Governments around the world are committing substantial public funds to upgrading their broadband infrastructure, partly in the hope of promoting education. Research findings by **Rosa Sanchis-Guarner** and colleagues raise doubts about whether faster internet speeds will raise young people's attainment at school.

Faster broadband: are there any educational benefits?

The UK government is investing over £1 billion in providing superfast internet coverage to 95% of the country by 2017.[1] Both the European Union and the United States have similarly ambitious plans to increase public access to broadband services providing download speeds of 30Mbps or higher.

These policies are partly motivated by claims that broadband upgrades will have positive effects on the economy and people's lives, ranging from higher productivity to more flexible working schedules. They also emphasise a supposed link between broadband upgrades and educational achievement in light of both the large amounts of time that young people devote to online content and the abundance of online educational resources. The latter range from longstanding platforms, such as the thousands of homework support channels on YouTube or Wikipedia, to more recent developments such as massive open online courses or 'MOOCs'.

Many of young people's most common online activities – research for homework, online games, streaming videos and downloading music – require fast connections. But it is an open question whether upgrading the available information and communication technologies (ICT) increases learning productivity or whether it leads to distractions that could in principle have negative effects on learning outcomes.

Despite its importance for policy, evidence on the impact of ICT on educational attainment is scarce since it is difficult to establish a causal connection. For example, richer households can afford faster internet packages and better ICT equipment; at the same time, young people from wealthy backgrounds generally attend good schools and perform better in national exams. We would then observe a positive correlation between home ICT and educational achievement without necessarily implying causality.

Internet access and internet speed at home have zero impact on children's educational attainment

Our research combines a rich collection of micro-data with a new empirical approach to provide such causal evidence. Our main result is that even large changes in connection speeds have no effect on educational attainment or on time spent studying online or offline.

To understand the relationship between ICT and educational achievement we decompose the effect into two mechanisms: the impact of ICT on study hours; and the impact of ICT on study-hour productivity. On the one hand, reduced ICT costs could have a positive impact on learning productivity as, with faster connections, young people can access more online content per unit of time. On the other hand, they might reduce their study hours by spending more time online on other activities. The net effect is unclear.

To test these hypotheses, we use micro-data for England that allow us to link administrative test scores for all

[1] https://www.gov.uk/guidance/broadband-delivery-uk

primary and secondary school pupils to the ICT available at their home addresses. Using data on the whole population of school children allows us to estimate nationally representative effects and how they vary across multiple dimensions.

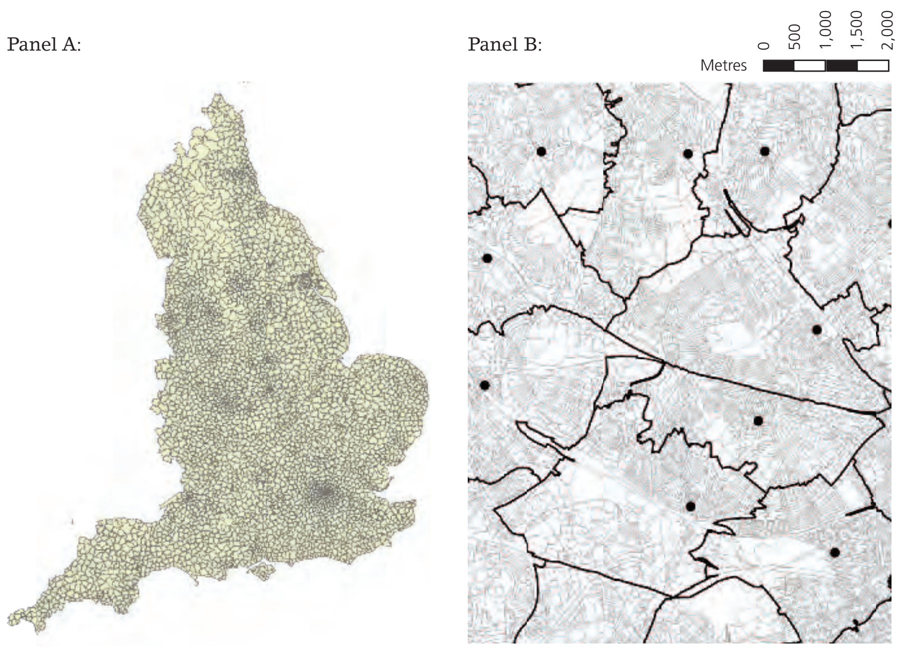
We focus on the impact of available ICT on key stage test scores for pupils aged 7 to 16 years old during the period 2002-08. In addition, we investigate the impact of ICT availability on study time and computer use of children aged 11 to 15 years old, using data from the youth questionnaires in the British Household Panel Survey (BHPS), the Understanding Society (US) survey and from the Longitudinal Study of Young People in England (LSYPE) survey.

To estimate causality, we exploit a well-known feature of DSL-broadband technology: that the length of the copper wire connecting homes to the local telephone exchange station is a key determinant of the available broadband speed (our measure of ICT). There are approximately 3,900 telephone exchange stations that provide all addresses in England with telephone connections (see Panel A of Figure 1).

Figure 1:

Telephone exchange stations

Panel A depicts telephone exchange station catchment area boundaries in England (thick black lines). Panel B depicts individual postcodes (thinner gray lines) in a residential area in North London. The black points indicate the locations of exchange stations.



One possible approach in this context would be to compare the outcomes of pupils whose homes are located at different distances from connected exchanges and who thus have access to potentially different broadband speeds. But neither observed differences in broadband speeds across households (which include package choices) nor residential distances to the connected exchange stations are randomly assigned.

Even if households might not actively locate close to the telephone exchanges to benefit from faster connections (for example, if they do not know where these are), to be able to connect the maximum number of addresses, planners located the switchboard infrastructure inside large buildings in central locations close to major road junctions ('local town centres'). Hence, the location of these exchanges is not random and households might 'passively sort' at different distances from them.

Improved broadband access has no significant effect on the time pupils spend studying online or offline

To identify the impact of differences in broadband speed across households, we use boundary discontinuities across usually unobserved exchange station catchment areas. How? We notice that each telephone exchange station serves an invisible catchment area of residential addresses. The extent and shape of this catchment area is a by-product of history: rapid growth in fixed-line telephony during and after the Second World War in combination with capacity constraints at the exchange switchboards led to invisible and essentially randomly placed station-level boundaries.

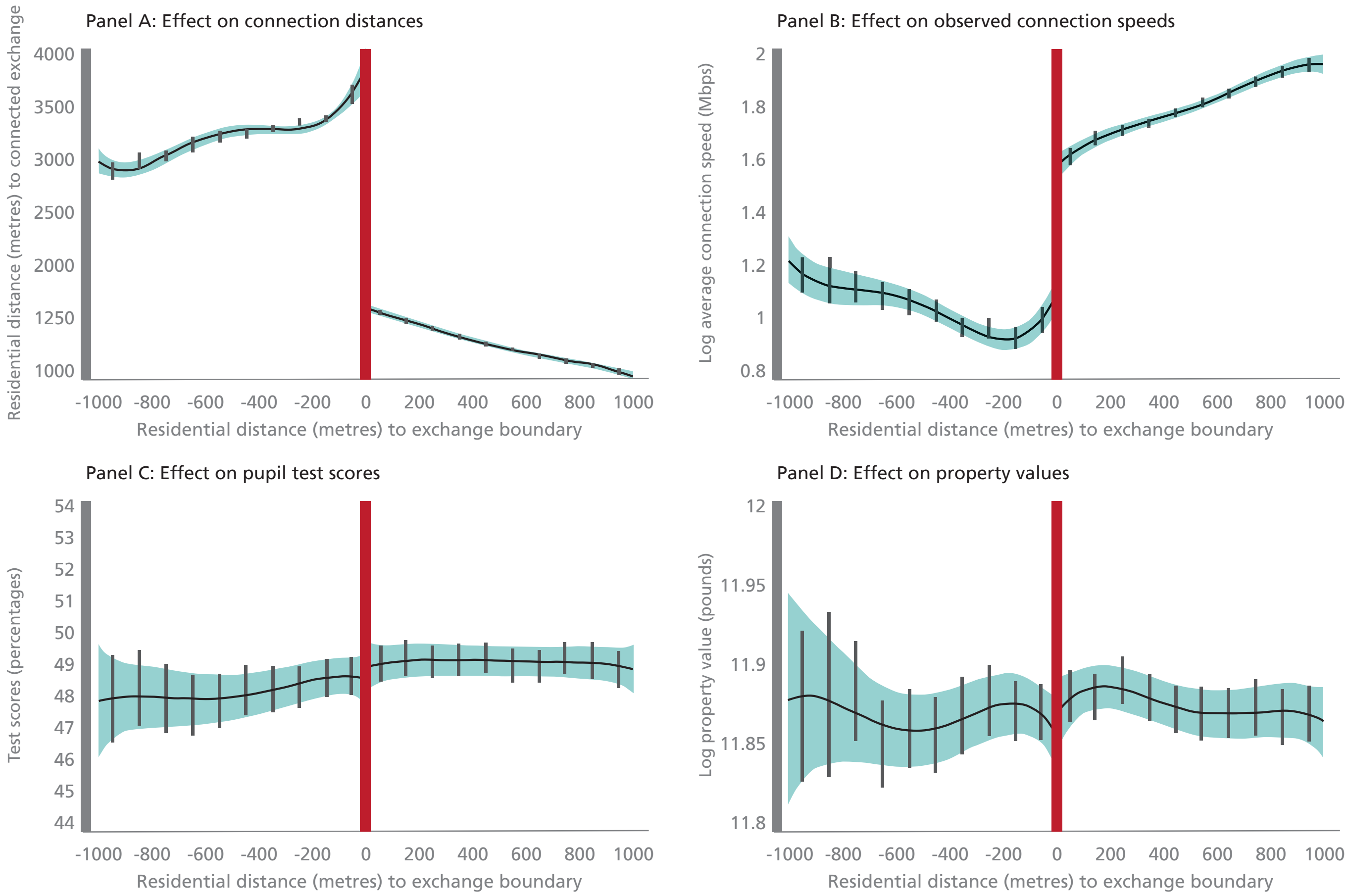
We use telecom network micro-data to construct these catchment areas for each of several thousand telephone exchange stations in England. As Panel B of Figure 1 shows, neighbouring residences on different sides of the boundaries can face substantial differences in broadband speed. This variation stems from jumps in the copper wire distances between homes and their connected exchange stations on the slower side (longer distances to connected exchange) relative to the faster side (shorter distances to connected exchange) across a given boundary segment.

We exploit this feature across more than 20,000 boundaries in England. The key element is that nothing that affects educational outcomes apart from broadband speed changes discontinuously

Figure 2:

The effects of invisible exchange station catchment area boundaries

The left-hand side in each chart shows the slower side of a given exchange boundary segment: the side with higher average residential distances to the connected exchange station.



between neighbouring homes when crossing the invisible boundary. We also complement this design with additional information about the date of first-time exchange station-level ADSL broadband upgrades. We can use this information to restrict the analysis to a subsample of boundaries for which only one side had been upgraded to broadband internet.

Taking this research design to the data, we present several new findings summarised in Figure 2. We find that the average jump in ICT across exchange station boundaries is substantial. The average difference in residential distances to their connected exchange station between neighbouring homes on different sides of the boundary is 725 metres (or 65% of a standard deviation). As Panel A of Figure 2 shows, this estimate increases to 2,250 metres (or two standard deviations) when restricting the estimation to the top third of boundary segments with the largest average difference in residential connection distances across the boundary.

Claims of the importance of fast broadband for educational success seem to be unjustified

These discontinuous jumps in copper wire connection lengths translate into substantial differences in broadband speeds. We find that the average jump in the time cost of accessing a given amount of online content rises by 22% when moving from the slow side of an invisible boundary to the faster side. As Panel B of Figure 2 shows, this effect increases to 47% when restricting attention to the top third of boundary segments with the largest jumps in connection distances. Thus, our strategy shows that being located on the side of a boundary with shorter connections to the telephone exchange affects broadband speeds at home.

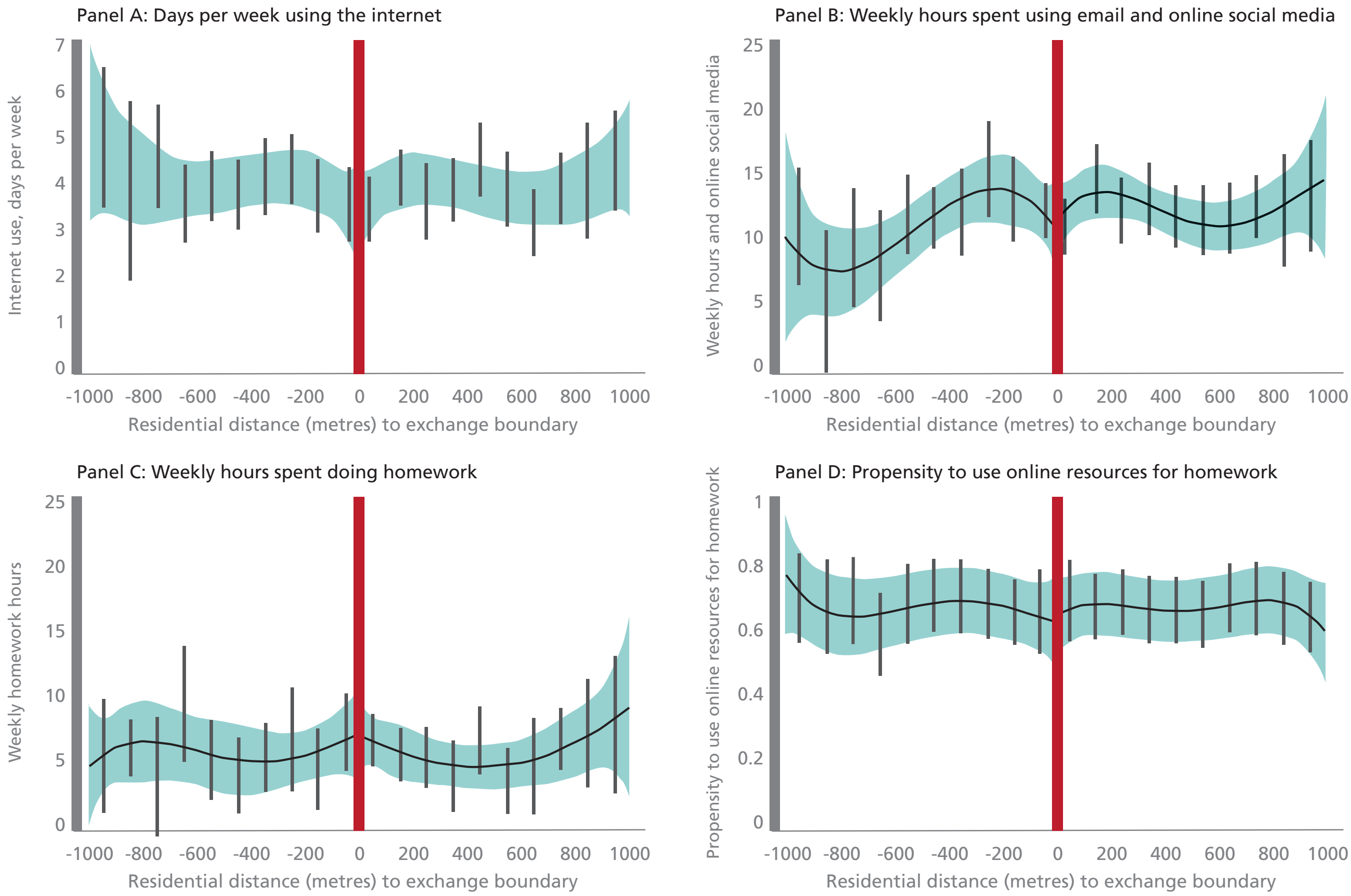
Turning to the effect of internet speed on test scores, our estimates suggest that even substantial changes in the connection speeds have a precisely estimated effect of zero on educational attainment (Panel C of Figure 2). The estimates are causally identified: house prices (Panel D of Figure 2), pupils' socio-economic characteristics and access to local amenities are unaffected by the boundaries.

We explore the extent to which this average effect may mask significant heterogeneity, and find that the result holds for all groups in the pupil population – by age, gender, ethnic and socio-economic characteristics. It also holds for

Figure 3:

The effects of invisible exchange station catchment area boundaries – BHPS/US results

The left-hand side in each chart shows the slower side of a given exchange boundary segment: the side with higher average residential distances to the connected exchange station.



every year in the period 2002-08, for different subjects (English, mathematics and science) and across different initial levels of available ICT.

We complement this analysis using the information about the date of first-time exchange station-level ADSL broadband upgrades. Even when we restrict the analysis to this subsample where the potential jumps in broadband speed would be larger, there is also zero impact when comparing pupils on different sides of boundaries.

Using additional micro-data on pupil time use and internet use to quantify the channels underlying this zero overall effect, we find that jumps in ICT have no significant effect on time spent studying online or offline, nor on study productivity. Figure 3 presents these results. We find that jumps in broadband access have no significant effect on time spent online, time spent doing homework or the propensity to use online resources for homework. As neither test scores nor the number of study hours are affected by ICT, we can conclude that study productivity is not affected either.

Our analysis serves to inform policy debates on ICT in two ways. The first is that it provides policy-makers with credible empirical estimates for an important outcome of interest (education) that has served as one of the central motivations for ICT upgrades and has featured prominently in discussions of the so-called 'digital divide'.

Second, our empirical approach provides a useful tool that can be applied to a number of questions about the effects of variation in available ICT upgrades – for example, on business creation, firm productivity or labour market outcomes – and in a variety of different empirical contexts – access to or upgrades of infrastructure.

Access to fast broadband has been claimed to be key for educational success, and the lack of such connections identified as a drawback for the development of rural communities. Our results suggest a less negative scenario. Given the amount of funds committed to ICT upgrades and the bold claims made about superfast broadband investment, our research highlights the fact that more robust evidence is urgently needed to justify such investment.

This article summarises 'ICT and Education: Evidence from Student Home Addresses' by Benjamin Faber, Rosa Sanchis-Guarner and Felix Weinhardt, CEP Discussion Paper No. 1359 (http://cep.lse.ac.uk/pubs/download/dp1359.pdf).

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It seems doubtful that having superfast broadband at home will raise young people's educational attainment