Broadband in Schools and Students' Performance

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Broadband in Schools

Information and Communication Technologies (ICTs) perceived as powerful tools to improve the quality of education:

- Widening **access to information**
- Fostering **new learning methods** (more interaction and feedback)
- Increasing students' interest and **performance**

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Governments have been investing considerable amounts of money to provide schools with ICTs, in particular for Broadband connectivity.

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Little empirical evidence that broadband connectivity generates significant benefits.

Research Question

"How does **broadband** ***use*** affect students' **performance**?"

- Is broadband use beneficial for student performance?
- What's the magnitude of this effect?

Methodology

Unit of analysis

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  - **Performance** - average national exam scores for students in a school.
  - **Internet use** - monthly average broadband traffic for the school.
- Period: Academic years **2005-2009**
  - Three- and four year differences: 2005-2008 and 2005-2009
  - Use of panel data allows us to control for school specific unobserved effects

Methodology

Econometrics

Performance depends on Internet use, on socio-economical factors, as well as on unobserved effects

$$\Delta p_i = \omega \Delta I_i + \mathbf{X}_i \beta + u_i \tag{1}$$

In which Δ represents differences between 2005 and 2008 (or 2009).

Internet usage

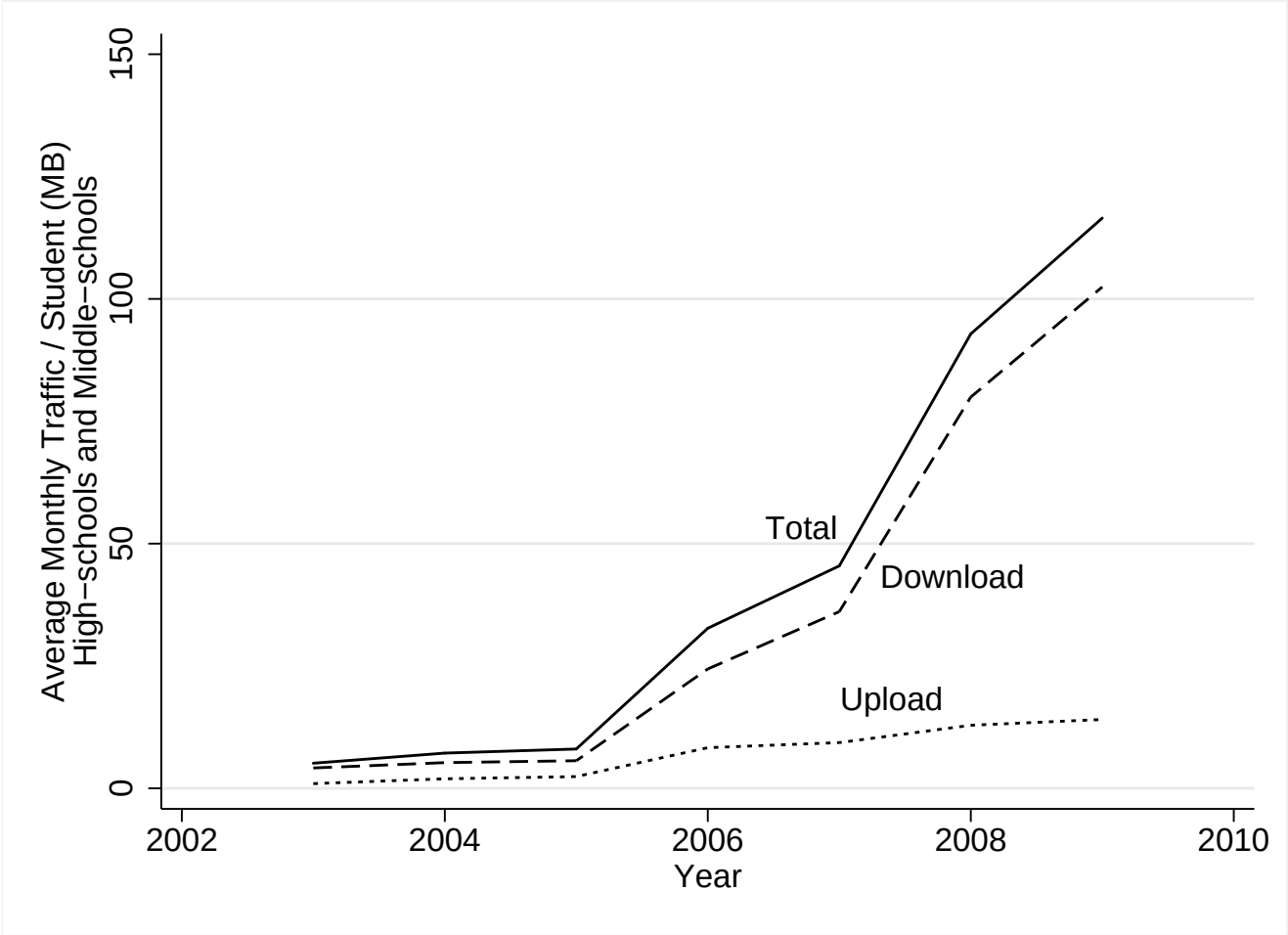
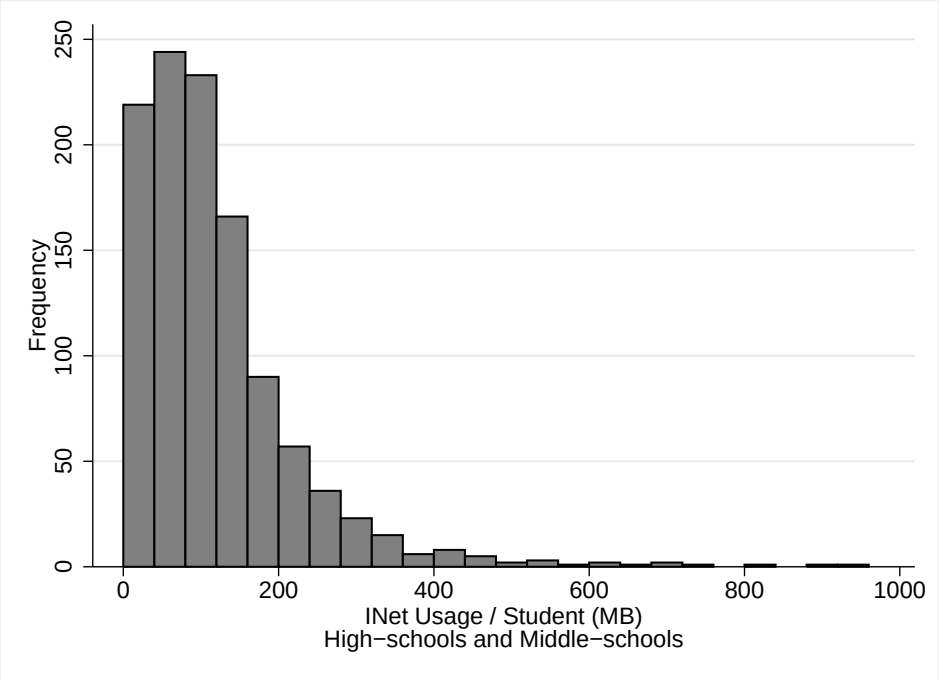


Figure: Internet usage evolution 2003-2009: download, upload and total traffic per student

Internet usage across schools



In 2009 the average student used **117 MB per month**, which corresponds to:

- Watching **one hour of YouTube** video per month (at 260 Kbps);
- Exchanging **390 emails** (at 300 KB per email); or
- Loading **900 webpages** (at 130 KB per page).

Exam scores

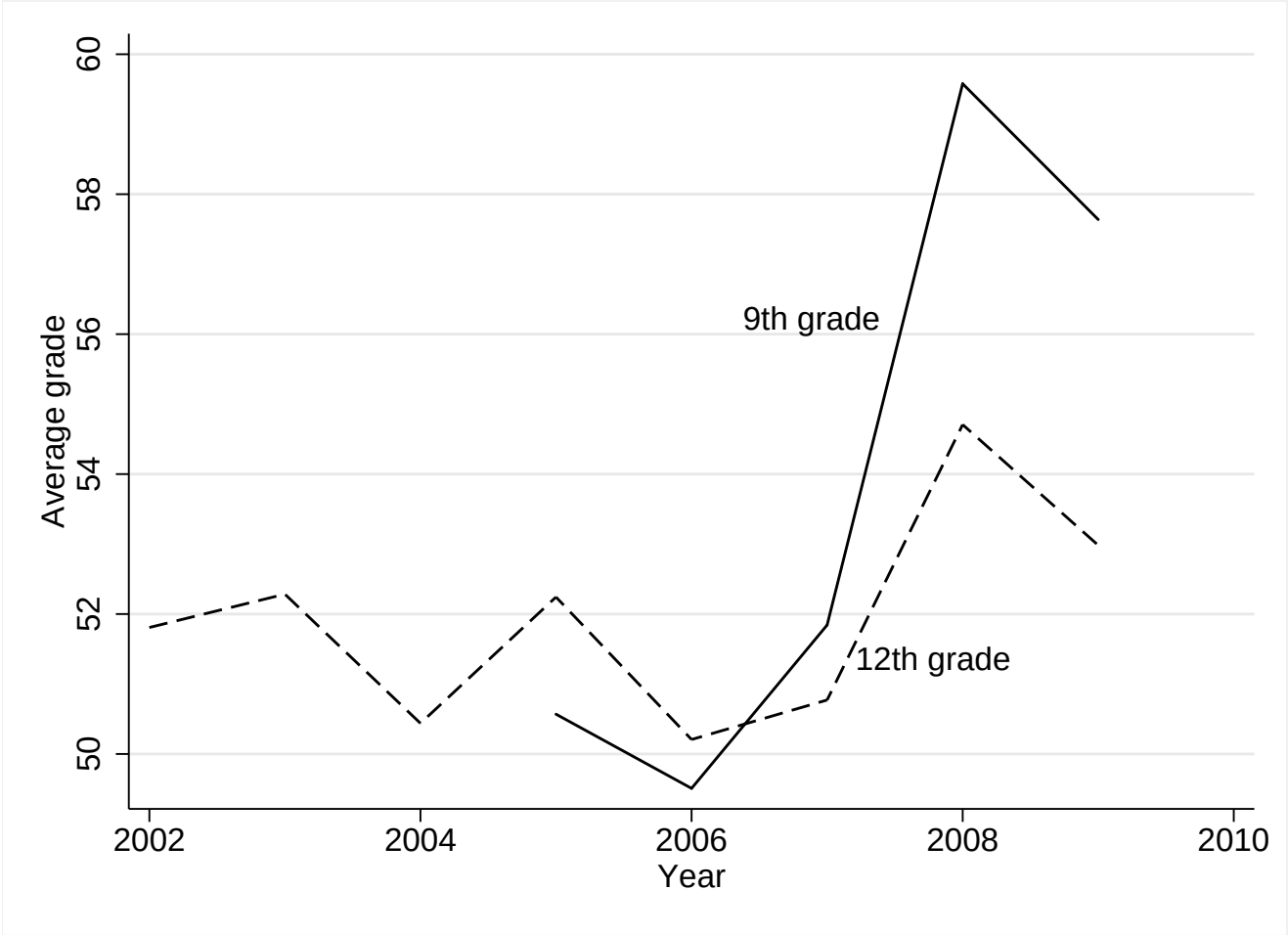


Figure: Exam score evolution 2002-2008: average exam score over time for 12th and 9th grades (0-100 scale)

Endogeneity

While school fixed effects should control for across school variations, we may still worry about unobserved *time-varying* effects that influence both exam scores and Internet use and might lead to inconsistent estimates.

- Examples: changes in **internal organization**, **technical savviness**, or **resources** available to a school

We may get a positive estimate on broadband use even if there is no causal effect.

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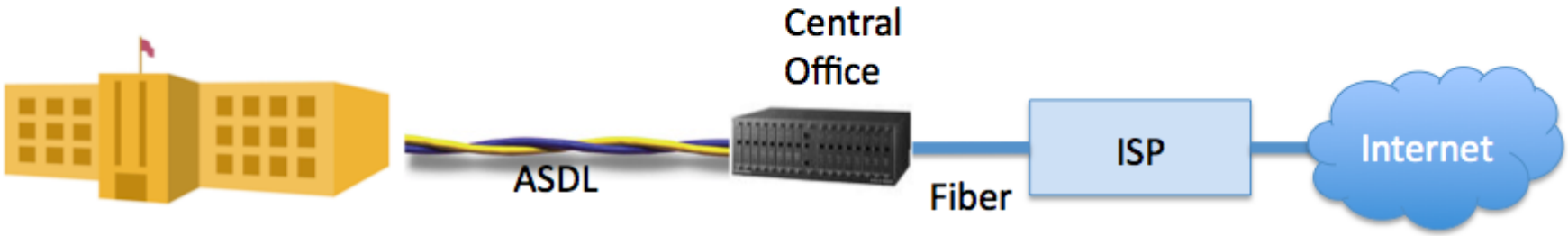
Solution: Instrumental Variable (IV)

1. Correlated with change in Internet usage
2. Not correlated with the unobserved effect

Methodology

Instrumental Variable



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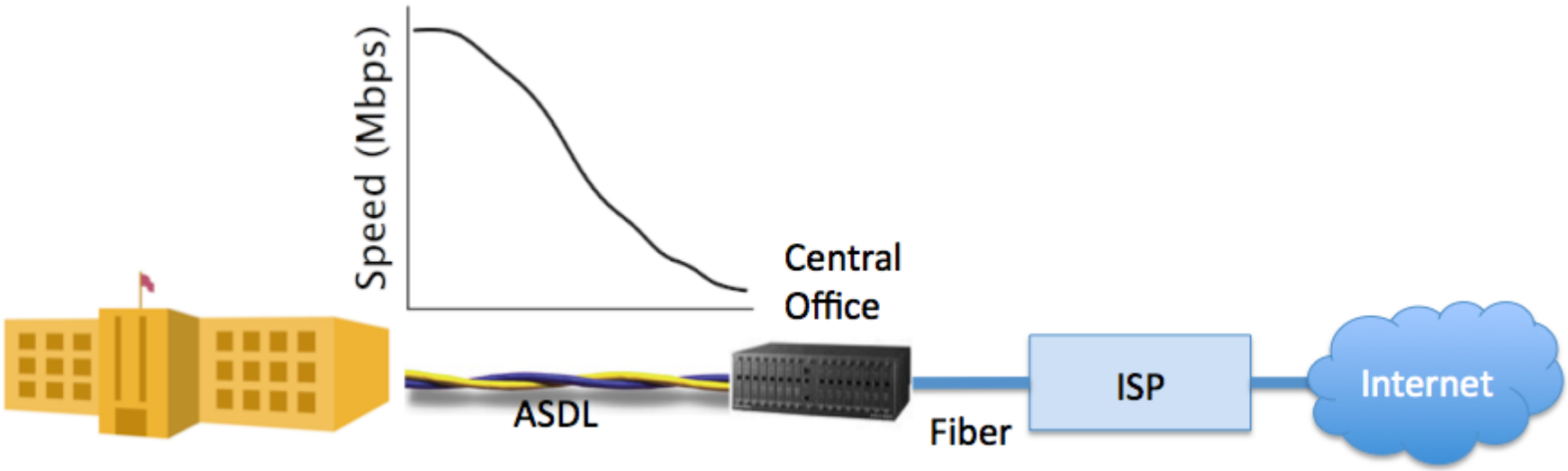

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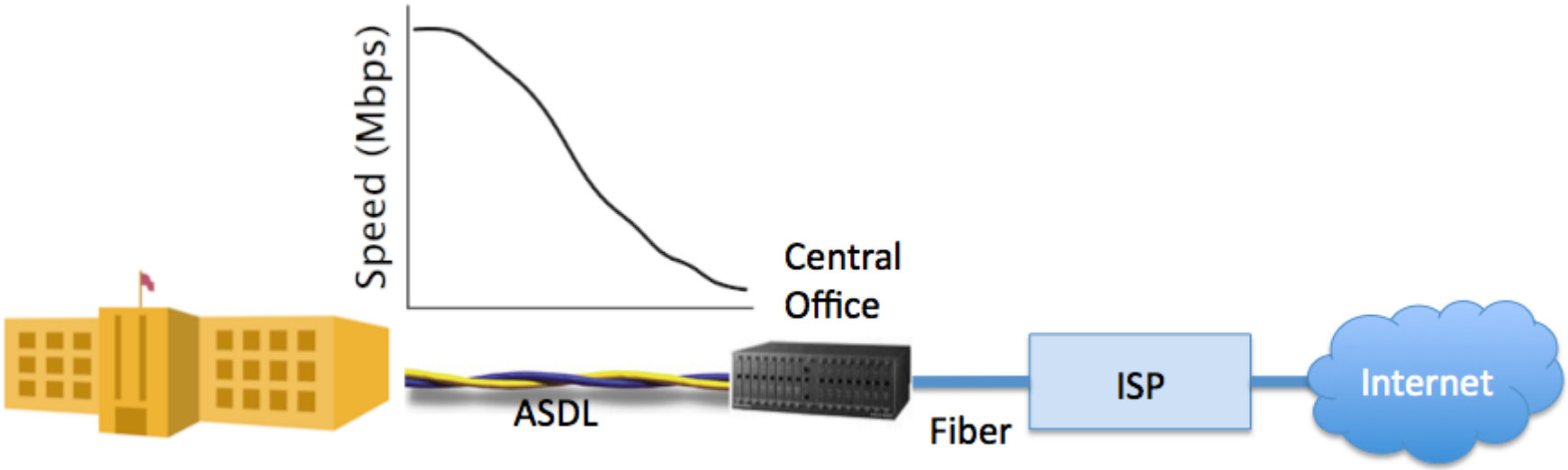

Distance to the ISP's Central Office:

1. Correlated with change in Internet usage
2. Not correlated with "change in grade".

Results

Correcting for Endogeneity

- The IV specification yields a **negative coefficient** on broadband usage for the 2005-2008 period.
- For 2008, the average broadband use in schools of **51 GB/month** in 2008 leads to a decrease of **8.9%** in the average exam scores, i.e., a decrease of about **one standard deviation** in 2008 scores.
- This effect is still negative for the 2005-2009 period, though it becomes smaller in magnitude and statistically insignificant.

Boys and Girls Behave Differently

To explore the distraction effect in more detail, we use a survey conducted by ANACOM on the activities performed by students on the Internet (659 students; 10-12th):

Table: Participation in activities by gender (%).

Activity	Male	Female	Diff.
Search for Scientific Info	67.5	74.1	-6.6**
Email	93.1	89.5	3.7**
Chat	89.4	88.2	1.1
Radio	48.4	42.5	6.0*
TV	27.8	13.9	14.0***
Music	75.6	52.7	22.9***
Games	71.9	34.9	36.9***

*** p<0.01, ** p<0.05, * p<0.1 (t-tests eq. var.)

Boys report to engage in distracting activities **more** than girls

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Boys report to engage in distracting activities **more** than girls
If our story is correct, boys are **more likely** to be adversely affected

Results

Boys and Girls Behave Differently

- For 2005-2008, the average broadband use in schools of **51 GB/month** in 2008 leads to a decrease of **12.1%** in the average exam scores of boys, i.e., an decrease of about **1.5 standard deviations** in 2008 scores. The adverse effect of Internet use is not statistically significant for girls.
- This effect reduces in magnitude and loses significance for both boys and girls in the 2005-2009 difference.

Results

Low Performance vs. High Performance Schools

We split our sample of schools in quartiles based on their 9th grade average exam score in 2005 and apply our IV setup separately for each group of schools.

- Broadband Internet use does not affect all schools in the same way:
  - Schools in the **lowest performance quartile** are **more negatively affected** by broadband in 2008

Schools might need a certainly level of maturity to be able to effectively counter the disruptive effect that the introduction of broadband Internet into schools might entail.

Discussion & Policy Implications

Mere provisions of broadband pipes does not seems to generate tangible benefits

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Introduction of broadband in schools needs to be complemented by measures that:

- Take into account **human** and **social factors**
- Ensure that broadband is used in **productive ways** (e.g., ICT training for teachers)
- Place **boundaries** on how broadband is used for other activities (e.g., implementation of tools that moderate Internet access)

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Broadband may still be beneficial for students in ways that are not captured by test scores

- For example, exposure to a set of technologies students will most likely use in their future professional and personal lives.

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Extras

Framework

CES Production function

Assume the performance of a school is given by the CES function

$$p(S, L) = [aS^r + (1 - a)L^r]^{1/r} \tag{2}$$

Differentiating it with respect to I, we get

$$\frac{\partial p}{\partial I} = \frac{1}{r}[aS^r + (1 - a)L^r]^{1/r-1} \cdot [-ar(T - I)^{r-1} + (1 - a)r\alpha^r I^{r-1}]$$

Recall that $S = T - I$ and $L = \alpha I$.

Framework

CES Production function

Performance will increase with Internet use as long as

$$\begin{aligned} -ar(T-I)^{r-1} + (1-a)r\alpha^r I^{r-1} &= 0 \\ \gamma\alpha^r &= \left(\frac{I}{S}\right)^{1-r} \end{aligned} \tag{3}$$

In which $\gamma \equiv \frac{1-a}{a}$ is the ratio between the productivity of learning in the Internet (L) and traditional study (S).

- When $r = 1$ we get a linear production function that is increasing with I iff $\gamma\alpha > 1$.
- When $r \to 0$ the CES tends to a Cobb-Douglas production function: $p(S, L) = S^a L^{(1-a)}$, increasing in I iff $\gamma > \frac{I}{S}$
  - the extra productivity of learning in the Internet must be greater than the ratio between Internet time and traditional study time.

Previous Work

Measuring Students' Performance

Table: Selected Previous Research

	Context	Exogenous Source of Variation	Result
Angrist and Lavy (2002)	Computerization of schools in Israel	Timing of delivery	NS/-
Goolsbee and Guryan (2006)	Subsidizing schools' Internet access in U.S.	Variation in subsidy rate	NS
Leuven et al. (2007)	Subsidy for schools with disadvantaged students in Netherlands	Discontinuity in financing scheme	-
Machin et al. (2007)	ICT subsidies to schools in the U.K.	Policy change in some regions	+

Table: Change in performance as a function of change in Internet use (9th grade; by quartile).

	Q1	Q4
Δ INet Usage (GB)	-0.101	0.00616
	(0.0704)	(0.0951)
Students	0.00132	-0.00176
	(0.00279)	(0.00363)
ln(Earnings 2005)	0.654	-1.368
	(1.787)	(2.524)
Urban	-0.471	1.346
	(0.942)	(1.320)
Constant	6.059	17.08
	(12.86)	(18.22)
Observations	841	857
R-squared		0.006

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results

Gender and Quartile

9th grade:

Table: Effect of Internet usage on students by gender and quartile

	Male	Female
Q1	-0.155*	-0.071
	(0.092)	(0.088)
Q4	0.005	-0.082
	(0.123)	(0.109)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- Boys in the lower grade quartile (Q1) are the most affected group
  - In our sample, growth in broadband use (40 GB on average) translates to about **11.5%** decrease in scores.

Other groups and 12th grade: No statistically significant effects

Table: Average score in 2005 as a function of distance to central office and other controls (OLS)

VARIABLES	(1) 9th grade	(2) 12th grade
Distance (Km)	-0.261	-0.507
	(0.193)	(0.182)
Students	0.00136**	0.00334***
	(0.000583)	(0.000700)
ln(Earnings 2005)	2.508***	5.727***
	(0.890)	(1.298)
Urban	-0.256	1.885**
	(0.386)	(0.795)
Constant	32.68***	8.919
	(5.813)	(8.396)
Observations	996	428
R-squared	0.021	0.212

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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