]	[0.045]	[0.014]	[0.042]	[0.253]
Nonparametric	-0.048	-0.021	-0.046	-0.084	0.099*	0.024	-0.024	0	-0.142**	0.166
Bandwidth - 30	[0.054]	[1.243]	[0.061]	[0.054]	[0.054]	[0.061]	[0.063]	[0.018]	[0.059]	[0.366]
Nonparametric	-0.001	-0.095	-0.079	-0.091	0.127	-0.011	0.018	-0.007	-0.167**	0.219
Bandwidth - 15	[0.079]	[1.693]	[0.084]	[0.076]	[0.078]	[0.088]	[0.090]	[0.029]	[0.081]	[0.489]
Nonparametric	-0.081	2.041	-0.05	-0.108	0.147	0.063	-0.11	0.048	-0.221*	-0.097
Bandwidth - 7.5	[0.111]	[2.381]	[0.126]	[0.102]	[0.105]	[0.121]	[0.122]	[0.040]	[0.117]	[0.655]
Nonparametric	-0.032	1.51	-0.058	-0.119	0.231*	0.232	-0.245*	0.053	-0.193	-0.109
IK Bandwidth	[0.146]	[1.845]	[0.160]	[0.124]	[0.121]	[0.146]	[0.140]	[0.050]	[0.131]	[0.709]
Nonparametric	-0.001	-0.676	-0.061	-0.069	0.066	0.024	-0.015	0.012	-0.136**	-0.346
CV Bandwidth	[0.079]	[1.078]	[0.068]	[0.095]	[0.044]	[0.061]	[0.065]	[0.027]	[0.056]	[0.290]
Parametric	-0.074**	-0.166	0.052	-0.039	0.003	0.008	-0.002	-0.007	-0.065*	-0.303
Linear Spline	[0.031]	[0.737]	[0.037]	[0.031]	[0.034]	[0.036]	[0.037]	[0.011]	[0.036]	[0.222]
Parametric	-0.052	-1.05	-0.084	-0.069	0.106**	0.034	-0.046	0.012	-0.129**	-0.263
Quadratic Spline	[0.048]	[1.139]	[0.056]	[0.047]	[0.051]	[0.056]	[0.058]	[0.018]	[0.054]	[0.332]
Parametric	-0.062	0.86	-0.003	-0.085	0.078	-0.016	0.016	0	-0.122*	0.253
Cubic Spline	[0.067]	[1.510]	[0.074]	[0.063]	[0.067]	[0.075]	[0.078]	[0.026]	[0.071]	[0.444]

Notes: Robust standard errors clustered at the household level are in brackets. ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The dependent variables are defined in Tables 1 and 2. The reported coefficients are for the variable "Winner", defined as 1 for individuals with an income below the program cutoff of 62.58 RON, 0 otherwise. All the parametric and non-parametric specifications are described in further detail in Section 5. All regressions include controls for age, gender, ethnicity and education of the head of household, age and gender of the child. Source: 2009 Euro 200 survey.