Surfing Alone? The Internet and Social Capital: Evidence from an Unforeseeable Technological Mistake[*]

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Abstract

Does the Internet undermine social capital, such as real-world inter-personal relations and civic engagement? Merging unique telecommunication data with geo-coded German individual-level data, we investigate how broadband Internet affects social capital. A first identification strategy uses first-differencing to account for unobserved time-invariant individual heterogeneity. A second identification strategy exploits a quasi-experiment in East Germany created by a mistaken technology choice of the state-owned telecommunication provider in the 1990s that hindered broadband Internet roll-out for many households. We find no evidence of negative effects of the Internet on several aspects of social capital. In fact, the effect on a composite social capital index is significantly positive.

JEL classification: Z13, J24

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1. Introduction

In his seminal book, "Bowling Alone," Robert Putnam (2000) laments the decline of social capital in modern times that threatens to undermine our societies. Part of the blame for this has been placed on the advent of new technologies for information, communication, and entertainment that keep people from civic engagement and from connecting to their communities. The prime example is the television: Gentzkow (2006) finds that the introduction of the TV in the United States significantly reduced voter turnout, and Olken (2009) confirms that TV consumption crowds out social participation in the context of a developing country. Less obvious is the effect of Internet access on social capital. On the one hand, the Internet obviously absorbs a lot of people's time, which may come at the detriment of social engagement and substitute real-world interaction with solitary entertainment in the virtual world. On the other hand, the Internet may help people to connect in the virtual world. It may in fact also facilitate social interaction in the real world by providing easy access to relevant information and reducing transaction costs to meet other people in such places as theaters, concerts, and bars. As Putnam (2000) put it, "The Internet may be part of the solution to our civic problem, or it may exacerbate it" (p. 170). There is anecdotal evidence that both aspects are at play – nerds disconnecting from their community by spending their life with online games, but also websites to inform oneself about what is going on in town, to learn about possibilities for volunteer or political engagement, and possibly for dating. However, little is known about which is the dominating force, a question crucial for assessing the societal repercussions of *the* mass medium of the twenty-first century.

This paper estimates the effect of broadband Internet access on social capital. The rich individual-level data of the German Socio-Economic Panel (SOEP) provides information on a battery of proxies for several dimensions of social capital in real-world situations that measure social participation by a wide range of activities. The indicators cover the frequency of going to theaters, exhibitions, concerts, restaurants, and bars; the frequency of meeting friends and relatives; and the prevalence of volunteer work in associations and social services and of political engagement and interest. The SOEP also provides information on broadband Internet access in the household. However, empirical identification is plagued by the obvious possibility that having high-speed Internet access at home may be endogenous to a person's social capital. Outgoing people may be more likely to make use of the information opportunities provided by the Internet, giving rise to a positive bias in standard estimates of the effect of the Internet on social capital. But the Internet may also attract intrinsically seclusive people and social nerds, giving rise to a negative bias. The direction of the possible endogeneity bias is thus not clear *a priori*.

We propose two identification strategies to address such endogeneity concerns. The first identification strategy exploits the panel structure of our database. In first-difference models, we investigate whether the differential introduction of broadband Internet from its emergence in 2001 to 2008 is related to changes in social capital at the individual level over the same period. By using first differences, the models avoid bias from time-invariant unobserved individual traits related both to social capital levels and to having broadband Internet access.

The second identification strategy exploits a quasi-experimental setting in East Germany where an unforeseeable technological mistake in the 1990s cut many people off from broadband Internet access for years. After reunification, telephone access lines, in particular of acceptable quality, were missing in many East German regions. *Deutsche Bundespost* – the former state-owned monopoly provider of postal and voice-telephony services in Germany – decided to provide telephony services by rolling out the so-called OPAL (optical access line) technology in 213 telephone access areas serving 11 percent of East German households. In the 1990s, OPAL was the leading high-end technology for voice-telephony and low-speed digital services. However, when the Internet became a mass phenomenon in the early 2000s, DSL (digital subscriber line) became the leading standard for high-speed broadband access. This turned OPAL into an outdated technology, because – in contrast to classical copper wires – OPAL is not compatible with the DSL standard. Huge investments are necessary to provide high-speed Internet in OPAL areas, which has not occurred in many of the areas until today. The fact that choosing the OPAL technology for the telecommunication network turned out to be a severe mistake was unforeseeable at the time of decision, because broadband Internet did not yet exist at the time. Thus, what turns out to be a mistaken technology choice gives rise to variation in access to broadband Internet in East Germany that is arguably exogenous to people's social capital and not driven by their affinity to connect to the Internet. Accordingly, we do not see significant differences in background characteristics such as income, education, gender, and age between individuals in areas with and without OPAL technology.

In order to exploit this variation, we combine the new SOEP feature of providing exact geographic coordinates of the surveyed households (in a procedure that ensures confidentiality)[1] with unique confidential data on the historical roll-out of the OPAL telecommunication technology, kindly provided to us by *Deutsche Telekom*, the successor for

[1] In fact, ours is one of the first academic research projects to make use of the new on-site facility to access information on geo-coordinates of SOEP households and connect them with external geographic information.

telephony services of *Deutsche Bundespost* after its privatization in 1995. In our micro-geographic data, East German households are assigned to over 1,000 small-scale telephone access areas. This allows us to use the information whether a household was located in a historical OPAL area before the emergence of broadband Internet as an instrument for broadband Internet access at home in 2008.

Our results suggest that the Internet did not undermine social capital. In virtually all specifications and for virtually all social capital indicators, the instrumental-variable (IV) models yield positive point estimates on having broadband Internet access at home. The precisely estimated first-difference models show positive point estimates for all but one social capital indicator and allow rejecting substantial negative Internet effects. While sizable standard errors warrant caution in interpreting the IV models, the results indicate significant positive effects of broadband Internet access on a social capital index that combines all our social capital measures as well as on the separate measure of political interest. Furthermore, specifications using East German administrative municipality-level data on voter turnout in elections provide very precise IV estimates that can reject even small negative effects of broadband Internet access on voter turnout.[2]

Several tests of validity and robustness support a causal interpretation of our results. A placebo test corroborates the validity of our instrument: If living in an OPAL area is a source of exogenous variation in broadband Internet access because OPAL is incompatible with the DSL broadband technology, it should predict households' high-speed Internet access after the emergence of the DSL broadband technology, but not (low-speed) Internet access before the emergence of broadband Internet. The panel structure of our dataset allows us to confirm that our instrument, which measures the technological situation in 1998, is indeed not associated with low-speed Internet access in 2000, but does predict broadband Internet access in 2008. A second placebo test shows that OPAL technology is also not significantly related to 2001 values of our social capital measures, providing direct evidence that individuals in OPAL and non-OPAL areas were not significantly different from each other in terms of social capital already before the expansion of broadband Internet. Given our detailed micro-geographic data, we can also show that results are robust to restricting the sample to households living

[2] Exploring a relatively small sample of children aged 7 to 16, also for children and adolescents we find no evidence that broadband Internet access crowds out social activities in or out of school, but rather indications that it may support the creation and attendance of social group activities outside school; see the working-paper version of this paper for details (Bauernschuster, Falck, and Woessmann 2011).

close enough (4.2 km) to a node to be sure that at least medium-speed Internet access is technologically viable.

The remainder of the paper is organized as follows. Section 2 places our study in the broader literatures on Internet and social capital and provides some conceptual background on how the Internet may affect social capital. Section 3 introduces our data on social capital and Internet access and provides descriptive evidence on the characteristics of broadband Internet users. Section 4 reports the association between home broadband Internet access and social capital. Section 5 exploits the panel structure of the data to estimate first-difference models. Section 6 develops our quasi-experimental identification strategy, presents the IV results, and discusses instrument validity and robustness. Section 7 concludes.

2. The Internet and Social Capital: Some Theory and Related Literature

An emerging literature studies the economic effects of the rise of the Internet (see, e.g., Varian (2010)). Aggregate cross-country evidence suggests that broadband infrastructure has an important impact on economic growth (Czernich, Falck, Kretschmer, and Woessmann (2011)). At a general level, the question arises how a general purpose technology like the Internet affects people's daily lives and decisions (see Helpman (1998)). Residential broadband infrastructure may facilitate the emergence of new work practices (Autor (2001)), home-based entrepreneurship (Fairlie (2006)), and job search (Krueger (2000); Autor (2001); Stevenson (2009)). At the same time, the Internet may also have negative effects on human behavior. In particular, Bhuller et al. (2013) argue that Internet availability has increased sex crime in Norway. Falck, Gold, and Heblich (2014) and Campante, Durante, and Sobbrio (2013) find negative effects of the introduction of the Internet on voter turnout in West Germany and Italy. Our analysis complements these studies by investigating the effects of the Internet on social capital.

A large literature addresses the economic consequences of social capital, although the concept of social capital often remains somewhat vague (see Sobel (2002) and Durlauf and Fafchamps (2005) for surveys). Measures of social capital have been found to be related to economic performance across countries (see, e.g., Temple and Johnson (1998) and the references therein). Social capital has been argued to matter for a variety of economic outcomes, in particular in the presence of asymmetric information and incomplete contracts. To name but a few examples that relate directly to individual networks, social capital is found to be relevant for job search (Mouw (2003); Bayer, Ross, and Topa (2008)), financial development (Guiso, Sapienza, and Zingales (2004)), entrepreneurial finance (Sanders and Nee (1996); McMillan and Woodruff (1999)), and firm location (Michelacci and Silva (2007)). Given the complexities of identification, work on the determinants of social capital is only starting to emerge (see Glaeser, Laibson, and Sacerdote (2002); Durlauf and Fafchamps (2005)).

From a conceptual point of view, social capital may be both negatively and positively affected by the Internet (for general discussions, see Putnam (2000), Chapter 9; Huysman and Wulf (2004)). On the one hand, if the Internet is mostly used for passive entertainment, then – similar to the television – it may crowd out social participation. Performing transactions like shopping and banking on the Internet may deprive people from face-to-face interactions (Franzen (2003)). The Internet may also increase the separation of communication into separate groups with specific interests (sometimes referred to as "cyber-balkanization", see Van Alstyne and Brynjolfsson (1996)), so that even if it lowers individual separation, it can at the same time increase group separation and community fragmentation (Rosenblat and Mobius (2004); Gentzkow and Shapiro (2011)). Furthermore, communication through the Internet may miss a lot of the non-verbal information transmitted in face-to-face communication.

On the other hand, there are also possible positive effects of the Internet on social capital. The information function of the Internet means that it facilitates the acquisition of information about places and times of social events, reduces transaction costs of reserving places or buying tickets for certain events, provides information on politics and civic initiatives, and even helps to find out about opportunities for volunteer engagement and proper matches to individuals' preferred social engagements. For example, many websites in Germany serve to connect people in the local region and enable political blogging. Apart from these demand-driven effects, there may also be supply-driven effects if the Internet facilitates the organization of exhibitions, concerts, and other social events. Furthermore, the communication function of the Internet means that it may make social interaction more convenient and efficient (e.g., Pénard and Poussing (2010)) and help interpersonal exchange by desynchronizing communication in time and space. This feature of interactivity distinguishes the Internet from the television.

The empirical knowledge about how the Internet affects social capital is limited so far (see Pénard and Poussing (2010) for a recent review of descriptive studies on the subject). Moreover, the evidence, while informative, is inconclusive (see, e.g., Franzen (2003)) and usually fails to identify correlation from causation (see below).

3. Individual-Level Data on the Internet and Social Capital

The German Socio-Economic Panel (SOEP) is a representative annual household survey covering a wide range of topics pivotal for social science. In 2008, roughly 20,000 adult individuals living in more than 11,000 households participated in the interviews. The SOEP wave 2008 provides information on whether Internet access is available at all in a household and, for the first time, whether this Internet access is based on a high-speed connection realized via DSL, the standard broadband technology in Germany. Additionally, extensive information is available on individuals' background characteristics such as gender, age, marital status, number of children in the household, secondary and university education, occupational status, migration background, ownership of a house or flat, and net household income. Table 1 presents descriptive statistics on these variables.

In measuring the somewhat vague concept of social capital, we aim to capture aspects of social capital in the "real" world. It is obvious that Internet users may have more "virtual" contacts, but our interest is in the effect of Internet access on real-world social engagement. Since social capital is a rather broad concept in the economic literature, we explicitly aim to take account of a wide range of proxies that capture different dimensions of social capital in our analysis. Here, again, the SOEP provides extensive and valuable information. Putnam (2000) distinguishes two general forms of real-world social engagement: People who spontaneously invest time in informal conversation by such activities as frequenting bars and meeting friends, and people who invest time in formal organizations by such activities as volunteer work and political engagement (which he refers to as "*schmoozers*" and "*machers*," pp. 93-95). Both dimensions of social connectedness are important, and we aim to capture both of them with our set of social capital indicators.

Thus, our first set of social capital measures captures informal dimensions of getting connected in the real world: the frequency of "attending events like opera, classic concerts, theater, exhibitions," of "attending cinema, pop or jazz concerts, dance events/disco," and of "going out for food or a drink (café, bar, restaurant)." All three measures for social participation draw on categorical information on how individuals spend their leisure time, with five answer options ranging from "never," "less than once a month," "at least once a month," and "at least once a week" to "every day." Our second set of social capital measures captures interaction with friends and relatives, which may be viewed as combining informal and formal elements of social connectedness: one indicator, measured in the same categorical way, measures the frequency of "mutual visits of neighbors, friends, and acquaintances," and another indicator measures the frequency of "mutual visits of family members and relatives". Finally, our third set of social capital measures captures more formal dimensions of social engagement: two categorical variables measuring the frequency of "volunteer activity in clubs, associations, and community services" and of "participation in political parties, in local politics, and civic initiatives," and a third categorical variable referring to how strongly the person reports to be interested in politics (answer options ranging from "not interested at all," "not strongly," and "strongly" to "very strongly").[3] Table 2 reports descriptive statistics on the full battery of individual-level measures of social capital.

To minimize measurement error in the social capital variables, throughout the paper we average standardized individual values of social capital over the period from 2007 to 2009 instead of just relying on the 2008 survey answers.[4] In these years, the social capital questions are comparable with two exceptions: The frequency of going to bars and restaurants is only measured in 2008 and visiting friends and relatives is condensed to one question in 2007 and 2009, whereas visits to friends and relatives are captured in two separate questions in 2008. We average over all these variables and build a social capital variable which we refer to as "socializing with friends and relatives".[5]

To increase statistical power to detect effects that point in the same direction, we also aggregate the individual social capital variables into a social capital index. Following Kling, Lieberman, and Katz (2007), the index is calculated as the sum of the *z*-scores of the individual social capital measures divided by the standard deviation of the sum, so that it also has a standard deviation of 1.[6]

In 2008, 56 percent of all individuals in the SOEP had broadband Internet access via DSL at home.[7] This number is significantly higher in West Germany (60 percent) than in East

[3] Additional possible proxies for social capital with which we have experimented include the number of friends, contacting friends and relatives abroad, active sports exercise, and attending sports events. Results are similar to the patterns reported here.

[4] Models using just the 2008 values of the social capital variables yield qualitatively very similar results.

[5] As in 2007 and 2009, the 1999 and 2001 values of this variable (used below) are based on the single question on "sociability with friends, relatives, or neighbors." The question on "attending events like opera, classic concerts, theater, exhibitions" was phrased "attending cultural events, e.g., concerts, theater, lectures" and the question on "attending cinema, pop or jazz concerts, dance events/disco" was phrased "attending cinema, pop concerts, dance events, discos, sports events" in years other than 2008.

[6] In Table A1 of the online appendix, we present pairwise correlations of all our individual social capital variables as well as the social capital index.

[7] The use of smartphones was not very common in Germany in 2008, which is the very year when the Apple iPhone 3G was first introduced by Deutsche Telekom, which marked the start of smartphone use in Germany. Nevertheless, two years after this event only eight percent of the mobile phone users had a smartphone (Allensbach (2012)).

Germany (44 percent).[8] This lower broadband penetration of East Germany is partly due to the DSL incompatibility of the OPAL technology used in some East German areas which we exploit in our quasi-experimental evidence below.

The group of individuals without broadband Internet access includes those households that have Internet access via dial-up type technologies such as modems and ISDN, which provide access at very low speed only. Even in the best case of high-end ISDN access, the maximum available speed is 128 kbit/s, compared to a broadband DSL standard of 6 Mbit/s. That is, a standard website of 1 MB (which is less than the entry site of standard German newspapers or of Ticketmaster), for example, which takes 1.3 seconds to download with standard DSL, would take more than a minute at the very least to download with the low-speed alternatives (an underestimate of the real problem in times when most websites require computer responses). This makes effective use of most Internet facilities today impossible.

In light of the possible channels discussed above through which Internet use may affect social capital, we restrict the empirical analysis to broadband Internet access. To ascertain that individuals with low-speed Internet access do not simply make up for the low speed through longer use, we can make use of categorical information in the SOEP of how often individuals privately use the Internet. In fact, ordered logit estimations show that compared to low-speed Internet access, broadband Internet access increases the probability of daily Internet use by 17.2 percentage points and reduces the probability of never using the Internet (of using it less than once a month) by 4.4 (3.2) percentage points (see Table A2 in the online appendix). This time use information is in line with the reasoning that low-speed Internet access hardly allows frequent Internet use.

To get a first impression of the characteristics of the group of broadband Internet users, Table 3 presents linear probability models that regress a dichotomous variable indicating broadband Internet access at home on the set of background characteristics.[9] Including a set of county dummies in addition to the individual level covariates hardly changes the results. The descriptive pattern reveals that women are somewhat less likely to have access to broadband Internet at home than men. The relationship between age and home broadband Internet access has an inverted U-shape. The probability of having broadband Internet access at home is smaller for single than for married individuals and increases with schooling. Unemployed,

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[8] Similarly, in a multivariate regression of broadband Internet access on an indicator for East Germany and a series of background variables (equivalent to adding an East Germany indicator to the first column of Table 3 below), the coefficient on the East Germany dummy is -0.143 (*p*-value 0.000).

[9] Probit models yield very similar results.

retired, and other non-working persons, as well as blue-collar workers, are less likely to have broadband Internet access than apprentices, white-collar workers, and entrepreneurs. Furthermore, the likelihood of having broadband Internet access is higher for natives and for owners of a house or flat and increases with household income.

4. The Association between the Internet and Social Capital

We start our empirical investigation whether individuals with broadband Internet access at home participate more or less often in social activities than individuals without home broadband Internet access with a look at the simple cross-sectional association. We regress each of the social capital variables S_i on a dummy for home broadband Internet access I_i and a vector of covariates X_i:

$$S_{i2008} = \alpha + \beta I_{i2008} + X_{i2008}\gamma + \varepsilon_i \tag{1}$$

Apart from the 22 individual-level covariates presented in Table 3, the control vector X_i includes fixed effects for the 439 German counties[10] as well as municipality characteristics such as the share of the female population, the share of the working-age population, the share of individuals aged 65 and older, the share of unemployed individuals as well as the net internal migration rate.[11] Standard errors ε_i are clustered at the county level. For comparability, we standardize all social capital measures to a mean of zero and a standard deviation of one throughout.

Table 4 presents the results of linear regressions for each measure of social capital in the sample of more than 17,000 individuals. Conditional on the covariates, there is a positive association between having broadband Internet access at home and all our social capital measures, statistically significant for six of the seven measures. Having broadband Internet access at home is related to a 9.6 percent of a standard deviation higher social capital index, statistically highly significant. Among the individual indicators, all three indicators in the set of social capital measures on informal connections and friendship-related measures – attending theaters, operas, and exhibitions; cinema and concerts; and socializing with friends and relatives – are significantly positively associated with Internet access. In the set of measures of formal social engagement, the coefficient on broadband Internet access captures significance for volunteer work and for general interest in politics.

[10] The average county size is about 812 square kilometers with a standard deviation of 597 square kilometers. If counties were circles, this would mean an average diameter of counties of about 32 kilometers.

[11] The municipality data are taken from the Statistik Lokal database of the German Federal Statistical Office.

Given the categorical nature of the original data of the dependent variables, rather than z-standardizing and estimating by linear models, we can also estimate ordered logit models of the original categorical variables surveyed in 2008. Results, reported in Table A3 in the online appendix, are qualitatively the same, with the sole exception that the positive average association of broadband Internet access with volunteer work becomes statistically insignificant. Decomposing the "socializing with friends and relatives" variable, we find positive effects for going to bars and restaurants, yet no significant results for visiting friends and visiting relatives. The marginal effects, which depict the effect magnitude category by category, suggest that broadband Internet access reduces the probability of never going to the theater, opera, and exhibitions, for example, by 5.3 percentage points and increases the probabilities of going less than once a month by 3.8 percentage points and of going at least once a month by 1.5 percentage points. By contrast, the highest positive marginal effects are in the "at least once a month" category for cinema and concerts and in the "at least once a week" category for restaurants and bars, where the highest negative marginal effects are in the "never" and "less than once a month" categories, respectively. In terms of interest in politics, the "not at all" and "not strong" categories both lose in favor of the "strong" category. The fact that, across the dependent variables, the marginal effects of Internet access tend to be strongest in the lowest two categories without comparably strong effects in the highest category suggests that the Internet is not related to a polarization of social capital measures.

As roughly a quarter of individuals with a personal computer at home do not have broadband Internet access, there is, in general, enough variation to test whether the overall picture is also confirmed when additionally controlling for a personal computer at home. We find that the association of the social capital index with Internet access is qualitatively robust in such a specification (see Table A4 in the online appendix). However, conditioning on having a personal computer at home may rule out indirect channels of broadband Internet access on social capital, for example if some individuals refrain from purchasing a personal computer because the value of its use is strongly reduced for them due to a lack of broadband Internet access.

5. First-Difference Models

Causal interpretation of the associations reported so far, albeit conditioning on a large set of socio-economic covariates, county fixed effects, and municipality characteristics, is obviously hindered by a range of endogeneity concerns. For example, reverse causality might arise if politically interested individuals are more likely to buy broadband Internet access exactly because they are politically interested and would like to use the Internet to get better information on politics. Omitted variables are another source of endogeneity concerns, for example when outgoing and open-minded individuals socialize more and at the same time are more susceptive to new technological developments like broadband Internet. Both types of selection would bias OLS estimates upwards. On the other hand, selection may also take the form that shy, lonely, and solitary individuals subscribe to broadband Internet access because they have less social contacts in the real world and look for compensation in the virtual world. Such selection would bias OLS estimates downwards. Thus, the degree and direction of bias in the reported associations is not clear *a priori*.

A first way to address the selection concerns is to exploit the panel structure of the SOEP database to estimate first-difference models. Such models are not affected by time-invariant unobserved individual traits that relate both to having broadband Internet access at home and to the social capital measures. The year 2001 provides a convenient date to measure the lagged dependent variable, as our social capital measures (which are not surveyed every year) were also surveyed in 2001 and as broadband Internet was hardly existent in 2001. Constructing a sample of individuals who responded both in 2001 and in 2008 leads to a sample reduction by about 30 percent of the original sample (see Tables 1 and 2 for descriptive statistics of the reduced sample).

The first-difference model expresses the change in an individual's social capital between 2001 (S_{i2001}) and 2008 (S_{i2008}) as a function of having gained access to broadband Internet access (or not) between 2001 and 2008 (I_{i2008}-I_{i2001}).[12] The model controls for differences in the set of individual-level and municipality-level control variables between 2001 and 2008 (X_{i2008}-X_{i2001}). In addition, a vector of county fixed effects (C_{i2001}) captures county-specific time trends in social capital:

$$(S_{i2008} - S_{i2001}) = \alpha + \beta(I_{i2008} - I_{i2001}) + (X_{i2008} - X_{i2001})\gamma + C_{i2001}\lambda + \varepsilon_i \qquad (2)$$

The county fixed effects are based on 2001 residence (rather than 2008 residence) to avoid possible endogeneity if relocation decisions since 2001 were based on the availability of broadband Internet access. Availability of broadband Internet at home was first surveyed in 2008 (I_{i2008}), but as broadband Internet access was hardly existent in 2001, we assume

[12] Results are qualitatively similar in value-added models that express social capital in 2008 as a function of the lagged social capital variable in 2001, having broadband Internet access in 2008, and the vector of controls in 2008; see the working-paper version of this paper for details (Bauernschuster, Falck, and Woessmann 2011).

broadband Internet access in 2001 (I_{i2001}) to be zero for all individuals. Again, average values of the social capital variables of 2007-2009 are used for the 2008 value, and average values of 1999 and 2001 for the 2001 value, in order to minimize measurement error in the social capital variables.

The identifying assumption of this specification is that there are no unobserved confounding factors that varied between 2001 and 2008 in a way that is correlated with broadband Internet access. Under this assumption, the coefficient on the broadband Internet indicator reflects the effect of gaining broadband Internet access on social capital. Time-invariant omitted individual traits that affect the level of social capital in both years are accounted for in the first-difference specification.

Table 5 shows the results of the first-difference models. Even after controlling for time-invariant unobserved individual heterogeneity and county-specific time trends, broadband Internet access is positively associated with most of our social capital variables. The Internet coefficient remains positive and significant for the social capital index, although the point estimate is cut roughly in half. The only negative point estimate is for "socializing with friends and relatives". While generally reduced in size compared to the cross-sectional models, all other point estimates are positive and capture statistical significance for attending theater, opera, and exhibitions; cinema and concert; and volunteer work. In particular in the first two cases, these significant effects relate to social events where the Internet, in addition to its information function, might facilitate reserving and purchasing tickets.

The first-difference models address endogeneity problems arising from unobserved time-invariant individual traits that are related both to the social capital variables and to having broadband Internet access. However, the first-difference estimates would still be biased if there were unobserved individual traits that changed between 2001 and 2008 in a way related both to social capital and to the probability of subscribing to broadband Internet at the same time. Therefore, in the next section, we explicitly model a source of exogenous variation in broadband Internet access.

6. Quasi-Experimental Evidence: An Unforeseeable Technological Mistake

6.1 The OPAL Technology in East Germany

After German reunification in 1990, there was a huge lack of telephone access lines in many parts of East Germany. Indeed, the German Democratic Republic (GDR) was often labeled a developing country in terms of telephone infrastructure. To overcome the legacy of the communist regime, *Deutsche Bundespost* (DBP)[13] decided to roll out telephony infrastructure built on the basis of a special type of fiber wires, the so-called OPAL technology, instead of the traditionally used copper wires. In the early 1990s, this technology was regarded the state-of-the-art technology that would dominate the ICT future. It is suited for voice-telephony services, ISDN (integrated services digital network) services, and for a limited amount of data transmission in denser areas (Ranft (1997)). Relying on this progressive technology, DBP expected to be prepared for the demand of the next decades. OPAL technology was eventually rolled out in 213 East German areas covering about 11 percent of East German households (see Figure 1). Even the press was enthusiastic about DBP's high-tech project and nominated DBP's Chief Technology Officer as the "Fiber Man of the Year." As an example from the German press, *VDI Nachrichten* wrote (6 December 1991, own translation): "Former GDR becomes model country of fiber technology. In the former developing country of telecommunication, DBP Telekom wants to build the most modern fiber network worldwide and carry it all the way to the customer. […] Thereby, the new federal states will receive the most modern telecommunication network in the world."

But subsequently, things changed dramatically: The telecommunication markets were liberalized across Europe; DBP was split into two privately operated firms, *Deutsche Post* for postal services and *Deutsche Telekom* for telephone services. Most importantly, the world saw the Internet revolution taking over. The Internet became a mass phenomenon and services on the Internet demanded higher and higher bandwidth. To meet this demand, DSL technologies became the leading standard of access technologies for broadband Internet. DSL technologies are highly attractive because they rely on the copper wires of the pre-existent voice-telephony network, which makes the supply of broadband Internet via DSL relatively cheap.

This development was beneficial for most parts of Germany. However, it was a misfortune for the thought-to-be-high-tech OPAL areas. Nobody could have guessed that the appraised OPAL technology would, only a few years later, turn out to be a major disadvantage for regional development. The reason for this is that OPAL technology is simply not compatible with DSL technologies. Thus, by this unforeseeable technological accident, OPAL areas were cut off from high-speed Internet. In order to still provide broadband Internet to OPAL areas, *Deutsche Telekom* was confronted with two very costly alternatives: They could either replace the OPAL wires of the access network by copper wires, which requires expensive excavation works, or – even more expensively – install new hardware and

[13] In the early 1990s, voice telephone services were solely provided by the state-monopolist *Deutsche Bundespost*, the integrated carrier for postal and telephony services.

software at the network's nodes. Thus, by the early 2000s, the sentiment in the German press had changed all over, castigating DBP's decision to roll out OPAL technology in East Germany as a money pit; for example, the leading business weekly *Wirtschaftswoche* titled (13 September 2001, own translation), "Deutsche Telekom: Burial of billions."

This unforeseeable technological mistake provides us with exogenous variation in the access to broadband Internet across households. We view this technologically determined variation as randomly allocated (we come back to testing this below) and exploit it as a quasi-experiment in an instrumental-variable (IV) approach.[14] A nice description of why this mistaken technological decision could happen is provided by online magazine *Telepolis* (12 February 2001, own translation): "Why did no one, in the conceptual design of OPAL, think of the potential problems with DSL? Because the Telekom […] had anticipated in 1990 the Internet Revolution as little as Honecker [the long-term leader of the GDR] in 1985 the fall of the wall." In fact, given that OPAL was the most modern technology at the time, if anything its roll-out might have been related to favorable rather than dismal conditions; the fact that it later turned out to be a hindrance for broadband Internet access might thus work against finding positive effects of the Internet.

Since 2003, *Deutsche Telekom* has invested millions of Euros to replace OPAL technology in about half of the original OPAL areas. Nevertheless, as of August 2009, OPAL technology was still in use in 103 areas. Because decisions to subsequently replace OPAL are likely endogenous to the variables of interest in our model, we use the initial roll-out of OPAL as of 1998 (by which time OPAL roll-out had been completed) based on 2001 residence, rather than actual OPAL incidence in 2008, as our instrument for access to broadband Internet at home.

In the remaining OPAL areas, East German households had limited access to broadband Internet at the end of our period of observation because, in contrast to the United States, the availability of other access technologies was restricted in Germany, and often more expensive than broadband Internet access via DSL. In 2009, Germany had 25.0 million broadband subscribers. Of these, 22.4 million subscriptions were realized via DSL and only 2.6 million via other access technologies (such as TV cable, power line, or satellite; see Bundesnetzagentur (2010)). As an average of the East German counties in 2005, only 6.9 percent of the population could theoretically access broadband Internet via TV cable (own

[14] Gebhardt (2010) uses the same technological mistake to analyze the effects of the Internet on retail competition at the municipal level. In contrast to our paper, he relies on self-reported data on OPAL technology by private households collected at an idiosyncratic website instead of original data from Deutsche Telekom.

calculations based on the data underlying the Broadband Atlas (Bundesministerium für Wirtschaft und Technologie (2011)). Moreover, in municipality-level regressions, we confirm that the availability of broadband Internet via cable TV is not correlated with the OPAL status of the municipality (whereas, in line with the basic idea of our identification, the availability of broadband Internet via DSL is negatively associated with the OPAL technology in the same municipality-level regressions) (see Table A5 in the online appendix).[15]

Thus, individuals in the remaining OPAL areas who want to access the Internet are only left with the choice of very low-speed access through dial-up type technologies. As discussed above, this makes the use of modern Internet facilities effectively impossible.

A first comparison of municipalities' socio-economic characteristics between non-OPAL and OPAL areas in the top part of Table 6 confirms that OPAL municipalities are situated in denser areas than non-OPAL municipalities. OPAL municipalities also exhibited slightly higher unemployment rates in 2001, i.e., in the pre-broadband-Internet period, but did not differ from non-OPAL municipalities in GDP per capita, the age distribution of the population, the female population share, and the net internal migration share. In 2008, differences between OPAL and non-OPAL municipalities are somewhat more pronounced, but this might be endogenous to broadband Internet access. Given that OPAL municipalities are situated in denser areas, they are likely to offer more opportunities for visiting bars, restaurants, theaters, museums, and the like compared to non-OPAL municipalities. This might indeed work against finding positive effects of the Internet on our informal social capital measures.

As a further depiction of the as-good-as-random allocation of the OPAL roll-out, the lower part of Table 6 provides a comparison of means of the individual-level background variables of our model by OPAL status. Since we exploit the OPAL roll-out that happened in East Germany after reunification, we restrict the sample to all individuals who lived in East Germany in 2001. To avoid bias from endogenous relocation decisions, OPAL technology is assigned to households based on 2001 residence again. The table shows raw differences in individual characteristics for both 2008 and 2001 between individuals having lived in OPAL and non-OPAL areas in 2001. In line with our identification, individuals having lived in OPAL areas in 2001 show a significantly lower probability of having high-speed Internet

[15] Broadband access through power line or satellite has so far been virtually non-existent in Germany, and third-generation mobile technology – whose speed is still far below standard broadband access and whose private use has been barred by expensive prices over most of our observation period – was not yet available in the majority of East German communities in 2008 (Bundesministerium für Wirtschaft und Technologie (2011)).

access at home in 2008 than individuals in non-OPAL areas. By contrast, none of the individual-level background characteristics measured in either 2001 or 2008 shows a significant difference between the two groups, apart from the fact that individuals having lived in non-OPAL areas are more likely to be a house or flat owner. Most importantly, there is no statistically significant difference in net household income between individuals having lived in areas with and without OPAL technology.[16] Since only one out of the 25 background variables captures statistical significance in the difference between the non-OPAL and the OPAL samples, this evidence supports the randomization interpretation.

6.2 Instrumental-Variable Model and Results

Our IV approach uses information whether a household was located in a telephone access area *a* (in county *c*) in 2001 that (as of 1998) used the OPAL technology ($OPAL_a$) as an instrument for whether an individual *i* has gained home broadband Internet access via DSL by 2008 $(I_{iac2008} - I_{iac2001})$. Thus, our two-stage model can be described by the following two equations:

$$(S_{iac2008} - S_{iac2001}) = \alpha + \beta(I_{iac2008} - I_{iac2001}) + (X_{iac2008} - X_{iac2001})\gamma + C_{c2001}\lambda + \varepsilon_{iac} \quad (3)$$

$$(I_{iac2008} - I_{iac2001}) = \eta + \chi OPAL_{a2001} + (X_{iac2008} - X_{iac2008})\theta + C_{c2001}\xi + \mu_{iac} \quad (4)$$

As the OPAL technology was rolled out at a large scale only in East Germany, we restrict our sample in the IV models to households located in East Germany in 2001, which reduces the sample size by about three quarters to slightly more than 3,000 individuals.[17] As our instrument provides variation at the level of telephone access areas, standard errors in the IV models are clustered at this level.

The identifying assumption of the IV model is that a household's location in a telephone access area originally covered by the OPAL technology is unrelated to the subsequent change in an individual's social capital except for the possible indirect effect through the impaired access to broadband Internet. Possible threats to this identification would arise if, for example, OPAL technology had been primarily used in regions that were correctly expected to become

[16] We also regressed a dummy of living in an OPAL area in 2001 on all individual background characteristics of Table 6. The background characteristics are jointly insignificant in this regression when measured in 2008 (*F*-statistic 1.36, *p*-value 0.131). They reach statistical significance when measured in 2001 (*F*-statistic 2.34), reflecting the difference in house or flat ownership.

[17] For comparison, Table A6 in the online appendix presents cross-sectional and first-difference estimates for the sample of the IV model. There are fewer significant effects, which is partly due to the lower statistical precision in this substantially smaller sample. However, all significant coefficients have a positive sign.

disproportionally more agglomerated or economically prosperous. Therefore, in addition to the vector of first-differenced individual-level covariates ($X_{iac2008}$-$X_{iac2001}$), we again include first differences of municipality characteristics to capture time-varying local factors as well as county fixed effects (based on 2001 residence) to control for county-specific time trends. Further tests of the validity of the identifying assumption are provided below.

To implement our IV approach, we draw on two unique data features. Within a catchment area, all households are connected to the Internet via the same node. Thus, first, *Deutsche Telekom* kindly provided us with their confidential data on the exact geographic extensions of the catchment areas as well as on which node had at some time used the OPAL technology, which we geo-coded for use in our analysis. As is evident from Figure 1, which shows the geographic distribution of OPAL areas across East Germany, the OPAL areas are highly dispersed across all of East Germany and not clustered in specific geographic areas. Second, we merge these data with the SOEP individual-level data by using exact geo-coordinates of the SOEP households, a newly established feature of the SOEP. This allows us to generate micro-regional information at the household level on whether the household is connected to a node that (historically) used the OPAL technology or not.

Figure 2 provides an impression of the small-scale geographic structure of our data. It shows the distribution of the distance of individuals to the node to which their household was connected in 2001. The average distance of a household to its node is clearly less than 2 kilometers (about 1 mile); the median distance is as low as 1,227 meters. When splitting up the sample into individuals living in OPAL areas and living in non-OPAL areas, the picture is very similar for both groups (see Figure A1 in the online appendix). The average distance to the node in non-OPAL areas is not significantly different from the respective distance in OPAL areas.[18] In non-OPAL areas, households located not too far from the node can access high-speed Internet.[19] By contrast, in OPAL areas the OPAL technology hinders the supply of Internet at high-speed bandwidth as long as the fiber wires of the access network are not replaced by copper wires.

We start by presenting the results of the reduced form of our IV model which regresses the first-differenced social capital variables on the OPAL area instrument while controlling for first-differenced individual and municipality-level variables and county fixed effects

[18] A Kolmogorov-Smirnov test rejects the hypothesis of equality of the full distributions, though.

[19] In non-OPAL areas, the bandwidth that a household can subscribe to is a function of its distance to the node. A distance of less than 2 km on average suggests that households in these areas can at least subscribe to DSL at a bandwidth of 6 Mbit/s; see below for additional analysis.

(Table 7). The OPAL coefficients have a negative sign for all our social capital measures, indicating that individuals in OPAL areas (who are exogenously cut off from gaining broadband Internet access at home) became less socially active over time relative to individuals in non-OPAL areas (who had the opportunity to access high-speed Internet). This intention-to-treat estimate is highly significant for the social capital index and suggests that having lived in an OPAL area reduces the social capital index by 11.3 percent of a standard deviation. Among the individual social capital measures, the negative effect captures statistical significance for visiting theaters, operas, and exhibitions and for interest in politics. Thus, the reduced-form estimates suggest that broadband Internet access has positive effects on individuals' social capital.

Table 8 shows the results of the corresponding IV models. The first stage indicates that the instrument is indeed a relevant predictor of broadband Internet access at home.[20] In OPAL areas, the likelihood of having home broadband Internet access is 8 percentage points lower than in non-OPAL areas. The robust *F*-statistic of the excluded instrument ranges from 5.6 to 6.3 for the different outcome variables.[21]

The second stage of the IV model suggests that home broadband Internet access has a positive effect on the social capital index of the order of magnitude of 1.3 standard deviations, statistically significant at the 10 percent level. Among the separate social capital measures, the second-stage results do not show a single negative coefficient of home broadband Internet access, and the size of the separate positive coefficients is in the same ballpark. Most of the second-stage results of the separate measures lack statistical significance, though, due to relatively large standard errors of the estimated coefficients. Only the effect of home broadband Internet access on interest in politics is significantly different from zero. The fact that the combined index does capture significance despite the fact that five of the six sub-components are statistically insignificant is an indication that the statistical insignificance of most of the sub-components might reflect lack of statistical power, rather than lack of a

[20] The shown first stage relates to the model with the social capital index as the dependent variable. Due to slight variations in the number of missing values, the first-stage models differ slightly for the separate social capital measures, but only in the third digit (between 0.080 and 0.083; see Table A7 in the online appendix). Respective *F*-statistics of the instrument in the first stage of all models are also reported at the bottom of Table 8.

[21] With a single instrument, our just-identified IV estimates are median-unbiased, which makes them less susceptible to weak instruments critique (Angrist and Pischke (2009)). Still, to be on the safe side, Angrist and Krueger (2001) suggest investigating whether the reduced-form estimates – which are proportional to the causal effect of interest – are significant, an approach validated by formal evidence in Chernozhukov and Hansen (2008). Indeed, our reduced-form estimates lend support to the 2SLS results, as they are significant for the two social capital outcomes for which we find significant 2SLS effects – the social capital index and being interested in politics – as well as for the third variable of visiting theaters, operas, and exhibitions.

positive effect.[22] Despite the limited precision of the estimates, we can reject with 95 percent (90 percent) confidence that the effect is below -15.9 percent (below +8.0 percent) of a standard deviation of the social capital index. Partly due to the large standard errors, we do not find systematic heterogeneity in the second-stage coefficients of home broadband Internet access across different subgroups of individuals (see Table A8 in the online appendix).

The 2SLS point estimates are substantially larger than in the OLS and first-difference models. We see three possible explanations that may all contribute to this pattern. First, among the possible biases in the OLS estimates discussed above, the downward biases may dominate the upward biases: People who tend to scare away from real-world social contact disproportionately select into having broadband Internet access, presumably because it offers them a good opportunity to avoid real-world social interactions. If choosing to subscribe to broadband Internet reflects an increasing trend in the tendency to be intrinsically disconnected from the community, such bias may also affect the first-difference estimates reported in the previous section. Second, the non-IV estimates may suffer from attenuation bias due to measurement error. Apart from standard response errors, respondents may not be fully aware of the broadband status of their Internet connection. Instrumenting by an independent source of information about the availability of broadband access, namely the OPAL technology of the telecommunication network, solves this attenuation bias. Third, the causal effect of broadband Internet access on social capital may possibly differ between the total population and the subgroup of those who change their broadband access status because of its unavailability due to the OPAL technology. In a local average treatment effect (LATE) interpretation, treatment effects may not be homogenous in the population. The IV approach identifies the treatment effect for the subpopulation of compliers who change their treatment status due to the variation induced by the instrument. In our case, the complier subpopulation comprises those individuals who do not have access to broadband Internet at home for the exogenous reason of living in a (historical) OPAL area, but would otherwise have subscribed to broadband Internet.

6.3 Instrument Validity and Robustness Tests

To test the validity of our instrument and the identifying assumption underlying our IV model, we perform a number of specification tests. First, living in an OPAL access area is a

[22] For most of the insignificant IV coefficients, tests for exogeneity based on robust regressions do not reject exogeneity, so that one cannot rule out that the standard first-difference results depict the causal effect. Yet, due to the low statistical precision of the 2SLS estimates, one should not over-interpret this result.

valid instrument for home broadband Internet access only if OPAL roll-out does not correlate with pre-existing dispositions in favor of Internet access. It is possible to test this in a placebo test: If the negative first-stage correlation of the OPAL area dummy with high-speed Internet access is indeed due to the technological shortcomings of the OPAL technology, we should find no effect of our instrument on Internet access in years where broadband Internet via DSL was not available. In order to test this presumption, we use data on Internet access in a household from the year 2000 wave of the SOEP. OPAL roll-out had been terminated by 2000. At the same time, 2000 was the very first year in which broadband Internet connections were realized in Germany, and most SOEP interviews take place in spring. The total number of (the then expensive) broadband subscriptions in 2000 was a mere 0.16 million (Dialog Consult/VATM (2007)), compared to 25 million in 2009. Thus, in 2000 individuals with home Internet access almost exclusively relied on modem or ISDN, that is, low-speed Internet technologies which are not hindered by the OPAL technology. Consequently, running our first-stage regression on the 2000 data can be interpreted as a placebo treatment test.

As is evident in Table 9, the results of the placebo first-stage regression indeed confirm the interpretation of our instrument: The historical OPAL area dummy – assigned to households based on residence in the year 2001 – is small and does not capture statistical significance in predicting (low-speed) Internet access in 2000. By contrast, the OPAL area dummy proves a strong negative predictor for broadband Internet access in 2008 in the same sample[23] of individuals who were surveyed in both 2000 and 2008.

This finding is encouraging also from another perspective. In 2000, low-speed Internet access at home was still a high-end technological attainment. Note that one source of endogeneity concern was that more outgoing and open-minded individuals socialize more and at the same time could be more susceptive to new technological developments and thus be early adopters of a new technology. However, our placebo first-stage result suggests that being an early adopter is not systematically correlated with living in an OPAL area.

If historical OPAL areas were indeed as good as randomly distributed across East Germany, we should not observe systematic differences in characteristics between households located in a historical OPAL area and households not located in a historical OPAL area before the advent of high-speed Internet. Table 6 already provides evidence speaking in favor of this randomization interpretation. A related test is to estimate the 2SLS regressions without any individual and municipality-level controls. Indeed, our results are hardly affected by this

[23] The slight difference in the number of observations between the two columns is due to differences in missing values in the dependent variables in the two years.

exercise. The second-stage coefficients are all large and positive, although they lose significance due to a lack of precision in the estimates (see Table A9 in the online appendix).

An even more direct test of the validity of our IV approach is a placebo test of whether the OPAL technology is correlated with our *outcome* variables, the measures of social capital, before the advent of high-speed Internet. To this end, we replicate our reduced-form model with the social capital variables measured in 2001 (when they were surveyed and broadband Internet was hardly existent). This placebo test regresses the social capital outcomes measured in 2001 on the instrument, i.e., the OPAL area dummy based on 2001 residence, while controlling for all individual and municipality-level controls measured in 2001 and county fixed effects.[24] Results, shown in the upper panel of Table 10, suggest that social capital was not significantly different between OPAL and non-OPAL areas before the spread of broadband Internet. The point estimates even suggest *higher* pre-existing levels of all but one of the social capital indicators in the Internet-deprived OPAL areas (even reaching statistical significance in the case of interest in politics).

The lower panel of Table 10 presents results of the respective 2SLS regressions. While overall, the standard errors are too large to draw rigorous conclusions from these estimates, the placebo estimates provide direct evidence that individuals living in OPAL areas were not negatively selected as compared to individuals in non-OPAL areas in terms of social capital before the expansion of broadband Internet. This result corroborates the validity of our IV approach.

Some households in the control group located in non-OPAL areas may in fact not have effective access to broadband-speed Internet because with the DSL technology, the possible bandwidth of Internet access is a declining function of the distance between the household and its node. Thus, to restrict our sample to those who technically could have access to broadband Internet given the distance to the node, in another robustness specification we drop all individuals who lived in households located more than 4.2 km away from the closest node in 2001. Again, the results in this subsample do not differ systematically from the results for the full sample (see Table A10 in the online appendix).[25]

Another concern might be that some instances of retracting into the virtual world might not be captured by the SOEP since those individuals drop out of the survey. A correlation of

[24] Results are unaffected if we include the first-differenced controls instead of the 2001 level controls.

[25] As an additional placebo test, we ran our baseline reduced-form specification of Table 7 on the restricted sample of 160 individuals living more than 4.2 km from the nearest node. The OPAL coefficient is small and far from statistical significance in this placebo specification (-0.063, std. err. 0.263).

such attrition with the OPAL instrument might bias our results. To check the relevance of this concern, we regress an indicator variable that equals one for East German individuals which are in the survey waves 2001 and 2008 and zero for individuals only in the survey wave 2001 on the OPAL instrument and all control variables measured in 2001. The OPAL coefficient is 0.014 with a standard error of 0.024. Given a baseline attrition rate of 23.7 percent between 2001 and 2008 for the East German SOEP population living in non-OPAL areas in 2001, this result indicates that living in an OPAL area does not explain attrition from the survey.

As a further robustness check, we drop all observations from the capital city Berlin and find that our results are unaffected. Since some individuals moved between 2001 and 2008, we also analyze whether our results are robust to including a mover dummy in our IV regressions. As expected, this makes the first stage slightly stronger. Our second stage results remain virtually unchanged.

Finally, the fact that our results indicate a significant *positive* effect of broadband Internet on the social capital index suggests that the information and communication functions of the Internet tend to dominate its entertainment function on average. Suggestive evidence that the Internet is indeed predominantly used for informative and communicative activities comes from a media analysis survey conducted by *Arbeitsgemeinschaft Media-Analyse* in 2007. The questionnaire surveyed a number of non-exclusive Internet usages among a sample of 18,954 Internet users in Germany. The highest two categories, reported by 94.6 percent and 89.4 percent of respondents, respectively, were use of the Internet for "information search" and for "e-mail." Categories like "news," "services," and "ordering of products" follow at 71.7, 54.9, and 55.3 percent, respectively. By contrast, only 48.8 percent of respondents report to use the Internet for "entertainment choices." This is suggestive evidence that the information channel may indeed be a dominating mechanism of the Internet's impact on social capital.

6.4 Administrative Measures of Voter Turnout

A remaining drawback of the evidence from survey-based measures of social capital is the limited statistical precision of the IV estimates. An alternative approach to gain statistical precision is to use social capital measures from administrative data that cover the universe of East Germans at an aggregate level. Specifically, we consider voter turnout as an additional social capital measure.[26] Voter turnout is often seen as a measure for the civicness of the local

[26] Voter turnout has the advantage as a municipality-level measure of social capital that votes are registered in the municipality of residence, which aligns with the information on broadband Internet access. By contrast, counts of theaters, operas, and cinemas, or of their visitors, would erroneously include social activity of visitors

population (Putnam (1993)). We draw on data on voter turnout for various (federal, state, or local) elections put together by Falck, Gold, and Heblich (2014). In the election cycle 2004-2008, average voter turnout is 60.5 percent (with a standard deviation of 11.4) across all East German municipalities. Data on broadband Internet availability at the municipality level are taken from the *Broadband Atlas* (Bundesministerium für Wirtschaft und Technologie (2011)), an annual survey conducted by the German Ministry of Economics and Technology since 2005 that measures broadband Internet availability as the share of households that are technically able to access DSL.

The left panel of Table 11 has changes in voter turnout from the election cycle 1995-99 (before the introduction of broadband Internet) to the election cycle 2004-08 (after the introduction of broadband Internet) as the dependent variable. All models control for changes in municipalities' socio-economic characteristics, namely in the female population share, age structure (shares aged below 18 or above 64), the unemployment rate, and the net migration rate, as well as fixed effects for counties, years, and election types. The first-difference model indicates a positive association of broadband Internet introduction with changes in voter turnout. In the municipality-level regression, OPAL proves a strong instrument for broadband Internet access. The IV estimate is again positive, but statistically insignificant. Likewise, the reduced-form model indicates an insignificant negative point estimate on OPAL in predicting voter turnout. These estimates are precise enough to reject with 95 percent confidence the possibilities that voter turnout in (broadband-deprived) OPAL areas is 0.11 percentage points higher than in non-OPAL areas and that an increase in broadband Internet availability by 10 percentage points decreases voter turnout by 0.19 percentage points.

The right panel of Table 11 presents placebo tests for these models, using changes in voter turnout in the pre-broadband era (from the election cycle 1990-94 to the election cycle 1995-99) as the dependent variable. Since availability of information on municipalities' socio-economic characteristics is limited in the early 1990s, this specification can only control for changes in population and in the female population share. The first-difference, the IV, and the reduced-form specifications indicate a negative association of later broadband Internet introduction with earlier changes in voter turnout before the advent of high-speed Internet. If anything, voter turnout used to be going up in OPAL areas, suggesting that the negative point estimate on broadband-deprived OPAL areas in predicting changes in voter turnout after the

from other municipalities and would thus not capture well the social capital of those with and without high-speed Internet access.

advent of broadband Internet is not reflecting pre-existing trends in turnout in these areas. The placebo reduced-form estimates allow us to reject with 95 percent confidence that people living in OPAL vs. non-OPAL areas differed from one another in their pre-broadband changes in voter turnout by more than 0.80 percentage points in either direction. Comparing the placebo reduced-form estimates to the actual reduced-form estimates, we do not find any evidence for positive effects of the OPAL technology, i.e., negative effects of broadband Internet, on voter turnout.

The bottom line is that there is no significant reduction in voter turnout in East German municipalities due to the exogenous variation in access to broadband Internet identified in our model, confirming the previous results based on individual-level survey data. If anything, the point estimates indicate a positive effect of broadband Internet access on voter turnout, and these estimates based on administrative data are precise enough to reject substantial negative effects.

7. Conclusions

How does society change through the introduction of the new technologies for information, communication, and entertainment that arrived over the past decade? Does the advent of modern Internet media overthrow the fundamentals of society? Does a withdrawal into a virtual world alienate humans from one another? This paper examines the effect of broadband Internet access at home on social capital. Based on German individual-level data, we measure social capital in terms of a wide range of measures of social participation in the real world that cover both informal and formal dimensions of social engagement. The measures include such informal interactions as going to theaters and operas, cinema and concerts, bars and restaurants, direct measures of interactions with friends, family, and relatives, more formal civic engagement in volunteer and political work, and political interest. We also use administrative municipality-level data on voter turnout in elections.

We devise two identification strategies designed to address concerns of endogeneity bias in OLS estimates. First, we make use of the panel structure of our data and estimate first-difference models to control for unobserved time-invariant individual heterogeneity. Second, we merge the individual data with unique historical telecommunication data and exact geo-coding of households and telecommunication distribution frames to exploit a quasi-experimental setting that provides us with exogenous variation in broadband Internet availability in East Germany: In the aftermath of reunification, the telecommunication infrastructure in some East German areas was modernized with the OPAL fiber technology, the most up-to-date technology at the time, which later turned out to be incompatible with the DSL standard required for high-speed Internet access when the latter emerged.

Our pattern of results across the two identification strategies provides no indication that the Internet has a significant negative impact on average on any of our social capital measures. Rather, virtually all estimates in both models and for all social capital measures point in the positive direction. Both the first-difference identification and the IV identification indicate significant positive effects of broadband Internet access on a social capital index that condenses the available social capital information into one measure. The first-difference models are also significantly positive for three separate measures of social capital – visiting such places as theaters, operas, and exhibitions; going to the cinema or to concerts; and engaging in volunteer work. Although the IV estimates of the separate measures have low statistical precision, the estimate for interest in politics is significantly positive. Despite the limited precision of our IV estimates based on survey data, we can reject with 95 percent (90 percent) confidence that broadband Internet reduces the social capital index by more than 15.9 percent (increases it by less than 8.0 percent) of a standard deviation. While statistical power of the survey-based estimates is limited, the estimates from administrative data are precise enough to reject that living in an area that prevents access to broadband Internet has even small positive effects (of 0.11 percentage points) on voter turnout.

Our findings are in clear contrast to the significant negative impact of TV consumption on social capital and voter turnout shown by Olken (2009) and Gentzkow (2006). It seems that on average, because of the distinguishing feature of interactivity, the Internet is qualitatively different from the television in that its main function is not so much one of passive entertainment. At least in some areas of social engagement, the main function of the Internet seems rather one of active information and communication – which the Internet provides in an individualized form at any time – that is conducive to social interaction. Such an interpretation is in line with suggestive evidence that most people use the Internet for information search and communication, whereas much fewer people use it for mere entertainment purposes.

Of course, our analysis does not capture all relevant aspects of social capital, and our measures of social capital are only indirect. We observe activities where real interactions between individuals can possibly take place, and, eventually, trust between individuals can emerge. This caveat is shared with a vast literature on social capital. But our study does show that broadband Internet does not necessarily crowd out other real-world activities.

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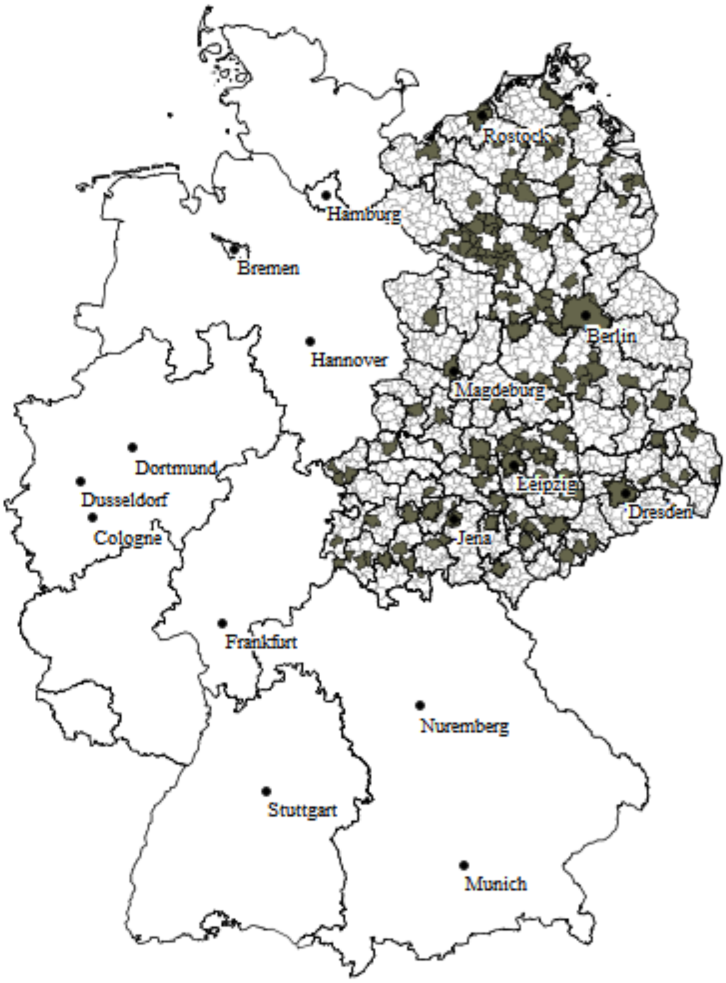
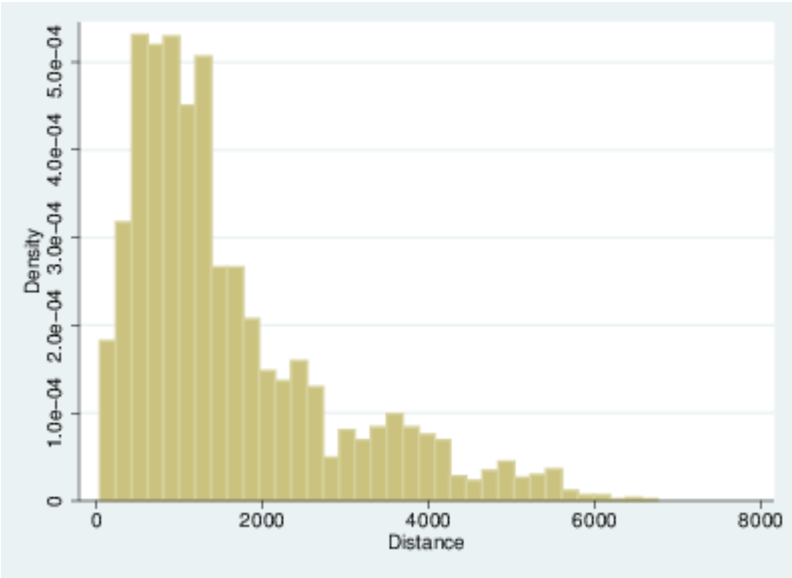
Figure 1: The location of OPAL areas in East Germany



Notes: Map of Germany with East German borders for counties (black lines) and telephone access areas (grey lines). Telephone access areas with historical OPAL nodes in East Germany are highlighted. Own depiction based on data kindly provided by *Deutsche Telekom*.

Figure 2: Distance to node



Notes: Histogram of distance (in meters) to node to which East German households were connected in 2001. Sample: all individuals in SOEP 2008 having lived in East Germany in 2001. Data: SOEP 2001, 2008.

Table 1: Descriptive statistics of 2008 variables

		OLS sample	First-difference sample	First-difference IV sample
Broadband Internet Access (DSL) at home		56.02	50.33	40.74
Female		52.43	53.00	52.95
Marital Status	Married	62.89	68.56	64.43
	Single	30.51	23.63	28.07
	Widowed	6.60	7.81	7.51
Owner of House/Flat		54.12	54.24	42.92
Occupational Status	Not-Working	6.28	6.37	2.55
	Apprentice	6.47	1.39	1.42
	Unemployed	5.04	5.06	8.39
	Retired	27.11	31.17	33.90
	Blue collar worker	15.63	17.62	17.41
	White collar worker	33,31	32.74	30.78
	Entrepreneur	6.16	5.65	5.55
Schooling	No or lower secondary	34.09	39.11	27.37
	Medium secondary	27.07	27.61	37.18
	Higher secondary	10.36	8.44	6.43
	Other	4.83	5.23	1.23
	Uni of Applied Science	8.88	8.92	14.60
	University	12.90	10.68	13.18
	Pupil	1.88	0.01	0.00
Migration Background	None	85.19	84.77	96.28
	Direct	9.97	11.26	1.92
	Indirect	4.83	3.97	1.80
Age	Mean	49.94	53.25	53.45
	Std. dev.	17.42	15.74	15.63
Children in household	Mean	0.45	0.45	0.31
	Std. dev.	0.84	0.85	0.71
Net household income p.m.	Mean	3,058.90	2,751.79	2,396.40
	Std. dev.	2,251.99	1,578.47	1,252.73
Number of observations		[17,386]	[12,103]	[3,171]

Percentage shares unless otherwise noted. Number of observations in square brackets. Samples: OLS: all individuals in SOEP 2008; First difference: all individuals in SOEP 2008 with available information on social capital in SOEP 2001; First difference IV: all individuals in SOEP 2008 having lived in East Germany in 2001 with available information on social capital in SOEP 2001. Data source: SOEP 2008.

Table 2: Descriptive statistics: Measures of social capital in 2008

	Theater, opera, and exhibitions	Cinema and concert	Restaurant and bar	Visit friends	Visit relatives	Volunteer work	Political engagement		Interest in politics
OLS sample									
Never	42.54	38.58	9.19	2.80	2.11	71.00	89.38	Not at all	15.22
Less often than once a month	47.21	42.79	38.98	21.62	21.39	10.78	7.51	Not strong	48.67
At least once a month	9.78	15.71	29.87	33.34	30.42	8.03	2.09	Strong	28.53
At least once a week	0.44	2.90	20.62	38.50	38.01	8.79	0.80	Very strong	7.57
Every day	0.02	0.03	1.34	3.74	8.07	1.40	0.21		
N	17,357	17,337	17,353	17,320	17,317	17,327	17,304		17,343
First-difference sample									
Never	45.33	44.01	10.64	3.33	2.31	71.93	89.50	Not at all	15.09
Less often than once a month	46.52	42.62	43.30	23.41	20.59	10.79	7.59	Not strong	51.07
At least once a month	7.75	11.81	28.26	34.69	29.92	8.02	2.08	Strong	27.25
At least once a week	0.36	1.52	16.61	35.96	38.97	8.13	0.70	Very strong	6.58
Every day	0.02	0.03	1.18	2.60	8.21	1.12	0.14		
N	12,084	12,072	12,076	12,054	12,057	12,063	12,048		12,065
First-difference IV sample									
Never	43.54	40.43	12.72	3.89	2.09	76.97	91.10	Not at all	15.12
Less often than once a month	48.72	46.53	51.85	26.54	19.85	9.14	6.43	Not strong	51.64
At least once a month	7.55	11.75	24.25	37.78	33.68	7.62	1.87	Strong	26.96
At least once a week	0.19	1.26	10.55	29.48	37.54	5.60	0.57	Very strong	6.28
Every day	0.00	0.03	0.63	2.31	6.84	0.66	0.03		
N	3,167	3,166	3,167	3,158	3,159	3,161	3,158		3,168

Samples: OLS: all individuals in SOEP 2008; First difference: all individuals in SOEP 2008 with available information on the respective social capital variable in SOEP 2001; First difference IV: all individuals in SOEP 2008 having lived in East Germany in 2001 with available information on the respective social capital variable in SOEP 2001. Data source: SOEP 2008.

Table 3: Description of the broadband Internet users in 2008

	Broadband Internet access (DSL) at home			
Female	-0.035^{***}	*(0.005)*	-0.034^{***}	*(0.004)*
Age	0.006^{***}	*(0.001)*	0.006^{***}	*(0.001)*
Age^2 (/100)	-0.013^{***}	*(0.001)*	-0.013^{***}	*(0.001)*
Marital status (omitted category: married)				
Single	-0.049^{***}	*(0.012)*	-0.056^{***}	*(0.012)*
Widowed	-0.014	*(0.014)*	-0.021	*(0.015)*
Number of children in household	0.010^{*}	*(0.006)*	0.006	*(0.006)*
Schooling (omitted category: nor or lower secondary)				
Medium secondary	0.046^{***}	*(0.010)*	0.062^{***}	*(0.010)*
Higher secondary	0.134^{***}	*(0.014)*	0.126^{***}	*(0.014)*
Other	-0.011	*(0.019)*	-0.001	*(0.019)*
University of Applied Sciences	0.093^{***}	*(0.014)*	0.119^{***}	*(0.014)*
University	0.114^{***}	*(0.014)*	0.127^{***}	*(0.014)*
Pupil	0.125^{***}	*(0.027)*	0.124^{***}	*(0.026)*
Occupational status (omitted category: non-working)				
Apprentice	0.008	*(0.024)*	0.035	*(0.022)*
Unemployed	-0.044^{*}	*(0.023)*	-0.001	*(0.022)*
Retired	-0.094^{***}	*(0.018)*	-0.069^{***}	*(0.018)*
Blue collar worker	-0.062^{***}	*(0.017)*	-0.038^{**}	*(0.016)*
White collar worker	0.022	*(0.015)*	0.024^{*}	*(0.014)*
Entrepreneur	0.019	*(0.020)*	0.029	*(0.019)*
Migration background (omitted category: none)				
Direct	-0.018	*(0.016)*	-0.050^{***}	*(0.016)*
Indirect	-0.002	*(0.017)*	-0.021	*(0.017)*
Tenant (omitted category: owner)	-0.024^{**}	*(0.010)*	-0.028^{***}	*(0.011)*
Log net household income	0.201^{***}	*(0.009)*	0.179^{***}	*(0.010)*
County fixed effects	No		Yes	
N	17,386		17,386	
R^2	0.263		0.326	

OLS regressions. Sample: all individuals in SOEP 2008. Robust standard errors clustered at the household level in parentheses. *** 1%, ** 5%, and * 10% level of significance. Data source: SOEP 2008.

Table 4: The association between broadband Internet access and social capital in 2008

	Social capital index		Theatre, opera, and exhibitions		Cinema and Concert		Socializing with friends and relatives		Volunteer work		Political engagement		Interest in politics	
Broadband Internet Access (DSL) at home	0.096***	*(0.019)*	0.082***	*(0.019)*	0.094***	*(0.016)*	0.042***	*(0.014)*	0.039**	*(0.020)*	0.022	*(0.017)*	0.053***	*(0.017)*
Female	-0.149***	*(0.011)*	0.125***	*(0.011)*	-0.060***	*(0.009)*	0.031***	*(0.008)*	-0.119***	*(0.014)*	-0.138***	*(0.013)*	-0.395***	*(0.012)*
Age	-0.001	*(0.003)*	0.032***	*(0.003)*	-0.035***	*(0.002)*	-0.032***	*(0.002)*	0.018***	*(0.003)*	0.014***	*(0.002)*	0.028***	*(0.003)*
$Age^2/(100)$	-0.006**	*(0.003)*	-0.027***	*(0.003)*	0.012***	*(0.002)*	0.017***	*(0.002)*	-0.017***	*(0.003)*	-0.009***	*(0.002)*	-0.014***	*(0.003)*
Marital status (omitted category: married)														
Single	0.106***	*(0.018)*	0.120***	*(0.019)*	0.186***	*(0.018)*	0.036**	*(0.014)*	-0.040*	*(0.021)*	-0.008	*(0.018)*	0.064***	*(0.019)*
Widowed	0.079***	*(0.030)*	0.027	*(0.031)*	0.042*	*(0.023)*	0.134***	*(0.024)*	-0.025	*(0.031)*	-0.030	*(0.030)*	0.025	*(0.029)*
No. Children in household	-0.070***	*(0.010)*	-0.076***	*(0.010)*	-0.111***	*(0.009)*	-0.048***	*(0.007)*	0.028**	*(0.011)*	-0.005	*(0.010)*	0.003	*(0.009)*
Schooling (omitted category: nor or lower secondary)														
Medium secondary	0.230***	*(0.017)*	0.268***	*(0.017)*	0.132***	*(0.014)*	0.040***	*(0.015)*	0.083***	*(0.020)*	0.055***	*(0.017)*	0.232***	*(0.018)*
Higher secondary	0.450***	*(0.028)*	0.490***	*(0.027)*	0.198***	*(0.025)*	0.064***	*(0.019)*	0.214***	*(0.029)*	0.164***	*(0.028)*	0.482***	*(0.028)*
Other	-0.090***	*(0.034)*	-0.045	*(0.034)*	-0.080**	*(0.031)*	-0.060*	*(0.032)*	-0.088***	*(0.029)*	-0.015	*(0.032)*	0.008	*(0.038)*
University of Applied Sciences	0.465***	*(0.028)*	0.523***	*(0.025)*	0.210***	*(0.023)*	0.074***	*(0.018)*	0.217***	*(0.032)*	0.152***	*(0.029)*	0.481***	*(0.026)*
University	0.683***	*(0.029)*	0.774***	*(0.026)*	0.233***	*(0.023)*	0.102***	*(0.019)*	0.289***	*(0.029)*	0.297***	*(0.033)*	0.697***	*(0.026)*
Pupil	0.369***	*(0.056)*	0.462***	*(0.058)*	0.141**	*(0.056)*	-0.101**	*(0.039)*	0.248***	*(0.067)*	0.199***	*(0.058)*	0.385***	*(0.059)*
Occupational status (omitted category: non-working)														
Apprentice	0.196***	*(0.044)*	0.235***	*(0.043)*	0.318***	*(0.036)*	-0.093***	*(0.032)*	0.170***	*(0.047)*	0.051	*(0.037)*	0.125**	*(0.049)*
Unemployed	-0.150***	*(0.041)*	-0.099***	*(0.037)*	-0.057*	*(0.034)*	-0.136***	*(0.033)*	-0.073*	*(0.038)*	-0.013	*(0.033)*	-0.046	*(0.036)*
Retired	0.121***	*(0.036)*	0.128***	*(0.033)*	0.074***	*(0.027)*	0.113***	*(0.029)*	0.007	*(0.038)*	-0.035	*(0.036)*	0.079**	*(0.035)*
Blue Collar Worker	-0.092***	*(0.031)*	-0.070**	*(0.029)*	0.073***	*(0.025)*	-0.075***	*(0.025)*	-0.042	*(0.035)*	-0.044	*(0.029)*	-0.103***	*(0.029)*
White Collar Worker	0.066**	*(0.029)*	0.047*	*(0.027)*	0.194***	*(0.023)*	-0.034	*(0.023)*	-0.001	*(0.032)*	0.026	*(0.027)*	0.060**	*(0.028)*
Entrepreneur	0.113***	*(0.039)*	0.072**	*(0.036)*	0.133***	*(0.032)*	-0.021	*(0.027)*	0.038	*(0.043)*	0.142***	*(0.043)*	0.108***	*(0.036)*
Migration background (omitted category: none)														
Direct	-0.193***	*(0.261)*	-0.167***	*(0.027)*	-0.099***	*(0.027)*	0.046**	*(0.021)*	-0.208***	*(0.029)*	-0.040	*(0.026)*	-0.278***	*(0.028)*
Indirect	-0.044	*(0.032)*	-0.048	*(0.034)*	0.006	*(0.028)*	0.030	*(0.023)*	-0.084**	*(0.034)*	0.003	*(0.025)*	-0.086**	*(0.034)*
Tenant (omitted category: owner)	-0.160***	*(0.019)*	-0.129***	*(0.018)*	-0.058***	*(0.016)*	-0.069***	*(0.014)*	-0.156***	*(0.019)*	-0.071***	*(0.017)*	-0.052***	*(0.016)*
Log net household income	0.199***	*(0.020)*	0.234***	*(0.016)*	0.182***	*(0.016)*	0.063***	*(0.014)*	0.034**	*(0.017)*	0.042**	*(0.017)*	0.115***	*(0.017)*
Municipality level controls	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
County fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
N	17,075		17,323		17,303		17,218		17,293		17,270		17,310	
Overall R^2	0.244		0.262		0.425		0.123		0.070		0.042		0.251	

OLS regressions. Dependent variable (*z*-standardized, averaged over 2007 to 2009) reported on top of each column. Municipality controls included in each model: the share of females, the share of working-age population, the share of individuals aged 65 and older, the share of unemployed persons, and the net migration rate. Sample: all individuals in SOEP 2008. Robust standard errors clustered at the county level in parentheses. *** 1%, ** 5%, and * 10% level of significance. Data source: SOEP 2007, 2008, 2009.

Table 5: Broadband Internet access and social capital: First-difference models

	Social capital index	Theater, opera, and exhibitions	Cinema and concert	Socializing with friends and relatives	Volunteer work	Political engagement	Interest in politics
Broadband Internet access (DSL) at home	0.041**	0.058***	0.037**	-0.040*	0.075***	0.026	0.011
	(0.018)	*(0.019)*	*(0.018)*	*(0.021)*	*(0.020)*	*(0.020)*	*(0.016)*
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	10,828	11,158	11,133	11,091	11,082	11,039	11,169
Overall R^2	0.012	0.011	0.039	0.018	0.005	0.004	0.004

OLS regressions. Dependent variable (*z*-standardized, average 2007-2009 minus average 1999/2001) reported on top of each column. Variables refer to first differences (2008 minus 2001) unless noted otherwise. Sample: all individuals in SOEP 2008 with available information on the respective social capital variable also in SOEP 2001. Individual controls included in each model: differences in marital status, in the number of children living in the household, in secondary and university education, in occupational status, in house/flat ownership, and in log net household income. Municipality controls included in each model: differences in the share of females, in the share of working-age population, in the share of individuals aged 65 and older, in the share of unemployed persons, and in the net migration rate. Robust standard errors clustered at the county level in parentheses. *** 1%, ** 5%, and * 10% level of significance. Data source: SOEP 1999, 2001, 2007, 2008, 2009.

Table 6: Comparison of background characteristics between non-OPAL and OPAL areas

	2008				2001			
	Non-OPAL	OPAL	Difference		Non-OPAL	OPAL	Difference	
	Mean	Mean	Mean	Std. err.	Mean	Mean	Mean	Std. err.
Municipalities' socio-economic characteristics								
Share of females	0.501	0.503	-0.002*	*(0.001)*	0.505	0.508	-0.003	*(0.001)*
Share of working-age population	0.563	0.574	-0.010***	*(0.003)*	0.694	0.694	0.001	*(0.001)*
Share of population older than 65	0.226	0.231	-0.004	*(0.003)*	0.175	0.179	-0.004	*(0.002)*
Net internal migration rate	-0.010	-0.008	0.001	*(0.001)*	-0.006	-0.006	0.001	*(0.001)*
Unemployment rate	0.120	0.132	-0.012***	*(0.004)*	0.127	0.136	-0.009***	*(0.003)*
GDP per capita (county level)	50,820.58	49,975.41	845.17*	*(495.54)*	41,682.68	42,004.88	-322.21	*(305.55)*
Population density (county level)	103.02	234.77	-131.75***	*(13.30)*	109.56	240.90	-131.34***	*(13.35)*
Individual background variables								
Broadband Internet Access (DSL) at home	0.418	0.360	0.057**	*(0.023)*	0.000	0.000	0.000	*(0.000)*
Female	0.530	0.527	0.003	*(0.023)*	0.530	0.527	0.003	*(0.023)*
Age	53.47	53.33	0.146	*(0.729)*	46.47	46.32	0.146	*(0.729)*
Marital status								
Married	0.648	0.627	0.021	*(0.022)*	0.645	0.625	0.019	*(0.022)*
Single	0.280	0.285	-0.005	*(0.021)*	0.309	0.321	-0.012	*(0.022)*
Widowed	0.072	0.088	-0.015	*(0.012)*	0.046	0.054	-0.007	*(0.010)*
Number of children in household	0.321	0.276	0.045	*(0.033)*	0.507	0.495	0.012	*(0.039)*
Schooling								
No or lower secondary	0.276	0.263	0.012	*(0.021)*	0.276	0.263	0.013	*(0.021)*
Medium secondary	0.369	0.384	-0.014	*(0.023)*	0.371	0.378	-0.007	*(0.023)*
Higher secondary	0.064	0.068	-0.005	*(0.011)*	0.072	0.072	-0.000	*(0.012)*
Other	0.013	0.009	0.004	*(0.005)*	0.013	0.009	0.004	*(0.005)*
University of Applied Sciences	0.145	0.149	-0.003	*(0.016)*	0.137	0.138	-0.001	*(0.016)*
University	0.133	0.127	0.006	*(0.016)*	0.114	0.113	0.001	*(0.015)*
Pupil	0.000	0.000	0.000	*(0.000)*	0.017	0.027	-0.010	*(0.006)*
Occupational status								
Non-working	0.024	0.030	-0.006	*(0.007)*	0.031	0.020	0.011	*(0.008)*
Apprentice	0.015	0.011	0.004	*(0.006)*	0.073	0.073	-0.001	*(0.012)*
Unemployed	0.082	0.091	-0.009	*(0.013)*	0.119	0.115	0.004	*(0.015)*
Retired	0.339	0.340	-0.002	*(0.022)*	0.233	0.244	-0.011	*(0.020)*
Blue collar worker	0.175	0.172	0.002	*(0.018)*	0.197	0.195	0.002	*(0.019)*
White collar worker	0.309	0.303	0.006	*(0.021)*	0.304	0.317	-0.013	*(0.022)*
Entrepreneur	0.056	0.052	0.004	*(0.011)*	0.043	0.036	0.007	*(0.009)*
Migration background								
None	0.962	0.968	-0.006	*(0.009)*	0.962	0.968	-0.006	*(0.009)*
Direct	0.021	0.013	0.008	*(0.006)*	0.021	0.013	0.008	*(0.006)*
Indirect	0.018	0.020	-0.002	*(0.006)*	0.018	0.020	-0.002	*(0.006)*
House/flat ownership	0.444	0.358	0.086***	*(0.023)*	0.418	0.290	0.127***	*(0.023)*
Log net household income	7.661	7.627	0.035	*(0.024)*	7.635	7.633	0.002	*(0.022)*

Sample: all individuals in SOEP 2008 having lived in East Germany in 2001 with available information on social capital in SOEP 2001. *** 1%, ** 5%, and * 10% level of significance. Data source: Statistik Lokal and SOEP 2001, 2008.

Table 7: Broadband Internet access and social capital: Reduced-form first-difference results exploiting variation from a technological mistake

	Social capital index	Theater, opera, and exhibitions	Cinema and concert	Socializing with friends and relatives	Volunteer work	Political engagement	Interest in politics
OPAL access area in 1998	-0.113***	-0.103**	-0.069	-0.057	-0.062	-0.047	-0.076**
	(0.039)	*(0.043)*	*(0.043)*	*(0.046)*	*(0.046)*	*(0.053)*	*(0.034)*
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3,029	3,104	3,102	3,084	3,087	3,076	3,107
R^2	0.083	0.093	0.091	0.076	0.043	0.040	0.060

OLS regressions. Dependent variable (*z*-standardized, average 2007-2009 minus average 1999/2001) reported on top of each column. Variables refer to first differences (2008 minus 2001) unless noted otherwise. Sample: all individuals in SOEP 2008 having lived in East Germany in 2001 with available information on social capital in SOEP 2001. Individual controls included in each model: differences in marital status, in the number of children living in the household, in secondary and university education, in occupational status, in house/flat ownership, and in log net household income. Municipality controls included in each model: differences in the share of females, in the share of working-age population, in the share of individuals aged 65 and older, in the share of unemployed persons, and in the net migration rate. Robust standard errors clustered at the level of the telephone access area in parentheses. *** 1%, ** 5%, and * 10% level of significance. Data source: SOEP 1999, 2001, 2007, 2008, and 2009.

Table 8: Broadband Internet access and social capital: Instrumental-variable first-difference results exploiting variation from a technological mistake

	1st stage	2nd stage						
	Broadband Internet access	Social capital index	Theater, opera, and exhibitions	Cinema and concert	Socializing with friends and relatives	Volunteer work	Political engagement	Interest in politics
OPAL access area in 1998	-0.085***							
	(0.033)							
Broadband Internet access (DSL) at home		1.329*	1.267	0.865	0.705	0.774	0.571	0.914*
		(0.760)	*(0.777)*	*(0.682)*	*(0.629)*	*(0.707)*	*(0.692)*	*(0.527)*
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1st-stage *F*-statistic of excluded instrument	6.315	6.315	5.773	5.580	5.519	5.731	6.230	5.944
Robust exogeneity test: *F*-statistic		7.965	5.750	2.406	1.688	1.560	0.779	4.411
p-value		0.005	0.017	0.121	0.194	0.211	0.378	0.036
N	3,029	3,029	3,104	3,102	3,084	3,087	3,076	3,107
R^2	0.152							
Wald χ^2		13,893.99	4,786.09	29,993.35	4,953.03	4,510.37	192.62	1,287.31
Prob > χ^2		0.000	0.000	0.000	0.000	0.000	0.000	0.000

2SLS regressions. The first column reports first-stage results (for the specification with the social capital index); the other columns report second-stage results of separate 2SLS regressions. Dependent variable of the second-stage models (*z*-standardized, average 2007-2009 minus average 1999/2001) reported on top of each column. Variables refer to first differences (2008 minus 2001) unless noted otherwise. Sample: all individuals in SOEP 2008 having lived in East Germany in 2001 with available information on the respective social capital variable also in SOEP 2001. Individual controls included in each model: differences in marital status, in the number of children living in the household, in secondary and university education, in occupational status, in house/flat ownership, and in log net household income. Municipality controls included in each model: differences in the share of females, in the share of working-age population, in the share of individuals aged 65 and older, in the share of unemployed persons, and in the net migration rate. Robust standard errors clustered at the level of the telephone access area in parentheses. *** 1%, ** 5%, and * 10% level of significance. Data source: SOEP 1999, 2001, 2007, 2008 and 2009.

Table 9: Placebo first-stage specification: OPAL access areas and Internet access in 2000

	Broadband Internet access (DSL) at home in 2008	Internet access at home in 2000
OPAL access area in 1998	-0.087***	-0.036
	(0.030)	*(0.027)*
Individual controls	Yes	Yes
Municipality controls	Yes	Yes
County fixed effects	Yes	Yes
N	3,164	3,074
R^2	0.278	0.187

OLS regressions. Dependent variable reported on top of each column. Sample in both columns: all individuals in SOEP 2008 having lived in East Germany in 2001 who were also surveyed in 2000. Additional individual controls included in each model are measured in 2001 and include: the individual's gender, age (and its square), marital status, number of children living in the household, secondary and university education, occupational status, migration background, a dummy indicating house/flat ownership, and log net household income. Additional municipality controls included in each model are measured in 2001 and include: the share of females, the share of working-age population, the share of individuals aged 65 and older, the share of unemployed persons, and the net migration rate. Robust standard errors clustered at the level of the telephone access area in parentheses. *** 1%, ** 5%, and * 10% level of significance. Data source: SOEP 2000, 2001 and 2008.

Table 10: Placebo reduced-form and second-stage results: OPAL access areas and social capital in 2001

	Reduced form 2001						
	Social capital index	Theater, opera, and exhibitions	Cinema and concert	Socializing with friends and relatives	Volunteer work	Political engagement	Interest in politics
OPAL access area in 1998	0.066	0.033	0.031	0.062	0.041	-0.033	0.092*
	(0.046)	*(0.046)*	*(0.045)*	*(0.051)*	*(0.055)*	*(0.054)*	*(0.051)*
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3,124	3,156	3,155	3,157	3,145	3,137	3,158
R^2	0.296	0.272	0.457	0.217	0.101	0.107	0.265

	Second stage 2001						
	Social capital index	Theater, opera, and exhibitions	Cinema and concert	Socializing with friends and relatives	Volunteer work	Political engagement	Interest in politics
Broadband Internet access (DSL) at home	-0.746	-0.383	-0.358	-0.725	-0.466	0.374	-1.056*
	(0.574)	*(0.539)*	*(0.543)*	*(0.585)*	*(0.654)*	*(0.586)*	*(0.633)*
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3,124	3,156	3,155	3,157	3,145	3,137	3,158
R^2	0.17	0.223	0.429	0.089	0.064	0.078	0.023

OLS regressions (upper panel) and 2SLS regressions (lower panel). Dependent variable (z-standardized, average 1999/2001) reported on top of each column. Sample: all individuals in SOEP 2008 having lived in East Germany in 2001 with available information on the respective social capital variable also in SOEP 2001. Additional individual controls included in each model are measured in 2001 and include: the individual's gender, age (and its square), marital status, number of children living in the household, secondary and university education, occupational status, migration background, a dummy indicating house/flat ownership, and log net household income. Additional municipality controls included in each model are measured in 2001 and include: the share of females, the share of working-age population, the share of individuals aged 65 and older, the share of unemployed persons, and the net migration rate. Robust standard errors clustered at the level of the telephone access area in parentheses. *** 1%, ** 5%, and * 10% level of significance. Data source: SOEP 1999, 2000, 2001, 2008.

Table 11: Broadband Internet access and voter turnout: Municipality-level results

	Election cycle 2004-08 – Election cycle 1995-99				Election cycle 1995-99 – Election cycle 1990-94			
	OLS	2SLS		Reduced form	OLS	2SLS		Reduced form
		1st stage	2nd stage			1st stage	2nd stage	
Broadband Internet availability (DSL)	0.408*		4.133		-0.514*		-4.681	
	(0.225)		*(3.082)*		*(0.225)*		*(3.193)*	
OPAL access area in 1998		-0.074***		-0.321		*-0.074****		0.347
		(0.017)		*(0.219)*		*(0.017)*		*(0.231)*
Municipality controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County, year, and election-type fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1st-stage *F*-statistic of excluded instrument		18.983				19.054		
Robust exogeneity test: *F*-statistic			1.798				1.761	
p-value			0.180				(0.184)	
N	11,024	11,024	11,024	11,024	11,024	11,024	11,024	11,024
R^2	0.619	0.315	0.605	0.619	0.722	0.312	0.711	0.721

OLS and 2SLS first-difference regressions. Dependent variable: changes in voter turnout (in percent). Sample: 3,674 East German municipalities observed in federal, state, and local elections between 1990 and 2008. Municipality controls included in each model: differences in the share of females, in the share of working-age population, in the share of individuals aged 65 and older, in the share of unemployed persons, and in the net migration rate. Robust standard errors clustered at the municipality level. *** 1%, ** 5%, and * 10% level of significance. Data source: Statistical offices of the German federal states and Broadband Atlas.