IDB WORKING PAPER SERIES No. IDB-WP-382

Home Computers and Child Outcomes:

Short-Term Impacts from a Randomized Experiment in Peru

Diether W. Beuermann
Julián P. Cristia
Yyannu Cruz-Aguayo
Santiago Cueto
Ofer Malamud

December 2012

Inter-American Development Bank
Department of Research and Chief Economist

Home Computers and Child Outcomes:

Short-Term Impacts from a Randomized Experiment in Peru

Diether W. Beuermann*
Julián P. Cristia*
Yyannu Cruz-Aguayo*
Santiago Cueto**
Ofer Malamud***

* Inter-American Development Bank
** Grupo de Análisis para el Desarrollo (GRADE)
*** University of Chicago and National Bureau of Economic Research

Inter-American Development Bank

2012

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Home computers and child outcomes : short-term impacts from a randomized experiment in Peru / Diether W. Beuermann, Julián P. Cristia, Yyannu Cruz-Aguayo, Santiago Cueto, Ofer Malamud.

p. cm. (IDB working paper series ; 382)

Includes bibliographical references.

1. Educational technology—Peru. 2. Education—Experimental methods—Peru. I. Beuermann, Diether. II. Cristia, Julián P. III. Cruz-Aguayo, Yyannu. IV. Cueto, Santiago, 1960-. V. Malamud, Ofer. VI. Inter-American Development Bank. Research Dept. VII. Series.

IDB-WP-382

http://www.iadb.org

Abstract[*]

This paper presents results from a randomized control trial in which approximately 1,000 OLPC XO laptops were provided for home use to children attending primary schools in Lima, Peru. The intervention increased access and use of home computers, with some substitution away from computer use outside the home. Beneficiaries were more likely to complete domestic chores but less likely to read books. Treatment children scored almost one standard deviation higher in a test of XO proficiency, though there were no effects on objective and self-reported skills for using a Windows-based PC and Internet. There were positive impacts on the Raven's Progressive Matrices test among children who did not have a home computer before the intervention, but no significant effects for the sample as a whole. Finally, there was little evidence for spillovers within schools, although close friends and classmates of laptop recipients did exhibit higher proficiency with the XO computer.

JEL classifications: C93, I21, I28
Keywords: Education, Technology, Experiments

[*] This project is the result of a collaborative effort involving many people. We want to especially thank Mariana Alfonso (IDB) and Jennelle Thompson (IDB) for their significant contributions. This project would not have been materialized without the collaboration and commitment shown by the Dirección General de Tecnologías Educativas in the Ministry of Education of Peru (DIGETE). We thank its current and former directors, Sandro Marcone and Oscar Becerra, respectively, and their excellent team including among others Roberto Bustamente, Carmen Alvarez and Victor Castillo. We also thank Giuliana Avila, Olga Namén, Elizabeth Rosales, Claudia Sugimaru, Diego Vera, and Micaela Wensjoe for outstanding research assistance. We acknowledge excellent comments and suggestions by Bruce Meyer, and by seminar participants at Cornell University, the Inter-American Development Bank (IDB), the SIEP conference in Peru, and the University of Pennsylvania. The views expressed in this paper are those of the authors and should not be attributed to the Inter-American Development Bank.

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. Today, home computers are practically ubiquitous in developed countries. Data from the 2009 round of the Program for International Student Assessment (PISA) indicates that an average of 95 percent of 15-year-old students in OECD member countries report having a computer at home (Organization for Economic Co-operation and Development, 2010). In contrast, access to home computers in developing countries continues to lag. Only about half of 15-year-old students in Albania, Brazil, Mexico, and Thailand report having a computer at home, while these proportions are even lower in Indonesia and Peru (Organization for Economic Co-operation and Development, 2010). Many government and non-governmental organizations are seeking to bridge this "digital divide" by distributing home computers to children in developing countries despite relatively little evidence about their impacts on children. This paper presents results from the first large-scale experiment focusing on the effect of home computers on children's outcomes in a developing country.

Among the most prominent initiatives to provide computers to children in developing countries is the One Laptop per Child (OLPC) program.[1] To date, more than 2.5 million OLPC laptops have been distributed to children in more than 52 countries. Peru has invested most heavily in this initiative by purchasing almost one million laptops at a cost of $200 million. Usually, these laptops have been distributed through schools, and the preponderance of use has occurred in the classroom (Cristia et al., 2012). However, the emphasis on self-empowered learning by the founders of OLPC suggests that these laptops may also be beneficial when used outside the structured classroom environment.

We designed and implemented a randomized control trial (RCT) in which we provided OLPC laptops to approximately 1,000 students attending public primary schools in Lima, Peru. The RCT incorporated randomization at both the school level and the individual level. We began by randomly selecting 14 treatment schools and 14 control schools from a sample of low-achieving public primary schools and conducting a detailed baseline survey. Within treatment schools, we provided a random sample of participating students with the XO laptops for home

[1] The "Euro 200" program in Romania and the "Yo Elijo Mi PC" program in Chile are two examples of government initiatives that provide home computers to low-income children.

use through in-class lotteries, while students in control schools did not receive any interventions. The design of this RCT was explicitly intended to explore the potential for spillovers from treatment.[2] Taking advantage of the randomization across and within-schools, together with comprehensive data on social networks collected at baseline, we can examine the effects on direct beneficiaries who received laptops as well as indirect beneficiaries such as classmates and friends. Note that the present study is not intended to directly evaluate the OLPC initiative, which posits several other necessary provisions for the effective use of OLPC laptops including "digital saturation" in the community and wireless connectivity.

We find that our intervention was successful in increasing the exposure of children to OLPC laptops at home. Compliance with the randomized assignment was close to ideal: 93 percent of treatment students received OLPC laptops, and no student in the control group received an OLPC laptop. The effect of the intervention on the likelihood that children had a computer at home is approximately 40 percentage points, while children in the treatment group were 34 percentage points more likely to use computers at home during the previous week. Interestingly, the intervention led to a decline of 11 percentage points in the likelihood of computer use in Internet cafes, suggesting that children who won a laptop substituted computer use at home for use outside the home. Overall, children in the treatment group report using computers at home for about 19 minutes longer each day. The largest effects of computer use seem to be associated with playing computer games and, to some extent, with listening to music on the computer. Based on detailed logs that recorded actual computer use, we see a clear decline in utilization over time.

The intervention also affected the time spent on other activities. Specifically, children in the treatment group were significantly more likely to complete domestic chores. They also reported a 6 percentage point lower likelihood of reading books, stories or magazines. By far the most pronounced impact of the intervention was a 0.88 standard deviation increase for scores on an objective test that measured proficiency in using the XO laptop. On the other hand, there were no significant differences between treatment and control groups on objective and self-reported skills for using a Windows personal computer (PC) and Internet. The effect on cognitive skills, as measured by the Raven's Progressive Matrices test, were positive but small and insignificant.

[2] A similar approach was employed by Duflo and Saez (2003) to explore information spillovers in retirement decisions within academic departments of a particular university in the United States.

Interestingly, the effect on the Raven's test was significant, at 0.08 of a standard deviation, for the sample of children who did not have a home computer before the intervention. Based on reports by teachers, children in the treatment group were significantly less likely to exert effort at school compared with their counterparts in the control group. Finally, we did not observe much evidence for spillovers, though classmates within the social network of children who received OLPC laptops did display significantly higher levels of proficiency in using the XO laptop.

Although there is a large literature exploring the effects of computer use at school (e.g., Angrist and Lavy, 2000; Machin, McNally and Silva, 2006; Banerjee et al., 2007), only a few recent studies have examined the effect of home computers on children's outcomes. Malamud and Pop-Eleches (2011) used a regression discontinuity design to examine a Romanian government program which provided home computers to poor children in families below a particular income threshold. They found that home computers led to lower school grades but higher cognitive skills and computer skills one year after the computers were distributed. Cristia et al. (2012) evaluated the OLPC program by implementing a randomized-control trial across 319 primary schools in rural Peru. They found no impacts on academic achievement in math and language standardized tests but also observed some positive and significant impacts on cognitive skills. Finally, Fairlie and Robinson (2012) conducted an experimental study of home computers within middle and high schools in the United States. They found no impacts of home computers on academic achievement based on standardized tests or grades.[3]

This paper makes several contributions to the existing literature on technology in education. First, this study represents the first large-scale randomized experiment aimed at exploring the effects of expanding home computer access in a developing country. Focusing on this setting is especially policy-relevant given that governments and households in the developing world are making significant investments to expand home computer access. Second, we can provide evidence on spillover effects by exploiting the double-randomization design (across both schools and individuals) and rich baseline information on social networks. Third, because our individual-level randomization includes more than 2,700 students with follow-up data, we can provide very precise estimates of impacts on a variety of outcomes. Finally, our

[3] A number of earlier studies estimated the impacts of home computers using more demanding identification assumptions. For example, Vigdor and Ladd (2010) exploited changes in home computer ownership over time as reported by students in North Carolina and estimated negative impacts on math and language test scores.

study is the first to collect the entire history of computer use logs providing important evidence on potential mechanisms underlying the effects on final outcomes.

The remainder of the paper is structured as follows. Section 2 describes the design and implementation of the RCT. Section 3 explains our data collection efforts and the empirical strategy we use to analyze the data. Section 4 presents the main results, while Section 5 offers additional results on spillovers and impact heterogeneity. Finally, Section 6 provides a summary of our findings and discusses our future work.

2. Study Design

A randomized control trial (RCT) employing randomization at both the school level and the individual level forms the basis of the study design. First, we randomly selected 14 treatment schools and 14 control schools from a sample of low-achieving public primary schools. Then, within treatment schools, we provided a random sample of students with OLPC XO laptops while students in control schools did not receive any intervention. Children in all schools also had occasional access to their school's own computer lab. The timeline of the study is as follows. Baseline data were collected in April/May 2011, and the within-school lottery (and delivery of laptops) was implemented in June/July 2011. Training for students was offered in August/September 2011, and the follow-up data were collected in November 2011. This section describes the selection of schools and the within-school interventions in more detail.

2.1 Selection of Schools

We targeted large low-performing public elementary schools in Lima. Specifically, we selected public elementary schools with morning shifts which enrolled between 400 and 800 students according to the 2010 School Census data. We then ranked these schools according to their average performance on the second grade national standardized examination between 2007 and 2009. We administered a brief phone survey to the 70 lowest performing schools with valid contact information, and collected updated information on enrollment, number of sections, and access to computers and classrooms. We further restricted our sample to schools which had fewer than 25 class sections (namely, a maximum of 4 classes per grade), a ratio of school computers to students lower than 0.15, and a classroom available for a computer lab in the afternoon. This resulted in a target sample of 40 schools.

To assign schools to treatment and control status, we carried out a pair-wise matching procedure based on Bruhn and McKenzie (2009) who implement the "optimal greedy algorithm" suggested by King et al. (2007). We matched on average class size (enrollment divided by the number of class sections) and the ratio of computers to students in each school. The pairs were formed to minimize the Mahalanobis distance between the values of class size and computer-to-student ratios within pairs, and one unit in each pair was randomly assigned to treatment and the other to control. We proceeded to visit the treatment and control schools in each pair and invite each school to participate in the study. All schools agreed to participate in the study. However, to allow a higher fidelity of implementation we further reduced the study sample to 14 school pairs composed of 14 treatment schools and 14 control schools.

2.2 Within-School Interventions

The principal intervention for this study involved providing XO laptops to randomly selected students in treatment schools. In June-July 2011, we conducted a public lottery for four XO laptops within each class/section determined eligible for the intervention. A class was considered eligible for the intervention if more than 60 percent of the children in the class obtained consent from their parents or legal guardians. Furthermore, only children whose parents provided written consent were included in the lottery in the eligible classrooms. These procedures were developed in coordination with schools, principals, and teachers. The lotteries were conducted in class and parents were invited to attend in order to assure transparency.[4] We distributed 1,048 laptops provided by the Ministry of Education of Peru.

The laptops were specifically designed to be used by primary students in developing countries. These netbook-sized computers are light, sturdy, energy-efficient and portable. The laptops have 512 MB of RAM, 2 GB of flash storage and a battery that lasts for about two to three hours. The operating system is Linux and the graphical interface is known as Sugar.[5] This graphical interface has been designed to be used by children and there are hundreds of applications that can be installed.

Thirty-two applications, selected by the Ministry of Education for nationwide use, were installed in the distributed laptops. The applications include: i) standard applications such as

[4] We conducted several focus groups with parents and teachers from the schools to discuss the concept of lotteries and explore alternative approaches to conduct the lotteries.
[5] The laptops do not run Windows, and they are not compatible with software designed for that operating system. However, most files (e.g., images, sound and text documents) are compatible with the Windows environment.

word processor, drawing software, calculator and chat; ii) educational games including Tetris, Sudoku and a variety of puzzles; iii) applications to create, edit and play music; iv) two programming environments; and v) other applications including sound and video recording and specific sections of Wikipedia. The laptops were also pre-loaded with age-appropriate e-books selected by the Ministry of Education.

To encourage adequate use of the laptops, we provided all beneficiary students with an instruction manual and training sessions. The manual we developed presented general information about how to use the laptop and more in-depth practical instruction for 10 prioritized applications. The manual was designed for primary school children and emphasized graphical illustrations and practical assistance on how to use the applications rather than covering technical knowledge. Weekly training sessions took place in each treatment school during a seven-week period in August and September. On each Saturday during the training period, there were three two-hour sessions for students arranged by grade (1-2, 3-4 and 5-6 grades, respectively). Average student attendance was about 50 percent, and approximately 70 percent of students attended at least one session.

3. Data and Empirical Strategy

3.1 Data

The data used in this evaluation come from three primary sources: i) administrative data at the school level from the Peruvian Education Statistics Unit and individual-level standardized tests from Student Census Evaluation (ECE) at the Ministry of Education of Peru; ii) a baseline survey among all students attending grades 1 through 6 in treatment and control schools during April/May 2011 that collected information on basic demographics, computer literacy, computer and Internet use, time use, and detailed information about social networks, as well as tests of cognitive skills (Raven’s Progressive Matrices) and standardized tests in math and language ability; and iii) a short-term follow-up survey in November 2011 restricted to students attending grades 3 to 6 which covered most topics examined in the baseline survey except for the standardized tests in math and language ability. The attrition rate of students between the baseline and follow-up was 9 percent, and it was not statistically different between laptop winners and non-winners.

The administrative data from the Ministry of Education (MINEDU) consisted of several databases on primary schools in Peru and included annual information on a variety of school-level indicators from 2001 to 2010: school location (region, province and district), source of funding (public/private), year opened, presence of morning and afternoon shift enrollment (by year and gender) and number of sections in each year administrative, managerial and teaching staff (number, gender, qualifications). There was also information on infrastructure (water, electricity, sanitation), furniture (desks, blackboards), educational resources (existence of a library, number of books), computational resources (number of computers, Internet, network connection), basic educational outcomes (repetition rate, intra-annual dropout rate). The ECE is an annual census examination of second grade students in Spanish-only schools that has been conducted since 2006, covering both mathematics-logic and language comprehension. Coverage of schools in Lima has been extremely high, and all schools in our sample were tested in 2007-2009. This information, together with the school-level data for the most recent year of 2010, was used to construct the initial sample of primary schools and implement the pair-wise matching procedure.

The format of the baseline and follow-up data collection was extremely similar, with the exception of the achievement tests in Math and Reading, which were collected only at baseline. These achievement tests were administered in a group setting to all students in grades 1 to 6 and were developed separately for each grade using items drawn from previous nationally standardized exams. We also administered the Colored Raven Progressive Matrices test that was specifically designed for children ages 5 to 11 and has been widely used to assess non-verbal cognitive ability. In this test, respondents are presented a series of progressively more difficult matching-exercises that require choosing the figure that completes a pattern. The test measures "educative ability - the ability to make sense and meaning out of complex or confusing data; the ability to perceive new patterns and relationships, and to forge (largely non-verbal) constructs which make it easy to handle complexity" (Pearson, 2011). Note that, in the empirical analysis, cognitive and achievement measures are standardized by grade, subtracting the mean and dividing by the standard deviation in control schools. Finally, we administered three assessments of computer skills: i) an objective test that measured the proficiency in using an OLPC XO laptop, ii) a multiple-choice test consisting of five questions intended to measure practical knowledge about using a Windows personal computer (PC) and Internet, and iii) a set of 11 (yes/no) subjective questions in which students were asked to report whether they could perform various tasks related to using a PC and Internet.[6]

Student surveys were administered to children in grades 3 to 6 and aimed to capture information on socio-demographic characteristics, access and use of computers and laptops, as well as participation in other activities (e.g., reading, doing homework, watching television, etc.). The questions on participation were posed for whether a particular activity was completed in the previous day. The questions about computer and Internet use were substantially more detailed. They elicited information about where the computer and Internet use took place and what specific activities were undertaken; they also included the intensive margin by asking about hours and minutes of use in the prior day. We additionally extracted log files from the XO laptops to allow for objective assessments of patterns of use. These logs recorded the date and time when each session started as well as roughly when every application was closed (parental consent included permission to gather this information). Note that this provides an upper bound for use because we cannot be certain that children are actually using the computer throughout the time that an application is open. Effective computer records were collected for about 67 percent of beneficiaries. Finally, we collected information on social networks at baseline and in the follow-up by asking children to list their four closest friends and their friends when partaking in other activities.[7] To generate an estimate of the number of friends not constrained by the list, we constructed the number of friends for an individual based on the number of times they were listed by other students in the class.

All teachers in treatment and control schools completed self-administered questionnaires that collected information on socio-demographic characteristics, education and experience, access and use of computers and laptops, satisfaction with their work, self-efficacy and attitudes towards computers in education. School principals also completed a self-administered questionnaire covering the following: services at the school and the community (running water, sewage, electricity, phone, Internet); enrollment by grade; access and use of computers; laptops received; and implementation issues including number of malfunctioning and repaired laptops.

[6] These instruments were developed by the authors and are available upon request.
[7] These included the four friends with whom they did homework, the four friends whom they visited at home, and the four friends they listed as those with whom they would share a computer if they would receive one.

3.2 Empirical Strategy

The empirical framework for our analysis involves three comparisons. First, we use the observations on children in the 14 treatment schools to compare children that won the computer lottery with those who participated in the lottery but did not win. In particular, we estimate the following regression model:

$$Y_{ijk,t} = \delta_j + \lambda \cdot Y_{ijk,t-1} + \lambda_1^{'} X_{ijk,t-1} + \beta_1 \cdot Winner_{ijk} + \varepsilon_{1,ijk,t} \tag{1}$$

where $Y_{ijk,t}$ denotes the outcome of interest for child *i*, in class *j* and school *k* observed at follow-up, δ_j is a class fixed effect, $Y_{ijk,t-1}$ is the outcome of interest observed at baseline and $X_{ijk,t-1}$ is a vector of control variables observed at baseline that includes age, number of siblings, number of younger siblings, whether the father lives with the child, whether the father works at home and whether the mother works at home. $Winner_{ijk}$ is a treatment indicator which takes the value of one if child *i* in class *j* and school *k* won a computer and zero otherwise. Finally, $\varepsilon_{1,ijk,t}$ is the error term which is clustered at the school level in all regressions. Accordingly, estimates of β_1 quantify the differences in means between laptop winners and non-winners.

Table 1 provides evidence that the within-school randomization was successful in generating balance between treatment and control groups. Among the 14 selected characteristics only one is significant, and only at the 10 percent level. Moreover, Tables A1-A3 in the Appendix show that among all 40 collected characteristics, only three were significant at the 10 percent level. Thus, the randomization of computers was successful in creating appropriate treatment and control groups to consistently identify the effects of the intervention through equation (1).

Our second set of comparisons exploits the information collected on social networks at baseline to assess the presence of spillover effects among friends within classes. To do this, we split children who did not win the lottery into two sub-groups: children reported as close friends of at least one child who did win a lottery, and those not mentioned as a close friend of any child who won the lottery. Specifically, we run the following regression model:

$$Y_{ijk,t} = \delta_j + \lambda \cdot Y_{ijk,t-1} + \lambda_1^{'} X_{ijk,t-1} + \lambda_2 \cdot N_{ijk} + \beta_2 \cdot Winner_{ijk} + \gamma \cdot Friend_{ijk} + \varepsilon_{2,ijk,t} \tag{2}$$

where $Friend_{ijk}$ takes the value of one if child *i* in class *j* and school *k* was reported as a close friend by at least one lottery winner and zero otherwise. N_{ijk} is the number of participating children who report child *i* as a close friend. All other variables are defined as in equation (1). It is important to control for N_{ijk} because children with more participating friends are also mechanically more likely to have a lottery winner among their friends. However, conditioning on the number of friends, whether a child has a friend who won a laptop should be random. We find that, once we condition on the number of participating friends, baseline characteristics are well balanced between students whose friends won laptops and those who did not (see Table A4 in the Appendix).

In equation (2), β_2 is the difference in means between the outcomes of laptop winners and non-winners who were not friends with any of the lottery winners. Moreover, γ quantifies the difference in means between non-winners *with* friends among the lottery winners and non-winners *without* friends among any lottery winners. Under the assumption that children who were not close friends with the lottery winners experienced little or no spillovers from the intervention, we can interpret estimates of β_2 as a measure of the treatment effect, and γ as a measure of the spillover effect. Insofar as the intervention involved home computers that were used outside of school, we believe that this assumption is a reasonable one.[8]

To the extent that spillover effects are transmitted entirely through social networks, the aforementioned strategy will be effective in identifying spillover effects. But if some spillovers also occur outside of social networks, then such strategy would underestimate these effects. Accordingly, our third strategy estimates spillover effects among all winners' classmates by comparing all non-winner children within the 14 treatment schools to children in the 14 control schools. However, because the treatment schools and control schools do not seem to be well balanced at baseline (see Table A5 in the Appendix), we use a difference-in-difference specification.[9] This approach eliminates any bias from time-invariant differences between treatment and control schools. Still, due to the possibility of differential time trends, results from

[8] However, it is possible that the effect of computer use at home leads to differences in behavior at school which influence children who are outside the immediate social network of lottery winners.

[9] The lack of balance is likely due to the small number of treatment and control schools. Note, the groups are balanced on the characteristics selected for the pair-wise matching procedure but not on all other characteristics.

this approach are more tentative than conclusive. Formally, we run the following regression model:

$$Y_{ik,t} = \alpha + \lambda \cdot Treated_k + \lambda_1 \cdot Post_t + \beta_3 \cdot Treated_k \cdot Post_t + \varepsilon_{3,ikw,t} \quad (3)$$

where $Y_{ik,t}$ denotes the outcome of interest for child *i*, in school *k* observed at time *t*. $Treated_k$ takes the value of one if lotteries were conducted in school *k* and zero otherwise. $Post_t$ takes the value of one for observations collected in the follow-up data collection and zero otherwise. In equation (3), estimates of β_3 quantify spillover effects operating from laptop winners on their socially unrelated classmates.

There are two additional issues associated with estimating spillover across classmates. First, because the lottery in treatment schools was only performed among students whose parents provided an informed consent, non-winners are not a random sample of students within treatment schools. In particular, because winners are drawn only from those students who participated in the lottery, non-participants are over-represented in the sample of non-winners compared to the sample of all students. We deal with this problem by reweighting observations among non-winners to give more weight to those participating in the lottery. Specifically, we divide students in treatment school classes between those who participated in the lottery and those who did not participate: for the first group we have a random sample (i.e., the non-winners among lottery participants); for the second group we have the complete sample. Hence, reweighting those who participated in the lottery but did not win by $\frac{N_L+N_W}{N_L}$ (where N_L corresponds to the number of lottery participants that lost and N_L to those that won) yields a sample of non-winners that is representative of the population of students in each school.

The second issue relates to the small number of clusters when making direct comparisons across just 28 schools. It is well-known that standard approaches to estimating regression equations with a small number of clusters can introduce biases in the estimation of standard errors (Bertrand, Duflo and Mullainathan, 2004). Cameron, Gelbach and Miller (2008) suggest a bootstrapping procedure called wild bootstrap-t to produce an empirical t-distribution that can be used to derive p-values. We implement this bootstrapping procedure and derive critical values for t-stats which are used to determine the significance levels in Tables 11-14.

4. Main Results

This section presents the impact of the intervention on computer access and use, other time use, computer skills, cognitive skills, and teacher assessments. We examine spillover effects and heterogeneous impacts in the subsequent section. All our results are based on intent-to-treat (ITT) estimates; that is, we compare laptop winners with non-winners regardless of whether winners actually received a laptop. For one thing, this may be the more relevant parameter for policy interest. However, given the extremely high take-up rate of 93 percent, the ITT estimates will be similar to the treatment on the treated (TOT) estimates.[10] This take-up rate is not so surprising given that these families had already agreed to participate in the lottery. However, it also confirms the successful implementation of our intervention.[11]

4.1. Computer Access and Use

Table 2 presents our findings related to self-reported computer access and use. The effect of the intervention on the likelihood that children report having a computer at home is approximately 40 percentage points. This represents a large effect on access to home computers but it is somewhat ameliorated, as 50 percent of children in the control group already own a computer.[12] There are also significant differences in computer use, with impacts of 6 and 9 percentage points for using a computer last week and yesterday, respectively. Besides these aggregate measures, we collected several more detailed measures of computer utilization at both the extensive and intensive margins.

First, we examine *where* children use their computers. Consistent with the nature of our intervention, we observe a large increase of 34 percentage points in the likelihood of using computers at home during the previous week. There is no change in the likelihood of using a computer in school. Interestingly, lottery winners are 11 percentage points less likely to use computers in Internet cafes. Therefore, it seems that children who win a laptop are substituting computer use at home for use outside the home. We also measure computer utilization on the intensive margin by asking children about the number of minutes they used a computer during

[10] The approximate TOT estimates can be obtained by scaling up the ITT estimates by 1/0.93 or 1.075.

[11] The few cases of non-compliance seem to be because of children whose parents did not follow the procedure to receive the assigned laptop.

[12] Note that only 43 percent of students in the control group report having a home computer at baseline, suggesting that many of them acquired a computer after (and, perhaps, because of) our intervention. Although we did not collect information about the nature of other computers in the household, these are unlikely to be XO computers.

the previous day. We find that children in the treatment group report using computers at home for 19 minutes longer each day. There are no significant effects on the intensive margin of utilization at school, Internet cafes or friends' house. As a useful check on these self-reported measures of utilization, we also determine actual laptop utilization for the treated group from logs that we installed in the OLPC laptops. The average daily use based on these logs was 51 minutes over the first six months of the intervention, or 12 minutes lower than the 63 minutes a day reported by the children themselves. Note that students report overall computer use at home which can occur with the provided XO laptops or with other computers.

Second, we examine *how* children use their computers. Table 2 indicates that lottery winners are 10 percentage points more likely to use computers to play games and 5 percentage points more likely to use computers to listen to music. They are also 5 percentage points less likely to watch movies on their computers. Moreover, lottery winners do not differ from non-winners with their likelihood of reporting computer use for homework. Note that we also measured Internet access and utilization. However, although our initial intervention did not include any provision for Internet access, it is not surprising that there were no effects on either Internet access or utilization.

Finally, in Table 3, we explore the data from the computer logs in more detail. There is a clear decline in utilization over time by gender, grade, and prior home computer access. There is also some evidence that boys use computers more intensively than girls (an average of 55 versus 46 minutes daily). Furthermore, children that report having no previous access to home computer display a significantly higher utilization than children with previous access (an average of 58 versus 44 minutes daily). In terms of the particular software applications used, we observe that boys are more likely to listen to music than girls, and that younger children in 3^{rd} and 4^{th} grade are more likely use the music applications than their older counterparts.

4.2. Time Use

Table 4 shows the impact of the intervention on a broad set of activities. These measures are based on binary variables indicating that the child reported being engaged in each activity in the previous day. Again, there is a large and significant effect on the likelihood of computer use at home. Interestingly, there is also a small positive and significant effect on the likelihood of completing domestic chores such as cooking, cleaning and washing clothes and dishes. One potential explanation for this result is that parents of laptop winners have greater opportunities to engage their children in domestic activities because they are spending more time at home; another is that parents of laptop winners may be allowing their children to use the laptop as a reward for completing chores. The increased likelihood of using the computer seems to crowd out other activities. For example, we observe a 4 percentage point decline in the probability of playing without a laptop. Children who won the lottery also report a significantly lower likelihood of reading books, stories or magazines equivalent to 6 percentage points. This result is consistent with Malamud and Pop-Eleches (2011) who found that home computers were associated with lower daily reading. Finally, we find no evidence that winning an OLPC laptop affects the number of children who report themselves as friends or the frequency of visits from these friends.

4.3. Computer Skills, Cognitive Skills, and Teacher Assessments

We administered three assessments to measure changes in computer skills over the first 6 months of exposure to treatment: i) an objective test that measured the proficiency in using an OLPC XO laptop, ii) a multiple choice test consisting of five questions intended to measure practical knowledge about using a Windows personal computer (PC) and Internet, and iii) a set of 11 (yes/no) subjective questions in which students were asked to report whether they could perform various tasks related to using a PC and Internet. Table 5 reveals an extremely large positive effect of the intervention on the items testing XO-specific laptop knowledge. This effect equals 0.88 of a standard deviation. On the other hand, there are no significant differences between treatment and control students in both tests aimed at measuring skills related to using a PC and Internet.[13]

We also administered the Raven's Progressive Matrices test. This cognitive test is thought to measure general intelligence independent of formal schooling. Moreover, given that the test requires matching various shapes and patterns to a series of spatial configurations, it may also pick up an important spatial component of cognitive skills. Previous findings in Malamud and Pop-Eleches (2011) and Cristia et al. (2012) found significant effects of exposure to computers on this measure of cognitive skills. However, while the estimated effect of the current

[13] We do find some small positive significant effects on test items related to general computer skills that are useful for either an XO or a PC. However, we find no measurable impacts on items measuring specific computer skills for using a PC or Internet. The small number of items may also limit our ability to discern sizeable effects.

intervention is positive as in earlier studies, it is small and insignificant. One possible explanation for the absence of any effects here is the short period of exposure to the laptops. Another is that children in urban areas already have a relatively high base level of cognitive skills that is not as easily improved through technology. Indeed, their scores on this test are far higher than those of their counterparts in rural Peru.

Finally, we collected information based on teacher's perceptions of students about their social popularity, effort at school and expected educational attainment. For the first two dimensions, we asked teachers how they evaluate each pupil within his classroom: below average, average, or above average. Regarding educational expectations, the options reported by teachers consisted of whether the child was expected to attain primary, secondary or post-secondary education. We then constructed summary indicators that take the value of one if the teacher reported the highest possible outcome for the pupil and zero otherwise. We did not observe any effect of treatment on the teacher's perception of social popularity or educational expectations. However, there is some evidence that effort at school was negatively affected; children who won a lottery were 5 percentage points less likely to provide high levels of effort at school as compared to non-winners. Again, this finding is in line with the evidence on negative effects of home computer access on school grades in Romania reported by Malamud and Pop-Eleches (2011).

5. Further Results

5.1. Social Networks

Inherent in the nature of within-school interventions is the possibility for spillovers across students. This represents a potential concern for estimating treatment effects within schools because the comparison group of students may have also been affected by the treatment. However, the existence of spillovers across students is also a question of substantial interest in the education literature. We explore the potential for spillover effects by i) taking advantage of social network data reported by all students in treatment schools at baseline and ii) including a set of comparison schools in which no treatment was provided to any students.

We collected information on social networks from all children at baseline. Among children who did not win the OLPC lottery, we distinguish between those reported as being a "close friend" of at least one child who did win a lottery, and those not mentioned as a "close friend" of any child who won the lottery. Under the assumption that children who were not close friends with any lottery winner experienced little or no spillovers from the intervention, we can compare i) lottery winners with non-winners outside the winners' direct social networks as a measure of the treatment effect, and ii) non-winners *with* friends among the lottery winners versus non-winners *without* friends among the lottery winners as a measure of the spillover effect. Insofar as the treatment was experienced at home, this assumption seems plausible.

We do not observe strong spillover effects in computer access and utilization. However, as shown in Table 6, children within the direct social network of laptop winners have 3.1 more minutes of daily computer use at a friend's house. Although this is a small effect, it does suggest that some non-winners were able to increase their utilization of computers through their social networks. Table 7 does not reveal any evidence for spillover effects in time-use or sociability. But Table 8 does indicate a significant spillover effect of 0.14 standard deviations in XO computing skills. While the magnitude of this effect is much smaller than the one experienced by lottery winners, the elasticity of utilization is actually larger than that for lottery winners. Thus, the increase in computer utilization arising from having friends who received an OLPC laptop seems to have been translated into specific computer skills.

The strategy of identifying spillover effects through reports of "close friends" is effective as long as all these effects are transmitted through social networks. However, if some spillovers occur outside social networks, then this approach underestimates total spillovers. Therefore, our second strategy exploits the school-level randomization to explore spill-overs on all classmates in treatment schools.[14]

The results pertaining to computer access and utilization are presented in Table 9. Interestingly, we observe that non-winners had a 5 percentage point higher probability of having a computer at home than children in our control schools. This might suggest an increased demand for a home computer for children who participated in the lottery but did not win a computer. Moreover, we also see a decreased likelihood of computer utilization at school, equivalent to 17 percentage points. This effect is primarily driven by the increased utilization within control schools and, at this point, we have no specific explanation of this pattern. We do not find further effects in computer use and changes in time use, suggesting little action in these

[14] We do so with a difference-in-difference framework to address the absence of general baseline balance between treated and control schools.

important mediating variables (Tables 9 and 10). In general, we do not find effects on social networks except for a negative effect in number of homework partners. Finally, though we do not find evidence of spillover effects on cognitive abilities, teachers' assessments or PC and Internet skills, we find a significant positive effect on skills for using an OLPC laptop (Table 11). This suggests even larger effects of the intervention on OLPC-specific skills than documented when comparing winners and losers within treatment schools (Table 5).

5.2.Heterogeneous Effects

In addition to the effects of the intervention on the full sample, we also explored for heterogeneous effects by individual characteristics. We focused on differences by gender, age, and prior access to computers, which represent key factors that may be important in mediating the outcomes of a computer-based intervention. The findings, shown in Tables 12-14, are organized by our outcome variables in an analogous fashion to the tables showing the main effects, but we structure the subsequent discussion according to our principal mediating variables.

The impact of the intervention on access to home computers by gender is similar, with only slightly higher rates for girls than boys, which are not significantly different from one another. However, there are some differences in our measures of computer use: girls had higher impacts than boys on the extensive margin for the previous week (7 versus 5 percentage points), girls had significantly lower computer use at Internet cafés (11 percentage points) whereas boys did not; both girls and boys were more likely to play computer games than their non-winner counterparts (by 13 and 8 percentage points, respectively), but only boys had higher impacts for listening to music on their computer (9 percentage points). On the intensive margin, both boys and girls had a positive impact of 20 minutes a day of home computer use. The impact of the intervention on time use is relatively similar for boys and girls, although only girls have marginally significantly higher impacts of helping with chores at home (6 percentage points) and only boys have significantly lower impacts of reading (10 percentage points). Finally, despite the slightly lower impacts of computer access and use, the impact of the intervention on computer skills is higher for boys. There is evidence that boys did obtain some general computer skills from exposure to the OLPC laptop, and boys scored significantly higher on the OLPC-specific test as compared to girls (0.98 vs. 0.74 of a standard deviation).

The impact of the intervention on access to home computers by age is somewhat higher for younger (43 percentage points) than older children (36 percentage points). In part, this is because households with older children were more likely to own a home computer before the intervention. This difference in access is also reflected in higher impacts of use for younger children: for use in the previous week, younger children exhibit larger effects (8 percentage points) than older children (4 percentage points); on the intensive margin, younger children exhibit higher home use (26 minutes a day) than older children (13 minutes a day); and younger children seem to be spending their computer time playing games and listening to music. The positive impacts of the intervention on helping with household chores seems to be concentrated among older children, although it is more than offset by a reduction in spending time taking care of siblings and relatives. There are no significant differences in the impacts of the intervention on computer or cognitive skills between younger and older children. However, among younger children, the intervention is associated with reports of lower effort by teachers.

The differential impacts of the intervention by prior ownership of computers are quite substantial. Not surprisingly, the impact on access to a home computer at follow-up are substantially higher for children that reported no previous availability of a computer at home as compared to their counterparts who did report having access to a computer at home (57 versus 19 percentage points). This differential access is also reflected in patterns of extensive and intensive computer use in almost all categories: e.g., children with no previous access had larger effects on home use during the previous week (47 percentage points) than those with prior access (16 percentage points). Furthermore, the positive impacts on helping with household chores are also concentrated among children without previous access (8 percentage points). Despite the differential in access and use, lottery winners with and without prior access to home computers experienced similar increases in XO skills. For impacts on the Raven's Progressive Matrices tests, we observe a positive and significant effect of 0.08 standard deviations for lottery winners without previous access (and no significant impacts for lottery winners with previous access). The negative impacts on teacher's reports of perceived school effort are also concentrated in the group of lottery winners without previous access.

6. Summary and Further Work

This paper presents findings from a six-month follow-up of a randomized experiment in which approximately 1,000 OLPC laptops were provided for home use to students attending public primary schools in Lima, Peru. The intervention was successful at increasing children's exposure to computers by raising the likelihood that children had access to a computer at home and increasing the likelihood of home computer use at both the extensive and intensive margin. The intervention also affected the time spent on other activities, with children more likely to complete domestic chores but less likely to read books compared to their classmates. Although receiving an OLPC laptop led to a large impact in an objective test of XO proficiency, we find no evidence that the intervention translated into improvements in skills related to using a Windows PC or Internet. The effect of the intervention on cognitive skill, as measured by the Raven's Progressive Matrices test, was positive but small and insignificant. Moreover, based on reports by teachers, children who received OLPC laptops were significantly less likely to exert effort at school. There were some differences in impacts by gender and grade, but the largest impacts were observed for children who did not have a home computer prior to the intervention. Among this group of children, the intervention led to a small but significant increase in cognitive skills. Finally, we did not detect much evidence for spillovers in impacts within schools, although close friends and classmates of children who received OLPC laptops did show significantly higher levels of proficiency with the XO computer.

In terms of policy, the results above suggest that providing students with an OLPC XO computer access at home improves their skills in using this technology, even after only several months of use. Obviously, the provision of home computers to all students in public schools (in Peru or other countries in the region) would be quite expensive. But perhaps other options may be explored, such as increasing the time after school when they can use the computers freely and rotating the times when students can take computers home. At the very least, these options might be explored at least for those students that do not have a computer at home, in light of the large findings for this subgroup of children. To the extent that improving children's skills in using computers is an important goal for an educational system, providing access to them at home may be one way to achieve this.

This study is not meant to be an impact evaluation of the OLPC program; as mentioned earlier, an impact evaluation of OLPC in rural schools in Peru has already been conducted (see

Cristia et al., 2012). In this study, we examine the short-term effects of providing only some students with a laptop to take home, as well as providing them with training on how to use them. In Peru's official OLPC program, all students received a laptop, and training was typically provided to teachers but not to students. While the analysis of student training sessions is beyond the scope of this paper, we intend to analyze it in future work. Another of the main principles of the OLPC initiative is access to the Internet.[15] This was not part of our initial intervention. However, Internet access may have an impact on cognitive abilities or achievement through the provision of opportunities for information and communication.

We have followed-up on the central intervention analyzed in this paper with a second intervention that provided Internet to a subset of the children who received OLPC laptops. This second intervention was conducted in July and August of 2012, approximately 14 months after the start of the first intervention.[16] Among students who received XO laptops in grades 3 to 5, we randomly selected 260 students to receive high-speed Internet access at home for five months until the end of the school year in December 2012. We provided 10 additional training sessions and a manual for Internet use to help students take full advantage of this resource. We also attempted to minimize the possibility of exposure to adult content by blocking certain websites and providing guidelines for use to students and parents. The short-term impacts of this intervention will be explored in a follow-up survey to be conducted in November 2012, which will also allow us to investigate the medium term impacts of the original intervention that provided OLPC laptops. Thus, the combination of these two interventions will help us to disentangle the effects of home computers with and without Internet access, and to compare them with a baseline of students who had much more limited access to these technologies at home.

Our plans for the follow-up survey in November 2012 will focus on collecting an extensive array of educational outcomes, cognitive measures, and computer proficiency. We intend to administer standardized tests in math and language constructed using items from previous nationally standardized exams (as in the baseline). We also intend to administer a battery of cognitive tests including: i) a general cognitive test based on the Colored Raven's Progressive Matrices test together with an additional set of more difficult pattern-recognition

[15] OLPC principles are laid out in http://wiki.laptop.org/go/OLPC:Five_principles. Accessed November 22, 2011.

[16] Note that this intervention was only announced in June 2012, so children and parents were not aware of this intervention until immediately prior to the start of the intervention itself.

questions, ii) a test of verbal fluency that requires students to list the number of words starting with a particular letter, iii) a coding test similar to the one in the Wechsler test, iv) a test of spatial intelligence based on mental rotation exercises, and v) a short test of executive function. In addition, we plan to administer several instruments to test for computer skills, including i) a test of specific OLPC XO knowledge, ii) a test of general computer knowledge, iii) a test of Internet knowledge, and iv) self-reported assessments of computer and Internet literacy. Finally, as in the baseline, we will survey children on computer and Internet use, time spent on other activities, and detailed information on social networks. We will also survey teachers on children's academic ability, effort, and sociability. If funding permits, we are also considering whether to administer a more detailed time-use diary or a parent survey that will be conducted over the telephone.

References

Angrist, J., and V. Lavy. 2002. "New Evidence on Classroom Computers and Pupil Learning." *Economic Journal* 112: 735–765.

Banerjee, A. et al. 2007. "Remedying Education: Evidence from Two Randomized Experiments in India." *Quarterly Journal of Economics* 122: 1235–1264.

Bertrand, M., E. Duflo and S. Mullainathan. 2004. "How Much Should We Trust Difference in Difference Estimates." *Quarterly Journal of Economics* 119: 249–276.

Bruhn, M., and D. McKenzie. 2009. "In Pursuit of Balance: Randomization in Practice in Development Field Experiments." *American Economic Journal: Applied Economics* 1: 200–232.

Cameron, A., J. Gelbach and D. Miller. 2008. "Bootstrap-Based Improvements for Inference with Clustered Errors." *Review of Economics and Statistics* 90: 414–427.

Cristia, J. et al. 2012. "Technology and Child Development: Evidence from the One Laptop per Child Program." Working Paper IDB-WP-304. Washington, DC, United States: Inter-American Development Bank.

Duflo, E., and E. Saez. 2003. "The Role of Information and Social Interactions in Retirement Plan Decisions: Evidence from a Randomized Experiment." *Quarterly Journal of Economics* 118: 815–842.

Fairlie, R., and J. Robinson. 2012. "Experimental Evidence on the Effects of Home Computers on Academic Achievement among Schoolchildren." Santa Cruz, United States: University of California, Santa Cruz. Mimeographed document.

King, G. et al. 2007. "A 'Politically Robust' Experimental Design for Public Policy Evaluation, with Application to the Mexican Universal Health Insurance Program." *Journal of Policy Analysis and Management* 26: 479–506.

Machin, S., S. McNally and O. Silva. 2007. "New Technology in Schools: Is There a Payoff?" *Economic Journal* 117: 1145–1167.

Malamud, O. and C. Pop-Eleches, C. 2011. "Home Computer Use and the Development of Human Capital." *Quarterly Journal of Economics* 126: 987–1027.

Organization for Economic Co-operation and Development (OECD). 2010. "PISA 2009 Results: What Students Know and Can Do." Paris, France: OECD.

Pearson Assessment. 2011. "Raven's Progressive Matrices." Oxford, United Kingdom: Pearson Assessment. Accessed on November 22, 2011 at: http://www.psychcorp.co.uk/Psychology/AdultCognitionNeuropsychologyandLanguage/AdultGeneralAbilities/RavensProgressiveMatricesandVocabularyScales/RavensProgressiveMatricesandVocabularyScales.aspx

Vigdor, J., and H. Ladd. 2010. "Scaling the Digital Divide: Home Computer Technology and Student Achievement." NBER Working Paper 16078. Cambridge, United States: National Bureau of Economic Research.

Table 1. Balance: Laptop Winners versus Losers in Treatment Schools

	Treatment	Control	Adjusted Difference	*N*
	(1)	(2)	(3)	(4)
Student Characteristics				
Age	10.00	10.05	0.01	*2,817*
			(0.03)	
Male	0.49	0.48	0.02	*2,815*
			(0.02)	
Household Characteristics				
Number of siblings in household	2.30	2.24	-0.00	*2,815*
			(0.09)	
Father lives at home	0.76	0.77	0.00	*2,808*
			(0.04)	
Father works outside home	0.88	0.88	-0.01	*2,804*
			(0.02)	
Mother works outside home	0.51	0.53	-0.03	*2,817*
			(0.03)	
Phone	0.45	0.48	-0.03	*2,754*
			(0.02)	
Electricity	0.90	0.92	-0.00	*2,782*
			(0.02)	
Car	0.25	0.28	-0.03	*2,735*
			(0.03)	
Access				
Computer or laptop at home	0.41	0.43	-0.01	*2,867*
			(0.02)	
Internet at home	0.30	0.34	-0.04	*2,840*
			(0.02)*	
Academic achievement				
Math	-0.26	-0.23	0.02	*2,748*
			(0.03)	
Reading	-0.22	-0.14	-0.05	*2,691*
			(0.06)	
Cognitive skills				
Raven's progressive matrices	-0.13	-0.16	0.08	*2,832*
			(0.06)	

Notes: This table presents statistics and estimated differences between laptop lottery winners (treatment) and non-winners (control) within treatment schools. Baseline data collected in April 2011 restricted to students observed at follow-up are used. Columns (1) and (2) present means, column (3) presents estimated coefficients and standard errors from OLS regressions. Estimates in column (3) include class fixed-effects. Standard errors, reported in parentheses, are clustered at the school level. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 2. Effects on Laptop Winners: Computer Access and Use

	Treatment (1)	Control (2)	Adjusted Difference (3)	*N* (4)
Access				
Computer or laptop at home	0.89	0.50	0.40 (0.03)***	*2,786*
Use				
Last week	0.95	0.90	0.06 (0.01)***	*2,586*
Yesterday	0.81	0.73	0.09 (0.03)***	*2,645*
Use by place (last week)				
School	0.52	0.53	0.01 (0.03)	*2,586*
Home	0.82	0.50	0.34 (0.02)***	*2,588*
Internet café	0.42	0.52	-0.11 (0.02)***	*2,581*
Friend's house	0.20	0.23	-0.02 (0.02)	*2,511*
Use by place (minutes yesterday)				
School	20.04	23.07	-1.20 (1.99)	*2,645*
Home	63.04	44.72	19.15 (5.33)***	*2,645*
Internet café	31.55	33.84	-3.08 (3.22)	*2,645*
Friend's house	12.15	15.44	-3.96 (2.34)	*2,645*
Type of use (last week)				
Homework	0.75	0.74	0.01 (0.02)	*2,638*
Games	0.79	0.69	0.10 (0.03)**	*2,607*
Music	0.67	0.64	0.05 (0.03)*	*2,584*
Videos	0.38	0.42	-0.05 (0.02)*	*2,558*
Internet Access				
Internet at home	0.38	0.37	0.03 (0.02)	*2,751*
Used Internet last week	0.81	0.81	0.00 (0.02)	*2,645*

Notes: This table presents statistics and estimated differences between treatment and control students within treatment schools. Columns (1) and (2) present means, column (3) presents estimated coefficients and standard errors from OLS regressions. Estimates in column (3) include class fixed-effects and demographic controls as detailed in the text. Standard errors, reported in parentheses, are clustered at the school level. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 3. Average Daily Minutes of OLPC Laptop Use from Logs

		Gender		Grade		Baseline Computer Access	
	All	**Male**	**Female**	**3rd-4th**	**5th-6th**	**Access**	**No Access**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Use							
Overall	51	55*	46	50	53	44***	58
By month							
July	61	66	58	65	62	52***	74
August	54	59*	48	54	53	47*	61
September	49	54*	43	46	51	41*	56
October	39	42	37	36	45	34*	44
By type of application							
Music	14	16***	11	16***	12	11	16
Cognitive games	11	11	12	11	11	10	12
Utilities	11	11	11	11	11	9**	12
Reading	9	10*	8	9	9	8*	10
Programming	6	7	5	6	6	5*	7
Others	5	6*	4	5	6	5	6
Math	4	4	5	4	5	4	5
Measurement	1	2*	1	2	1	2	2
N	*490*	*212*	*236*	*239*	*230*	*193*	*267*

Notes : This table presents statistics on patterns of use by groups. It also indicates the statistical significance of differences across sub-groups within dimensions analyzed.***, **,* denote differences at the one, five and ten percent level, respectively. Column (1) represents overall average. Within each dimension, columns (3), (5) and (7) represent comparison groups. XO applications were grouped in eight types Cognitive, Reading , Math, Measurement, Music, Programming, Utilities and Others. Statistics are computed based on logs extracted from laptops for sessions lasting at most 12 hours. We present statistics for July to October to focus on months where all students had laptops for the entire period.

Table 4. Effects on Laptop Winners: Time Use and Social Networks

	Treatment (1)	Control (2)	Adjusted Difference (3)	*N* (4)
Use of time				
Helping at home	0.56	0.51	0.04	*2,809*
			(0.02)*	
Caring of household members	0.49	0.51	-0.03	*2,803*
			(0.02)	
Shopping	0.39	0.41	-0.03	*2,808*
			(0.02)	
Working in the street	0.04	0.03	0.01	*2,799*
			(0.01)	
Working at a store	0.15	0.15	-0.01	*2,787*
			(0.02)	
Doing homework	0.94	0.95	-0.01	*2,813*
			(0.01)	
Playing	0.80	0.83	-0.04	*2,813*
			(0.02)*	
Watching TV	0.88	0.89	0.00	*2,809*
			(0.01)	
Using a computer at home	0.72	0.37	0.36	*2,798*
			(0.02)***	
Reading	0.59	0.65	-0.06	*2,807*
			(0.03)*	
Using an Internet café	0.31	0.31	0.00	*2,807*
			(0.01)	
Social Networks				
Friends	3.44	3.48	-0.00	*2,786*
			(0.06)	
Visiting other classmates homes	1.98	2.00	-0.00	*2,786*
			(0.09)	
Homework partners	1.89	1.89	0.04	*2,786*
			(0.10)	
Total contacts	4.95	4.99	-0.02	*2,786*
			(0.09)	

Notes: This table presents statistics and estimated differences between treatment and control students within treatment schools. Columns (1) and (2) present means, column (3) presents estimated coefficients and standard errors from OLS regressions. Estimates in column (3) include class fixed-effects and demographic controls as detailed in the text. Standard errors, reported in parentheses, are clustered at the school level. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 5. Effects on Laptop Winners: Computer and Cognitive Skills

	Treatment	Control	Adjusted Difference	*N*
	(1)	(2)	(3)	(4)
Computer skills				
Objective OLPC test	1.21	0.39	0.88	*2,791*
			(0.07)***	
Objective PC and Internet test	0.40	0.40	0.02	*2,800*
			(0.01)	
Self-reported PC and Internet skills	0.67	0.67	0.01	*2,800*
			(0.01)	
Cognitive skills				
Raven's progressive matrices	-0.04	-0.07	0.05	*2,756*
			(0.04)	
Teachers' perceptions				
High skills in making friends	0.51	0.54	-0.02	*2,724*
			(0.02)	
High academic effort in class	0.42	0.46	-0.05	*2,725*
			(0.02)**	
Expected to complete University	0.61	0.64	-0.01	*2,719*
			(0.02)	

Notes: This table presents statistics and estimated differences between treatment and control students within treatment schools. Columns (1) and (2) present means, column (3) presents estimated coefficients and standard errors from OLS regressions. Estimates in column (3) include class fixed-effects and demographic controls as detailed in the text. Scores in the Raven's progressive matrices and the OLPC objective test have been normalized subtracting the mean and dividing by the standard deviation of students in control schools. Standard errors, reported in parentheses, are clustered at the school level. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 6. Effects on Laptop Winners and Spillovers on Friends: Computer Access and Use

	Effects on Winners (1)	Spill-Overs on Friends (2)	*N* (3)
Access			
Computer or laptop at home	0.41	0.01	*2,786*
	(0.03)***	(0.02)	
Use			
Last week	0.07	0.02	*2,586*
	(0.02)***	(0.02)	
Yesterday	0.10	0.01	*2,645*
	(0.03)***	(0.02)	
Use by place (last week)			
School	0.01	0.01	*2,586*
	(0.04)	(0.04)	
Home	0.34	0.01	*2,588*
	(0.02)***	(0.02)	
Internet café	-0.12	-0.03	*2,581*
	(0.03)***	(0.02)	
Friend's house	-0.02	0.00	*2,511*
	(0.02)	(0.02)	
Use by place (minutes yesterday)			
School	0.11	2.23	*2,645*
	(2.93)	(3.49)	
Home	17.83	-2.23	*2,645*
	(4.10)***	(3.99)	
Internet café	-5.12	-3.53	*2,645*
	(3.82)	(2.30)	
Friend's house	-1.99	3.45	*2,645*
	(2.06)	(1.56)**	
Type of use (last week)			
Homework	0.00	-0.00	*2,638*
	(0.03)	(0.03)	
Games	0.07	-0.04	*2,607*
	(0.03)**	(0.02)**	
Music	0.05	-0.01	*2,584*
	(0.03)	(0.01)	
Videos	-0.05	-0.02	*2,558*
	(0.02)**	(0.02)	
Internet Access			
Internet at home	0.03	0.01	*2,751*
	(0.03)	(0.02)	
Used Internet last week	-0.00	-0.01	*2,645*
	(0.02)	(0.02)	

Notes: This table explores the effects on laptop winners and spill-overs on their friends. Each row correspond to an OLS regression of the respective outcome on a dummy for lottery winner, a dummy for having a friend that won a lottery and controlling for number of friends (the omitted category are non-winners that do not have friends that won the laptop lottery). Column (1) presents estimated coefficients and standard errors for the effect on winners. Column (2) presents estimated coefficients and standard errors for the spill-over effect on non-winners that have friends that won a laptop lottery. Friendships are defined using baseline data. Estimates include class fixed-effects and demographic controls as detailed in the text. Standard errors, reported in parentheses, are clustered at the school level. Significance at one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 7. Effects on Winners and Spillovers on Friends: Time use and Social Networks

	Effects on Winners	Spill-Overs on Friends	*N*
	(1)	(2)	(3)
Use of time			
Helping at home	0.04	0.00	*2,809*
	(0.02)*	(0.01)	
Caring of household members	-0.04	-0.02	*2,803*
	(0.03)	(0.03)	
Shopping	-0.05	-0.03	*2,808*
	(0.02)*	(0.02)*	
Working in the street	0.01	-0.00	*2,799*
	(0.01)	(0.01)	
Working at a store	0.00	0.01	*2,787*
	(0.02)	(0.02)	
Doing homework	-0.01	0.01	*2,813*
	(0.02)	(0.01)	
Playing	-0.06	-0.03	*2,813*
	(0.02)**	(0.02)	
Watching TV	0.00	0.00	*2,809*
	(0.01)	(0.01)	
Using a computer at home	0.37	0.02	*2,798*
	(0.03)***	(0.02)	
Reading	-0.05	0.01	*2,807*
	(0.03)*	(0.02)	
Using an Internet café	-0.00	-0.00	*2,807*
	(0.02)	(0.01)	
Social Networks			
Friends	-0.02	0.06	*2,786*
	(0.06)	(0.09)	
Visiting other classmates homes	-0.03	-0.05	*2,786*
	(0.07)	(0.05)	
Homework partners	0.04	-0.02	*2,786*
	(0.11)	(0.07)	
Total contacts	0.00	0.00	*2,786*
	(0.10)	(0.08)	

Notes: This table explores the effects on laptop winners and spill-overs on their friends. Each row correspond to an OLS regression of the respective outcome on a dummy for lottery winner, a dummy for having a friend that won a lottery and controlling for number of friends (the omitted category are non-winners that do not have friends that won the laptop lottery). Column (1) presents estimated coefficients and standard errors for the effect on winners. Column (2) presents estimated coefficients and standard errors for the spill-over effect on non-winners that have friends that won a laptop lottery. Friendships are defined using baseline data. Estimates include class fixed-effects and demographic controls as detailed in the text. Standard errors, reported in parentheses, are clustered at the school level. Significance at one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 8. Effects on Winners and Spillovers on Friends: Computer and Cognitive Skills

	Effects on Winners	**Spill-Overs on Friends**	***N***
	(1)	**(2)**	**(3)**
Computer skills			
Objective OLPC test	0.96	0.14	*2,791*
	(0.09)***	(0.05)**	
Objective PC and Internet test	0.02	0.01	*2,800*
	(0.01)	(0.01)	
Self-reported PC and Internet skills	0.01	0.01	*2,800*
	(0.02)	(0.01)	
Cognitive skills			
Raven's progressive matrices	0.06	0.00	*2,756*
	(0.05)	(0.04)	
Teachers' perceptions			
High skills in making friends	0.00	0.03	*2,724*
	(0.02)	(0.02)	
High academic effort in class	-0.05	0.00	*2,725*
	(0.03)*	(0.02)	
Expected to complete University	-0.01	0.01	*2,719*
	(0.03)	(0.03)	

Notes: This table explores the effects on laptop winners and spill-overs on their friends. Each row correspond to an OLS regression of the respective outcome on a dummy for lottery winner, a dummy for having a friend that won a lottery and controlling for number of friends (the omitted category are non-winners that do not have friends that won the laptop lottery). Column (1) presents estimated coefficients and standard errors for the effect on winners. Column (2) presents estimated coefficients and standard errors for the spill-over effect on non-winners that have friends that won a laptop lottery. Friendships are defined using baseline data. Estimates include class fixed-effects and demographic controls as detailed in the text. Scores in the Raven's progressive matrices and the OLPC objective test have been normalized subtracting the mean and dividing by the standard deviation of students in control schools. Standard errors, reported in parentheses, are clustered at the school level. Significance at one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 9. Spillovers on Classmates: Computer Access and Use

	Non-Winners in Treatment Schools		All Students in Control Schools			
	Baseline	Follow-up	Baseline	Follow-up	Diff-in-Diff	*N*
	(1)	(2)	(3)	(4)	(5)	(6)
Access						
Computer or laptop at home	0.43	0.49	0.52	0.53	0.05	10,100
					(0.02)**	
Use						
Last week	0.87	0.90	0.86	0.93	-0.03	9,752
					(0.02)	
Yesterday	0.73	0.73	0.71	0.71	-0.00	9,800
					(0.03)	
Use by place (last week)						
School	0.51	0.53	0.43	0.62	-0.17	9,752
					(0.07)**	
Home	0.45	0.49	0.50	0.52	0.03	9,741
					(0.03)	
Internet café	0.52	0.52	0.49	0.52	-0.03	9,724
					(0.03)	
Friend's house	0.27	0.23	0.25	0.23	-0.02	9,636
					(0.01)	
Use by place (minutes yesterday)						
School	32.04	21.56	24.20	15.74	-2.02	9,800
					(5.70)	
Home	53.88	43.85	59.98	44.45	5.50	9,800
					(4.03)	
Internet café	48.54	34.67	41.80	34.27	-6.34	9,800
					(4.24)	
Friend's house	26.66	15.91	25.14	14.96	-0.57	9,800
					(3.48)	
Type of use (last week)						
Homework	0.71	0.73	0.72	0.74	0.01	9,861
					(0.03)	
Games	0.62	0.69	0.64	0.73	-0.02	9,792
					(0.02)	
Music	0.58	0.64	0.58	0.65	-0.01	9,759
					(0.02)	
Videos	0.45	0.44	0.42	0.43	-0.02	9,708
					(0.03)	
Internet Access						
Internet at home	0.34	0.37	0.40	0.43	0.01	10,045
					(0.02)	
Used Internet last week	0.84	0.81	0.84	0.84	-0.03	9,800
					(0.03)	

Notes: This table presents statistics and estimated differences between non laptop winners in treatment schools and those in control schools. Columns (1) to (4) present means, column (5) presents estimated coefficients and standard errors from differences-in-differences estimators. Estimates in column (5) include class fixed-effects. Standard errors, reported in parentheses, are clustered at the school level. Given the small number of clusters (28), the critical values for t-tests were drawn from a bootstrapped-t distribution following the procedure suggested by Cameron et al. (2008). Significance at one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 10. Spillovers on Classmates: Time Use and Social Networks

	Non-Winners in Treatment Schools		All Students in Control Schools			
	Baseline	**Follow-up**	**Baseline**	**Follow-up**	**Diff-in-Diff**	***N***
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Use of time						
Helping at home	0.57	0.52	0.56	0.54	-0.03	*10,023*
					(0.03)	
Caring of household members	0.61	0.51	0.60	0.52	-0.02	*9,999*
					(0.02)	
Shopping	0.46	0.42	0.44	0.39	0.01	*10,026*
					(0.03)	
Working in the street	0.05	0.03	0.03	0.02	-0.01	*10,008*
					(0.01)	
Working at a store	0.19	0.16	0.15	0.14	-0.02	*9,980*
					(0.02)	
Doing homework	0.95	0.95	0.97	0.97	-0.00	*10,022*
					(0.01)	
Playing	0.77	0.83	0.77	0.83	-0.00	*10,030*
					(0.02)	
Watching TV	0.82	0.87	0.83	0.89	-0.00	*10,021*
					(0.01)	
Using a computer at home	0.37	0.37	0.43	0.40	0.02	*10,006*
					(0.02)	
Reading	0.69	0.64	0.70	0.63	0.02	*10,025*
					(0.02)	
Using an Internet café	0.37	0.33	0.33	0.31	-0.02	*10,022*
					(0.02)	
Social Networks						
Friends	3.38	3.36	3.31	3.29	0.01	*9,708*
					(0.06)	
Visiting other classmates homes	2.52	1.91	2.06	1.73	-0.28	*9,708*
					(0.16)	
Homework partners	1.88	1.77	1.53	1.77	-0.35	*9,708*
					(0.15)**	
Total contacts	5.22	4.82	4.84	4.60	-0.16	*9,708*
					(0.18)	

Notes: This table presents statistics and estimated differences between non laptop winners in treatment schools and those in control schools. Columns (1) to (4) present means, column (5) presents estimated coefficients and standard errors from differences-in-differences estimators. Estimates in column (5) include class fixed-effects. Standard errors, reported in parentheses, are clustered at the school level. Given the small number of clusters (28), the critical values for t-tests were drawn from a bootstrapped-t distribution following the procedure suggested by Cameron et al. (2008). Significance at one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 11. Spillovers on Classmates: Computer and Cognitive Skills

	Non-Winners in Treatment Schools		All Students in Control Schools			
	Baseline	Follow-up	Baseline	Follow-up	Diff-in-Diff	*N*
	(1)	(2)	(3)	(4)	(5)	(6)
Computer skills						
Objective OLPC test	n.a.	0.31	n.a.	0.00	0.27 (0.08)***	4393
Objective PC and Internet test	0.33	0.39	0.34	0.42	-0.02 (0.02)	10,137
Self-reported PC and Internet skills	0.55	0.66	0.57	0.68	0.00 (0.01)	10,137
Cognitive skills						
Raven's progressive matrices	-0.25	-0.12	-0.01	0.00	0.12 (0.07)	9,991
Teachers' perceptions						
High skills in making friends	0.52	0.52	0.59	0.65	-0.05 (0.03)	9,625
High academic effort in class	0.43	0.42	0.47	0.51	-0.05 (0.03)*	9,624
Expected to complete University	0.60	0.59	0.68	0.68	-0.01 (0.03)	9,617

Notes: This table presents statistics and estimated differences between non laptop winners in treatment schools and those in control schools. Columns (1) to (4) present means, column (5) presents estimated coefficients and standard errors from differences-in-differences estimators. Estimates in column (5) include class fixed-effects. Scores in the Raven's progressive matrices and the OLPC objective test have been normalized subtracting the mean and dividing by the standard deviation of students in control schools. Standard errors, reported in parentheses, are clustered at the school level. Given the small number of clusters (28), the critical values for t-tests were drawn from a bootstrapped-t distribution following the procedure suggested by Cameron et al. (2008). Significance at one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 12. Effects on Winners by Selected Sub-Groups: Computer Access and Use

	Gender		Grade		Baseline Computer Access	
	Males	**Females**	**3rd-4th**	**5th-6th**	**Access**	**No Access**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Access						
Computer or laptop at home	0.37	0.41	0.43	0.36	0.19	0.57
	(0.03)***	(0.05)***	(0.03)***	(0.04)***	(0.03)***	(0.03)***
Use						
Last week	0.05	0.07	0.08	0.04	0.02	0.09
	(0.01)***	(0.02)***	(0.03)**	(0.02)**	(0.02)	(0.02)***
Yesterday	0.09	0.11	0.09	0.10	0.03	0.15
	(0.04)*	(0.02)***	(0.03)**	(0.02)***	(0.03)	(0.04)***
Use by place (last week)						
School	0.04	-0.02	0.04	-0.02	-0.03	0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Home	0.32	0.34	0.32	0.35	0.16	0.47
	(0.04)***	(0.04)***	(0.04)***	(0.03)***	(0.03)***	(0.03)***
Internet café	-0.07	-0.12	-0.08	-0.13	-0.08	-0.13
	(0.05)	(0.03)***	(0.03)**	(0.04)***	(0.04)*	(0.03)***
Friend's house	-0.02	-0.04	-0.03	-0.02	-0.07	0.01
	(0.03)	(0.02)	(0.03)	(0.03)	(0.031)**	(0.04)
Use by place (minutes yesterday)						
School	-7.25	2.53	-0.58	-1.77	1.36	-2.27
	(3.88)*	(2.52)	(2.55)	(2.42)	(2.95)	(2.34)
Home	20.59	19.94	26.10	12.89	11.70	26.77
	(7.71)**	(6.51)***	(5.18)***	(6.36)*	(8.62)	(5.74)***
Internet café	1.18	-4.44	-5.26	-0.73	5.71	-10.23
	(7.16)	(3.18)	(3.52)	(5.87)	(7.76)	(2.30)***
Friend's house	-3.47	-5.45	-3.94	-3.81	-0.16	-6.27
	(2.89)	(3.83)	(3.80)	(2.53)	(3.78)	(2.15)**
Type of use (last week)						
Homework	-0.02	0.04	0.03	-0.02	-0.01	0.01
	(0.03)	(0.04)	(0.02)	(0.04)	(0.02)	(0.04)
Games	0.08	0.13	0.15	0.05	0.06	0.14
	(0.03)**	(0.06)*	(0.05)**	(0.03)	(0.04)	(0.05)**
Music	0.09	0.02	0.07	0.03	0.04	0.04
	(0.03)**	(0.04)	(0.03)**	(0.04)	(0.03)	(0.04)
Videos	-0.05	-0.05	-0.04	-0.05	-0.09	-0.01
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)**	(0.03)
Internet Access						
Internet at home	0.04	0.01	0.01	0.05	0.03	0.03
	(0.02)*	(0.03)	(0.04)	(0.02)*	(0.03)	(0.03)
Used Internet last week	0.01	0.00	0.02	-0.01	0.01	0.02
	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)
N	*1,384*	*1,458*	*1,353*	*1,513*	*1,249*	*1,680*

Notes: This table presents evidence on heterogeneous impacts on laptop winners. Each cell corresponds to an OLS regression of the respective outcome on a lottery winner dummy for certain sub-sample in treatment schools. Estimates include class fixed-effects and demographic controls as detailed in the text. Standard errors, reported in parentheses, are clustered at the school level. Significance at one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 13. Effects on Winners by Selected Sub-Groups: Time Use and Social Networks

	Gender		Grade		Baseline Computer Access	
	Males	**Females**	**3rd-4th**	**5th-6th**	**Access**	**No Access**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Use of time						
Helping at home	0.02	0.06	0.02	0.05	-0.01	0.08
	(0.04)	(0.03)*	(0.03)	(0.02)**	(0.04)	(0.02)***
Caring of household members	-0.03	-0.03	0.03	-0.08	-0.06	-0.01
	(0.04)	(0.05)	(0.04)	(0.02)***	(0.05)	(0.03)
Shopping	-0.05	0.00	-0.02	-0.04	-0.03	-0.06
	(0.04)	(0.03)	(0.04)	(0.03)	(0.05)	(0.03)
Working in the street	0.01	0.01	0.02	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Working at a store	0.01	-0.02	-0.01	0.00	0.00	-0.02
	(0.02)	(0.03)	(0.02)	(0.02)	(0.04)	(0.02)
Doing homework	-0.01	-0.01	0.00	-0.02	-0.03	0.01
	(0.02)	(0.01)	(0.02)	(0.01)	(0.03)	(0.01)
Playing	-0.02	-0.05	-0.03	-0.05	-0.04	-0.04
	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)
Watching TV	-0.02	0.02	-0.02	0.02	0.00	0.02
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Using a computer at home	0.38	0.35	0.40	0.32	0.23	0.47
	(0.03)***	(0.03)***	(0.04)***	(0.02)***	(0.04)***	(0.02)***
Reading	-0.10	-0.02	-0.07	-0.05	-0.07	-0.05
	(0.04)**	(0.04)	(0.03)*	(0.04)	(0.04)	(0.03)
Using an Internet café	0.01	-0.03	0.02	-0.02	0.00	-0.01
	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
Social Networks						
Friends	0.04	0.02	-0.04	0.03	0.08	-0.01
	(0.17)	(0.11)	(0.10)	(0.13)	(0.11)	(0.09)
Visiting other classmates	-0.04	0.07	0.13	-0.13	0.05	-0.03
homes	(0.14)	(0.17)	(0.10)	(0.11)	(0.16)	(0.10)
Homework partners	-0.02	0.19	0.20	-0.11	0.08	0.05
	(0.11)	(0.16)	(0.11)*	(0.13)	(0.17)	(0.13)
Total contacts	-0.06	0.11	0.05	-0.06	0.04	0.02
	(0.22)	(0.13)	(0.13)	(0.17)	(0.19)	(0.14)
N	*1,384*	*1,596*	*1,353*	*1,513*	*1,249*	*1,680*

Notes: This table presents evidence on heterogeneous impacts on laptop winners. Each cell corresponds to an OLS regression of the respective outcome on a lottery winner dummy for certain sub-sample in treatment schools. Estimates include class fixed-effects and demographic controls as detailed in the text. Standard errors, reported in parentheses, are clustered at the school level. Significance at one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table 14. Effects on Winners by Selected Sub-Groups: Computer and Cognitive Skills

	Gender		Grade		Baseline Computer Access	
	Males	**Females**	**3rd-4th**	**5th-6th**	**Access**	**No Access**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Computer skills						
Objective OLPC test	0.98	0.74	0.83	0.93	0.85	0.89
	(0.08)***	(0.10)***	(0.09)***	(0.07)***	(0.09)***	(0.09)***
Objective PC and Internet test	0.03	0.01	0.03	0.01	0.03	0.01
	(0.01)**	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Self-reported PC and Internet skills	0.01	0.00	0.02	-0.00	0.00	0.02
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Cognitive skills						
Raven's progressive matrices	0.06	0.04	0.03	0.08	0.05	0.08
	(0.06)	(0.04)	(0.04)	(0.06)	(0.07)	(0.05)*
Teachers' perceptions						
High skills in making friends	-0.02	0.01	-0.03	-0.00	-0.01	-0.03
	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)
High academic effort in class	-0.04	-0.05	-0.07	-0.00	-0.03	-0.07
	(0.02)**	(0.04)	(0.02)***	(0.03)	(0.03)	(0.03)**
Expected to complete	0.00	-0.02	-0.05	0.03	0.02	-0.04
university	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)
N	*1,384*	*1,596*	*1,353*	*1,513*	*1,249*	*1,680*

Notes: This table presents evidence on heterogeneous impacts on laptop winners. Each cell corresponds to an OLS regression of the respective outcome on a lottery winner dummy for certain sub-sample in treatment schools. Estimates include class fixed-effects and demographic controls as detailed in the text. Scores in the Raven's progressive matrices and the OLPC objective test have been normalized subtracting the mean and dividing by the standard deviation of students in control schools. Standard errors, reported in parentheses, are clustered at the school level. Significance at one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A1. Within-School Randomization Balance: Computer Access and Use

	Treatment	Control	Adjusted Difference	*N*
	(1)	(2)	(3)	(4)
Access				
Computer or laptop at home	0.41	0.43	-0.01	*2,867*
			(0.02)	
Use				
Last week	0.87	0.86	0.01	*2,728*
			(0.02)	
Yesterday	0.71	0.74	-0.03	*2,712*
			(0.02)	
Use by place (last week)				
School	0.55	0.50	0.03	*2,728*
			(0.02)*	
Home	0.41	0.44	-0.04	*2,726*
			(0.02)*	
Internet café	0.54	0.51	0.03	*2,709*
			(0.02)	
Friend's house	0.27	0.26	0.00	*2,673*
			(0.03)	
Use by place (minutes yesterday)				
School	36.33	30.46	2.56	*2,712*
			(4.69)	
Home	49.76	52.36	-4.29	*2,712*
			(4.64)	
Internet café	43.46	46.76	-5.09	*2,712*
			(4.27)	
Friend's house	30.36	25.68	2.56	*2,712*
			(3.12)	
Type of use (last week)				
Homework	0.68	0.70	-0.03	*2,770*
			(0.03)	
Games	0.63	0.62	0.01	*2,733*
			(0.02)	
Music	0.57	0.58	-0.00	*2,711*
			(0.03)	
Videos	0.43	0.43	-0.01	*2,693*
			(0.03)	
Internet Access				
Internet at home	0.30	0.34	-0.04	*2,840*
			(0.02)*	
Used Internet last week	0.82	0.83	-0.02	*2,712*
			(0.02)	

Notes: This table presents statistics and estimated differences between laptop lottery winners (treatment) and non-winners (control) within treatment schools. Baseline data collected in April 2011 are used. Columns (1) and (2) present means, column (3) presents estimated coefficients and standard errors from OLS regressions. Estimates in column (3) include class fixed-effects. Standard errors, reported in parentheses, are clustered at the school level. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A2. Within-School Randomization Balance: Time Use and Social Networks

	Treatment	Control	Adjusted Difference	*N*
	(1)	(2)	(3)	(4)
Use of time				
Helping at home	0.57	0.55	0.01	*2,759*
			(0.03)	
Caring of household members	0.62	0.60	0.01	*2,754*
			(0.03)	
Shopping	0.48	0.45	0.03	*2,759*
			(0.03)	
Working in the street	0.04	0.05	-0.01	*2,756*
			(0.01)	
Working at a store	0.20	0.17	0.03	*2,748*
			(0.02)	
Doing homework	0.95	0.95	-0.00	*2,758*
			(0.01)	
Playing	0.77	0.78	-0.02	*2,763*
			(0.02)	
Watching TV	0.84	0.83	0.01	*2,761*
			(0.02)	
Using a computer at home	0.35	0.36	-0.01	*2,755*
			(0.02)	
Reading	0.73	0.70	0.02	*2,757*
			(0.02)	
Using an Internet café	0.33	0.35	-0.02	*2,757*
			(0.02)	
Social Networks				
Friends	3.42	3.47	-0.06	*2,867*
			(0.13)	
Visiting other classmates homes	2.69	2.58	0.06	*2,867*
			(0.06)	
Homework partners	1.99	1.93	0.08	*2,867*
			(0.06)	
Total contacts	5.40	5.31	0.08	*2,867*
			(0.15)	

Notes: This table presents statistics and estimated differences between laptop lottery winners (treatment) and non-winners (control) within treatment schools. Baseline data collected in April 2011 are used. Columns (1) and (2) present means, column (3) presents estimated coefficients and standard errors from OLS regressions. Estimates in column (3) include class fixed-effects. Standard errors, reported in parentheses, are clustered at the school level. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A3. Within-School Randomization Balance: Computer and Cognitive Skills

	Treatment (1)	Control (2)	Adjusted Difference (3)	*N* (4)
Computer skills				
Objective PC and Internet test	0.32	0.33	-0.01	*2,867*
			(0.01)	
Self-reported PC and Internet skills	0.56	0.56	0.01	*2,867*
			(0.01)	
Academic achievement				
Math	-0.26	-0.23	0.02	*2,748*
			(0.03)	
Reading	-0.22	-0.14	-0.05	*2,691*
			(0.06)	
Cognitive skills				
Raven's progressive matrices	-0.13	-0.16	0.08	*2,832*
			(0.06)	
Teachers' perceptions				
High skills in making friends	0.51	0.54	-0.02	*2,833*
			(0.02)	
High academic effort in class	0.45	0.46	-0.01	*2,834*
			(0.02)	
Expected to complete University	0.64	0.64	0.00	*2,835*
			(0.02)	

Notes: This table presents statistics and estimated differences between laptop lottery winners (treatment) and non-winners (control) within treatment schools. Baseline data collected in April 2011 are used. Columns (1) and (2) present means, column (3) presents estimated coefficients and standard errors from OLS regressions. Estimates in column (3) include class fixed-effects. Standard errors, reported in parentheses, are clustered at the school level. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A4. Balance between Non-winners with and without Winner Friends

	With Winner Friends (1)	Without Winner Friends (2)	Adjusted Difference (3)	*N* (4)
Student Characteristics				
Age	10.02	10.08	0.07	*2,214*
			(0.04)*	
Male	0.47	0.49	-0.02	*2,212*
			(0.03)	
Household Characteristics				
Number of siblings in household	2.18	2.31	-0.07	*2,212*
			(0.07)	
Father lives at home	0.78	0.77	-0.02	*2,204*
			(0.02)	
Father works outside home	0.88	0.88	-0.02	*2,204*
			(0.02)	
Mother works outside home	0.52	0.55	-0.02	*2,214*
			(0.03)	
Phone	0.48	0.48	0.00	*2,171*
			(0.02)	
Electricity	0.92	0.91	-0.02	*2,190*
			(0.02)	
Car	0.26	0.30	-0.04	*2,150*
			(0.03)	
Access				
Computer or laptop at home	0.43	0.42	-0.02	*2,249*
			(0.03)	
Internet at home	0.35	0.33	-0.00	*2,226*
			(0.03)	
Use (last week)				
At school	0.51	0.49	0.01	*2,143*
			(0.03)	
At home	0.46	0.42	-0.00	*2,136*
			(0.04)	
At an Internet café	0.51	0.52	-0.03	*2,127*
			(0.03)	
At other places	0.26	0.26	-0.01	*2,104*
			(0.03)	

Notes: This table presents statistics and estimated differences between non winner children with laptop lottery winner friends and non-winners without laptop winner friends within treatment schools. Baseline data collected in April 2011 are used. Columns (1) and (2) present means, column (3) presents estimated coefficients and standard errors from OLS regressions. Estimates in column (3) include class fixed-effects as well as total number of friends who participated in lottery as control variables. Standard errors, reported in parentheses, are clustered at the school level. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.

Table A5. School Randomization Balance

	Treatment (1)	Control (2)	Adjusted Difference (3)	*N* (4)
Student Characteristics				
Age	10.06	10.02	0.04	*5,200*
			(0.07)	
Male	0.50	0.48	0.03	*5,202*
			(0.02)	
Household Characteristics				
Number of siblings in household	2.33	2.11	0.21	*5,200*
			(0.13)	
Father lives at home	0.77	0.77	-0.00	*5,188*
			(0.02)	
Father works outside home	0.88	0.88	0.00	*5,184*
			(0.01)	
Mother works outside home	0.54	0.51	0.03	*5,198*
			(0.03)	
Phone	0.48	0.53	-0.05	*5,087*
			(0.05)	
Electricity	0.91	0.95	-0.05	*5,131*
			(0.01)***	
Car	0.27	0.28	-0.00	*5,030*
			(0.03)	
Access				
Computer or laptop at home	0.43	0.52	-0.09	*5,339*
			(0.04)**	
Internet at home	0.34	0.40	-0.06	*5,291*
			(0.04)	
Use (last week)				
At school	0.51	0.43	0.09	*5,079*
			(0.07)	
At home	0.44	0.50	-0.06	*5,097*
			(0.04)	
At a Internet café	0.52	0.48	0.04	*5,054*
			(0.03)	
At other places	0.26	0.37	0.01	*5,008*
			(0.02)	

Notes: This table presents statistics and estimated differences between treatment and control schools. Baseline data collected in April 2011 are used. Columns (1) and (2) present means, column (3) presents estimated coefficients and standard errors from OLS regressions. Estimates in column (3) include school pair fixed-effects. Standard errors, reported in parentheses, are clustered at the school level. Significance at the one, five and ten percent levels is indicated by ***, ** and *, respectively.