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Broadband Internet and Political Participation Evidence for Germany

Abstract

Previous studies found the introduction of the today well established media radio and television to affect political participation. This paper evaluates the effect of the relatively recent introduction of a new medium, broadband internet. OLS results suggest a positive association between DSL availability and voter participation across German municipalities. However, the roll-out of DSL networks is not random. The paper exploits the fact that DSL availability depends on a municipality's distance to the nearest interconnection point to the existing voice-telephony network. Instrumental-variable results using this distance to predict DSL availability confirm the effect of DSL availability on voter participation.

JEL Code: D72, L96, O33.
Keywords: Broadband internet, political economics, media, voting behaviour.

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1 Introduction

Today, parties regard online presence as an important part of their public relations and campaigns. The probably most often cited example for a successful online campaign is the presidential campaign of Barack Obama in 2008. Using different online platforms to mobilise voters and to keep in touch with his supporters is viewed as a key factor of his success. Also in Germany, parties and politicians increasingly use homepages, social networks, etc. to address (potential) voters online. But not only parties themselves put information online, also other platforms like online versions of newspapers and magazines provide information on politics and politicians. Moreover, new online publications and platforms have developed. Here, blogs and social networks with user-generated content play a special role. This large range of information sources, that is provided online, allows interested citizens to quickly obtain up-to-date information and to compare information from different sources easily. Exploring a survey for Germany, Emmer and Vowe (2004) find that starting to use the internet is associated with an increase of political information acquiring and participation in political communication.

Some observers even argue that online platforms like social networks and blogs strengthen democracy because they give everyone a voice. This may mean providing information and expressing one's opinion on single political measures and goes on to larger causes. For example, the protests after the elections in Iran in 2009, that were suspected to be manipulated, were to a large extent organised using online platforms. Therefore, the upcoming of internet and the communication and information opportunities that come along with it, have the potential to change how citizens perceive and evaluate politics and eventually to change their behaviour.

However, this paper, does not look at radical political changes, but focuses on voting behaviour within a given democratic system. Prat and Strömberg (2011) provide an excellent overview of the existing literature on the relation between the media, government behaviour and political outcomes. Previous studies on the influence of media on political participation found the introduction of the, today well established, mass media radio and television to positively affect political participation (Prat and Strömberg 2006, Strömberg 2004, DellaVigna and Kaplan 2007). They analysed if the introduction of one of these media had an effect on voter participation, vote shares for a specific party or public policy. This is based on the idea that media is the main source of information for voters about government policies and the behaviour of parties and politicians. An increase in the range of available media may change people's knowledge of politics and therefore their voting behaviour. If politicians take this into account they will change their policies accordingly, i.e. groups of the population that are better informed after the introduction of a new medium than before get more attention. Thus, the introduction of a new medium may have a considerable impact on behaviour of voters and politicians.

This paper adds to the literature by evaluating the effect of the relatively recent introduction of a new mass medium, the internet, on political participation. OLS estimates show a positive association between DSL availability and voter participation. However, this association cannot be interpreted as a causal effect but may be driven by reverse causality or omitted variables. For example, having a high income or high education is associated with a higher voter participation and also with a higher demand for broadband internet. To address such concerns, an instrumental-variable approach is used, that rests on impediments to the roll-out of DSL networks that stem from the structure of the existing voice telephony network.

In Germany, the most common technology to access the internet is DSL. The DSL network is built along the existing network for voice-telephony by replacing the copper wires of the voice-telephony network by optical fibre. This process started at the highest aggregation level, the backbones, and today the network is typically fibre-based up to the main distribution frame (mdf), which allows the provision of DSL. At the mdf, the fibre network connects to the existing copper wires that run from the mdf to the individual households. Especially in rural areas, the distance between the mdf and the individual households may be relatively long. For the provision of DSL this distance is important since the longer the distance, the less bandwidth is feasible via this wire. If the distance is too long, i.e. longer than around 5 km, additional measures for the upgrade to broadband are necessary. It may be necessary to substitute the copper wires with optical fibre not only up to the mdf but up to the next lower network level. Since the wires are laid subterraneously, the substitution of the wires involves excavation works which are very costly and may delay or even prohibit the provision of broadband for the affected households.

In rural areas, often more than one municipality share one mdf, which is set up in one of the municipalities. This municipality can be supplied with DSL relatively easily, while for the other municipalities without an own mdf the long distance to the mdf represents an impediment in the supply of DSL to their homes. Therefore, the distance from every municipality to the location of the nearest mdf is calculated to construct an instrumental variable that predicts DSL availability in a municipality.

The instrumental-variable results suggest that an increase of the DSL rate by one standard deviation increases voter participation by about 7 percent of a standard deviation. When a municipality gets connected to the DSL network, typically for most households within the municipality a DSL connection is available. In 2005, the median of DSL availability was 78 percent. This implies for a municipality, that getting connected to the DSL network with DSL getting available to 78 percent of all households increases voter participation by 1.17 percentage points.

The paper is structured as follows: Section 2 gives an overview of the existing literature on media and political participation. Section 3 describes the instrumental-variable approach in detail. Section 4 describes the model, data and the OLS results and Section 5 shows the results from the instrumental-variable estimations and additional robustness tests and discusses the results. Section 6 concludes.

2 Media and Political Participation – Related Literature

Bergan, Gerber and Karlan (2009) conducted a field experiment to address the question whether exposure to newspapers has an effect on political behaviour and opinion. One month before the Virginia Gubernatorial election in 2005, they conducted a survey among households in Virginia to find out about people's political opinions and voting behaviour and identified households that previously did not have a newspaper subscription. Those households were randomly assigned to a free subscription of the Washington Post, a free subscription of the Washington Times or a control group. A week after the election, a follow-up survey was conducted and respondents were asked about their political opinions and voting behaviour in the election. The authors do not find an effect of receiving either paper on political knowledge, stated opinions or voter participation in the election. However, the authors do find that receiving either paper led to more support for the Democratic candidate, which they interpret as showing that median slant mattered less than exposure to media.

The effect of another mass medium, radio, is analysed by Strömberg (2004). He argues that mass media may influence government policy-making since the media provide the information people use to make their decisions in elections. To put through their political interests via (re-)electing a politician, voters need to know whether a politician acted the way they expected him to. Hence, it is costly for politicians to overlook voters with access to political information. If it is true that better informed voters receive more favourable policies, then the introduction of a new medium may affect government policies. Therefore, Strömberg studies the effect of the introduction of radio as a mass medium in the United States, which took place from 1920 to 1940, on an unemployment relief program that was implemented from 1933 to 1935, i.e. during the diffusion period of radio. He finds that access to radio lead to higher voter turnout and to receiving higher funds from the relief programme, supporting the idea that voters' access to media may influence government policies. The effect is especially prominent in rural areas. A similar result is found by Besley and Burgess (2002) who show that in Indian states with higher newspaper circulation government responsiveness to droughts and floods is also higher.

Gentzkow (2006) looks at the effect of another mass medium in the United States, the introduction of television that started in 1940. He analyses whether the introduction of television can explain the decrease of voter participation from 1940 to 1970 using variation across regions in the timing of the introduction. He shows that the introduction of television had a negative effect on voter participation and argues that this is caused by the substitution of media with more extensive political coverage by television. This is supported by the observation that the introduction of television in a region was accompanied by a strong decrease of the diffusion of newspapers and radio in this region. Moreover, election surveys showed that political knowledge also decreased in these regions. Gentzkow finds that both the information and participation effects were significantly larger in off-year congressional elections, when only elections at state, district or local level take place, than in presidential election years. These relatively local elections receive extensive coverage in newspapers but little coverage on television which indicates to crowding out of local political information as a possible mechanism of how television influences voter participation. Gentzkow shows that television explains between one quarter and one half of the total decline in voter participation in off-year congressional elections since the 1950s. For presidential-year voter participation the effect is smaller and not significantly different from zero.

Also Prat and Strömberg (2006) analyse whether television has an effect on voter behaviour. However, they do not consider the introduction of television as a complete new medium but the introduction of a new TV channel. They address the question of whether the introduction of commercial TV in Sweden, which created a new source to obtain information, had an impact on political knowledge level and voter participation. The authors use a Swedish survey in which the same respondents were interviewed in two consecutive general elections in 1988 and 1991, thus before and after the entry of commercial TV in 1990. Before 1990, only public TV existed. Prat and Strömberg find that commercial TV news attracted mostly young people and those previously not well informed. Moreover, they find that those who started watching commercial TV news increased their levels of political knowledge and voter participation more than those who did not. This result by Prat and Strömberg (2006) is not necessarily contradictory to the result of Gentzkow (2006) since the latter found the negative effect of television on voter participation for local elections while the former look at nationwide election, for which Gentzkow does not find a significant negative effect.

Also DellaVigna and Kaplan (2007) analyse the impact of the introduction of a new TV channel on voting behaviour. They look at the introduction of the conservative cable channel Fox News in the United States between 1996 and 2000. Using voting data for more than 9,000 towns, the authors address the question whether Republican vote shares increased in towns where Fox News entered the cable market by the year 2000. They find that the entry of Fox News had a significant effect on the year 2000 Presidential elections, increasing the Republican vote share by 0.4 to 0.7 percentage point. This increase is not caused by voters switching parties, but Fox News appears to have increased voter participation, particularly through the mobilisation of conservative voters in Democratic districts.

Existing literature has shown that mass media influences behaviour of voters as well as of politicians. These studies addressed the effect of newspapers, radio and television, which were the dominant mass media at the time. While they are still important today, another mass medium, the internet, has come up and has become ever more prominent in the last years. This paper addresses the question whether the introduction of the internet in Germany had an effect on voter participation. To identify the effect of DSL availability an instrumental-variable approach is employed that is based on the distance-related transmission capacity of the existing voice-telephony network. This strategy is quite similar to other identification strategies that have been used to determine the effects of media. Strömberg (2004) uses geological features that affect the quality of radio reception as instruments for the share of households with a radio in a county. Similarly, Olken (2009) exploits topographical differences that are associated with signal strength to identify the effect of exposure to television.

3 Identification Strategy for the Effect of Broadband Internet on Political Participation

A positive association between broadband internet and political participation cannot be interpreted as a causal effect of internet on voter behaviour because of endogeneity concerns that may be caused by reverse causality or omitted variables. For example, in regions where many people are interested in politics and vote in elections, demand for internet connections may be high because these people seek information about politics online. This higher demand may lead to a faster roll-out of high speed networks to these regions. Further, demand for high speed internet may be driven by underlying factors also have an effect on political participation but cannot be observed on the municipality level. For example, high income and education are associated with a higher voter participation (Schäfer 2010) and at the same time with a higher demand for broadband internet (Coneus and Schleife 2010). To address these endogeneity concerns, an instrumental-variable approach is used that rests on technology-driven impediments to the roll-out of high-speed internet.[1]

In Germany, the most common technology to access the internet is DSL. The DSL network is built along the existing network for voice-telephony by upgrading the existing infrastructure. For this purpose, the existing copper wires of the voice-telephony network are gradually being replaced by optical fibre. This process started at the highest aggregation level, the backbones, and today the network is typically fibre-based up to the main distribution frame (mdf). This stage of the process allows the provision of DSL. At the mdf, the fibre

[1] The same identification strategy is used in Czernich (2011) to determine the effect of DSL availability on unemployment.

network connects to the existing copper wires that run from the mdf to the individual households. Especially in rural areas, the distance between the mdf and the individual households may be relatively long. For the provision of voice-telephony the length of this distance did not influence the quality of the connection. However, for the provision of DSL this distance matters since the longer the distance, the less bandwidth is feasible via this wire. If the distance is too long (i.e. longer than around 5 km) additional measures for the upgrade to broadband are necessary. It may be necessary to substitute the copper wires with optical fibre not only up to the mdf but up to the next lower network level. Since the wires are laid subterraneously, the substitution of the wires involves excavation works which are very costly and may delay or even prohibit the provision of broadband for the affected households.

In rural areas, often more than one municipality share one mdf, which is set up in one of the municipalities. This municipality can be supplied with DSL relatively easily, while for the other municipalities without an own mdf the long distance to the mdf represents an impediment for the supply of DSL connections to their homes. Hence, the location of the mdf may determine whether a municipality has access to the DSL network and therefore to high speed internet. In order to construct an instrumental-variable to predict DSL availability, the distance from every municipality to the location of the nearest mdf is calculated. This distance is then used as an instrument to predict the DSL rate in a municipality. The mdfs were set up for the provision of voice-telephony, i.e. for other purposes than the provision of broadband internet and the roll-out of the voice-telephony network was finished before DSL came up. The location of the mdf, and consequently the distance between a municipality and its nearest mdf, is therefore predetermined when considering DSL roll-out. However, this does not guarantee exogeneity in an econometric sense. The validity of the instrument is therefore further discussed in Section 5.2.

The location of each of the approximately 8,000 mdfs in Germany is taken from the broadband initiative *Zukunft Breitband* of the Federal Ministry of Economics and Technology. As a proxy for the location of the municipality, the geographic centre (centroid) of each municipality is computed and used for the calculation of the distance. Figure 1 is a section of a map of Germany showing the area north east of Munich (Munich can be found in the bottom left corner). It illustrates the distribution of the municipalities, their centres and the main distribution frames. Each area is one municipality and the black dots represent the geographic centres of the municipalities. The grey triangles represent the mdfs. While Munich has many mdfs, the more rural municipalities typically have only one or no mdf. These municipalities without their own mdf use the mdf of one of their neighbouring municipalities. The two lines in Figure 1 show the distance to the nearest mdf for two neighbouring municipalities that both do not have an mdf. Although being neighbours, the distance between the centres of the municipalities and the nearest mdf varies. This variation in the distance has an important effect on the availability of broadband in a municipality and is therefore used to predict broadband availability.

However, this method to calculate the distance is not perfect, since the centre of the municipality is only a proxy for the location of the settlement, i.e. the area within a municipality where people actually live. This problem is most prominent in municipalities that do have their own mdf. The circle in Figure 1 points to two municipalities where this problem is particularly obvious. In the upper municipality, the geographic centre of the municipality and the mdf, which is typically set up in a village or town, lie very close to each other. Hence, here the location of the settlement within the municipality and the geographic centre of the municipality seem to coincide. In contrast, in the lower municipality, the geographic centre and the mdf are far apart. Since the mdf is typically set up within a residential area, in this example the geographic centre and the actual location of the settlement seem not to coincide and the geographic centre is not a good proxy. This problem causes the calculated distance between a municipality and its nearest mdf to be higher than the actual distance in municipalities with their own mdf.

Figure 1: Distribution of Main Distribution Frames

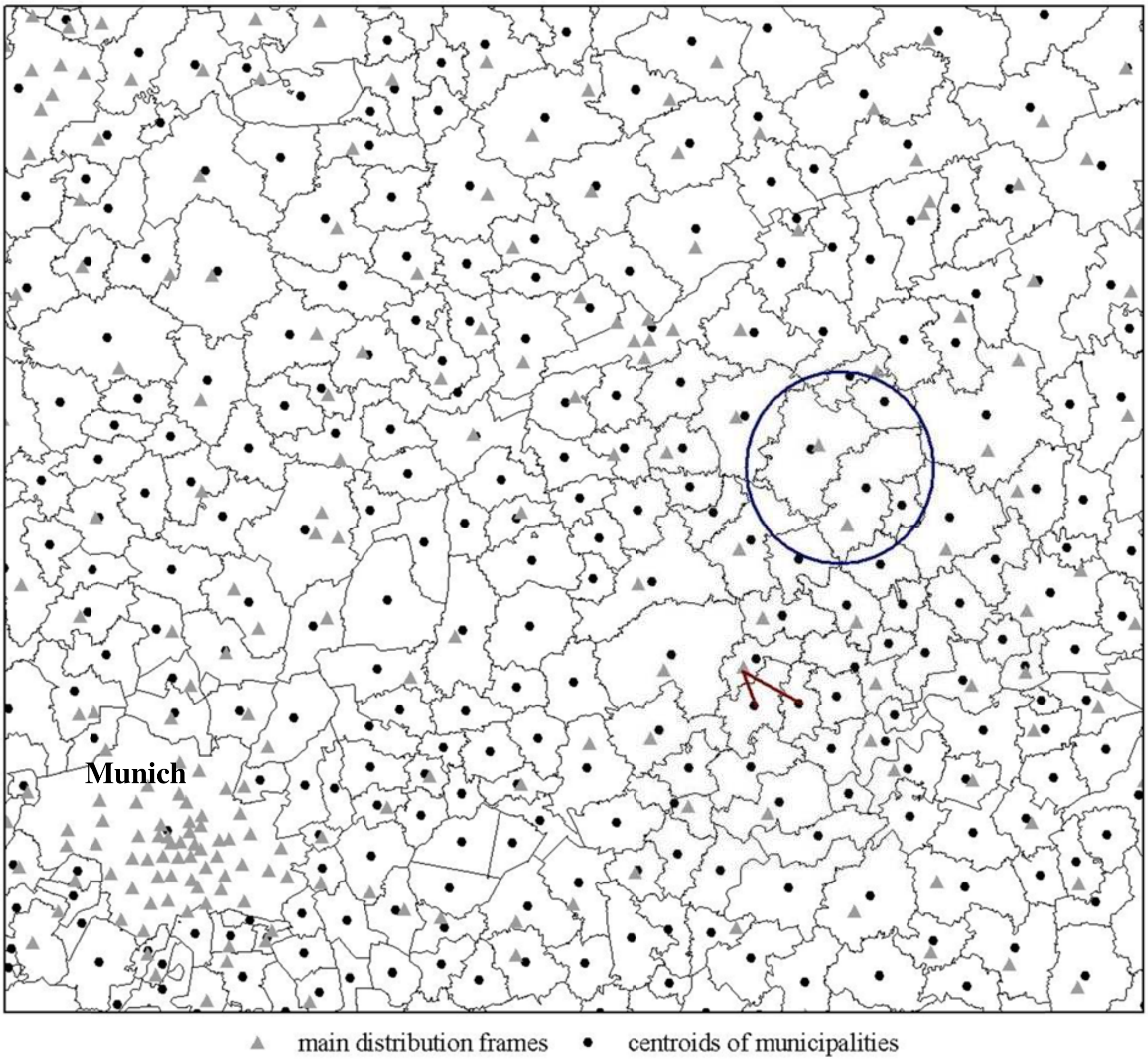
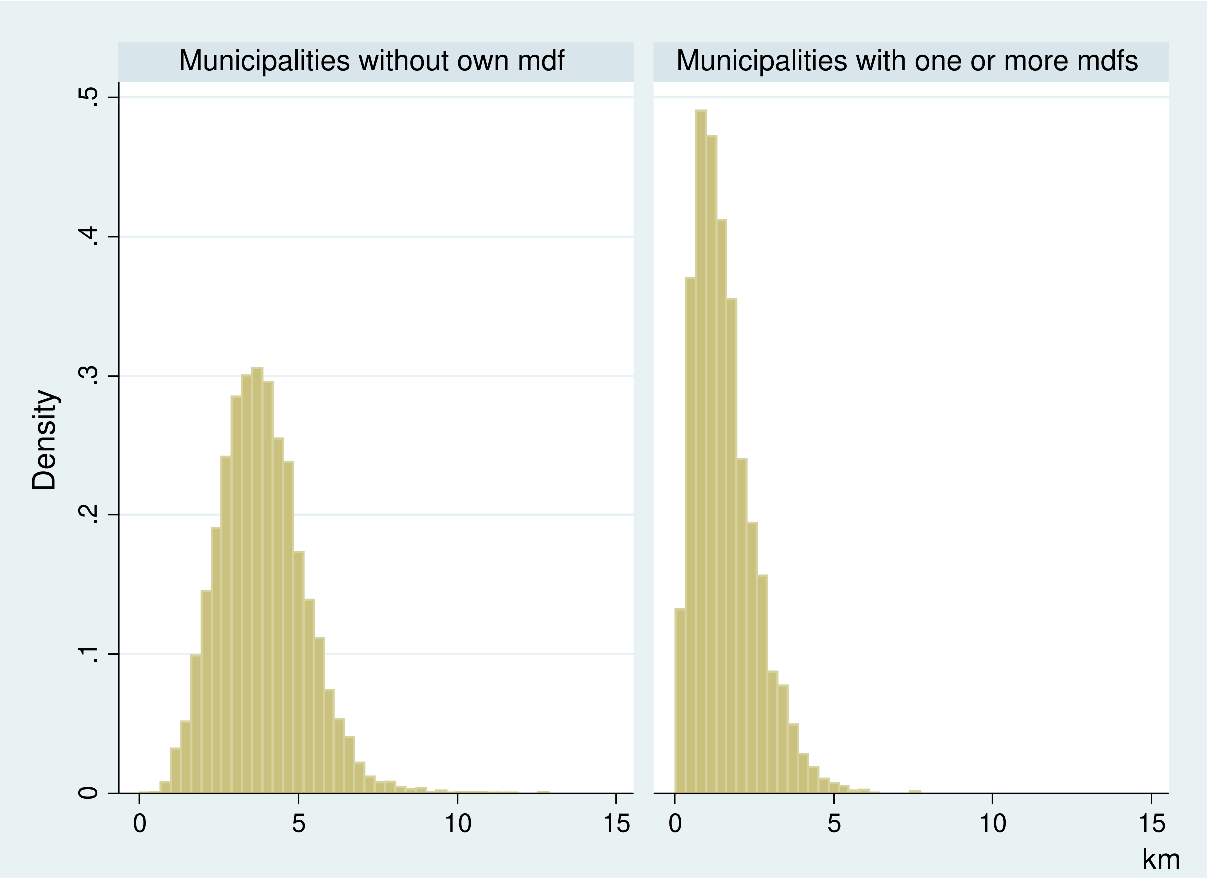


Figure 2 shows the distribution of the distance between the geographic centre of a municipality and the nearest mdf for the samples of the approximately 7,000 municipalities without an mdf (left panel) and the approximately 5,000 municipalities with at least one mdf (right panel). As expected, the distance is smaller for municipalities with at least one mdf, however, it is probably still too high because of the calculation error described above. Further, the municipalities with an own mdf can be supplied with DSL easily, thus, there is little variation in DSL availability in these municipalities. Therefore, the analysis will focus on the sample of municipalities without an mdf. This restriction generates a subsample of municipalities that have similar initial positions regarding DSL roll-out.

Figure 2: Distribution of the Distance to the Nearest Main Distribution Frame



In East Germany, a technological particularity has to be considered. After the German Reunification, the outdated and insufficient East German telephone network was modernised. Instead of the classic copper based telephony network infrastructure, optical network elements (opal technology) were used in some areas. In the 1990s, these optical network elements were considered to be the key future technology for telecommunication networks. However, only a few years later, the superior DSL technology was developed and became the prevalent technology for broadband networks since it allows higher bandwidths at lower investment costs. Unfortunately, the opal technology only allows narrowband connections and is not suitable to be upgraded to DSL, which is based on copper wires. Therefore, it is much more costly to provide DSL in areas in which voice telephony services are provided via the opal technology than in areas where the telephone network is completely based on copper wire. The higher costs result from the need to roll-out copper wire in parallel to the fibre glass in the opal regions. In East Germany, 210 of the approximately 1,500 mdfs are equipped with the opal technology and for the areas that are served via these mdfs the roll-out of DSL is severely obstructed. To account for this, these mdfs are excluded from the list of mdfs to which the distance from the municipalities is calculated.[2]

4 Model, Data and Descriptive Evidence

4.1 Model

The paper aims at estimating the effect of broadband internet on political participation in the German Federal Election (*Bundestagswahl*) in the year 2005 using data on the municipality level. Since relatively little information on municipality characteristics is available, a value-added model is estimated. Therefore, the lagged value of the dependent variable at a time before DSL has become a mass phenomenon is included on the right hand side of the estimation equation. This estimation equation is derived by taking first differences, i.e., voting behavior in the DSL era (election results from 2005) minus voting behavior before the DSL era (election results from 2002). Thereby, all past variables drop out and are implicitly captured by the lagged value of the dependent variable before the DSL era. Further, time-invariant omitted municipality characteristics that affect voting behavior in a municipality in the DSL era and before the DSL era are leveled out.

This leads to the following estimation equation:

$$V_{i2005} = \beta_0 + \beta_1 DSLrate_{i2005} + \beta_2 V_{i2002} + \beta_3 X_{i2005} + \beta_4 Y_{j2005} + \varepsilon_{ij} \ . \qquad (1)$$

V_i stands for either overall voter participation in municipality i. Voter participation is measured as the number of votes (*Zweitstimmen*) relative to eligible voters. Voter participation in 2005 is regressed on the DSL rate in 2005 $DSLrate_{i2005}$, voter participation in

[2] The information which main distribution frames are equipped with the opal technology was provided by the Deutsche Telekom AG.

the last election in 2002 V_{i2002} and a couple of control variables on the municipality level X_{i2005} and the county level Y_{j2005}. In 2002, merely 3.3 million DSL lines existed, while in 2005 the number had more than tripled to 10.5 million (Bundesnetzagentur 2006).

4.2 Data

Table 1 gives an overview of the descriptive statistics for all municipalities without an own mdf. The information on voter participation and vote shares of the parties as well as the control variables on the municipality level, population density and surface area, are taken from *Statistik lokal*, a dataset on the municipality level that is issued by the German Federal Statistical Office. The average voter participation hardly changed from 2002 to 2005: in both years it was just above 75 percent.

The information on DSL diffusion is taken from *Breitbandatlas Deutschland*, an annual survey on broadband availability that is conducted by the German Ministry of Economics and Technology. Network providers are asked which geographic areas they cover with their services and so a comprehensive dataset on DSL availability on the municipality level is compiled. The DSL rate is measured as the percentage of households in a municipality for which DSL is available. In the year 2005, DSL was available to 64.7 percent of the households, i.e. they could subscribe to a DSL connection.

Table 1: Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Voter participation 2005	7230	75.96	6.81	39.60	100
Voter participation 2002	7230	75.14	7.85	0	100
DSL rate 2005	7230	64.68	31.33	0	100
Population	7230	1,338.90	1,771.43	9.00	22,903.00
Surface area	7230	13.96	12.18	0	177.99
Share of population age 18 to 30	7092	12.97	2.50	0	28.76
County level variables:					
GDP per capita	6473	20.18	4.91	12.16	84.47
Firms relative to population	7230	0.58	0.23	0	1.68
Urban hinterland	7230	0.36	0.48	0	1
Rural hinterland	7230	0.28	0.45	0	1
Rural area	7230	0.36	0.48	0	1

Notes: Descriptive statistics for municipalities without an own mdf. Regional data on German municipalities for the year 2005 is taken from the German Statistical Office, data in the county level from the regional database of the German Statistical Office. Information on DSL availability is taken from the *Breitbandatlas Deutschland*. DSL rate is measured as the percentage of households for which DSL is available. The distinction into different types of settlement areas follows the distinction of the Federal Institute for Research on Building, Urban Affairs and Spatial Development. Not included are municipalities that are defined as an agglomerated city or that have more that 500,000 inhabitants. Voter participation is measured as the number of votes relative to eligible voters.

Since many relevant control variables are not available on the municipality level, economic variables at the county level are added to the data. This information at the county level is taken from the regional database (Regionaldatenbank) of the German Federal Statistical Office. GDP per capita and number of firms relative to the population are included to represent the economic strength of the county a municipality belongs to. The division of counties into the different settlement areas, urban hinterland, rural hinterland and rural zones, follows the distinction of the Federal Institute for Research on Building, Urban Affairs and Spatial Development. The distinction is based on whether a county is part of an agglomeration area (hinterland versus zone) and on its population density (urban versus rural). Table 1 shows that 36 percent of the municipalities without an own mdf are in the urban hinterland, 28 percent are in the rural hinterland and 36 percent are in a rural zone.

4.3 The Association between Broadband Internet and Political Participation

Table 2 reports the OLS estimation results of the association between voter participation in the federal elections and the DSL rate in the year 2005. All models include only municipalities without an own mdf and standard errors are clustered at the county level. Model 1 shows the bivariate correlation between DSL rate and voter. The coefficient of the DSL rate is 0.051 and statistically significant at the one percent level. Model 2 corresponds to the value added model, i.e. it is controlled for voter participation in the previous federal election in 2002. This reduces the coefficient by more than half to 0.023; still it is significant at the one percent level. In Model 3, additional control variables on the municipality level are included. While population and surface area reflect whether an area is rather rural or urban, the share of the population in a municipality that is between 18 and 29 years old accounts for the fact that the voter participation among the young is typically lower than for the rest of the population (Statistisches Bundesamt 2006). Including these variables reduces the coefficient of the DSL rate slightly to 0.017. Model 4 additionally controls for economic variables on the county level. The variables GDP per capita and the number of firms in a county relative to the population do not enter significantly and hardly change the coefficient of the DSL rate. Model 5 controls for the different settlement types by including dummies for rural hinterland and rural zones which reduces the coefficient of the DSL rate to 0.013, still with significance at the one percent level.

The size of the association between DSL availability and voter participation can be interpreted as follows: a coefficient of 0.015 indicates that an increase of the DSL rate by 10 percentage points is associated with an increase of voter participation by 0.15 percentage points. Expressed in standard deviations, this means that an increase of the DSL rate by one standard deviation is associated with a voter participation by about 7 percent of a standard deviation. What does this mean for a municipality that gets connected to the DSL network? When a municipality gets connected to the DSL network, typically for most households within the municipality a DSL connection is available. In 2005, the median of DSL availability was 78 percent. Given the estimated coefficient of 0.015, this implies for a municipality, that getting connected to the DSL network with DSL getting available to 78 percent of all households increases voter participation by 1.17 percentage points.

However, as stated above, the results of the OLS estimations have to be interpreted cautiously and the associations cannot be interpreted as a causal effect of internet on voter behaviour because of endogeneity concerns that may be caused by reverse causality or omitted variables. To address these concerns, the instrumental-variable approach that was described in Section 3 is employed in the next section.

Table 2: DSL Availability and Voter Participation: OLS Results

Dependent variable: Voter participation 2005	Model 1	Model 2	Model 3	Model 4	Model 5
DSL rate 2005	0.051***	0.023***	0.017***	0.018***	0.013***
	[6.99]	[4.54]	[4.07]	[3.66]	[2.95]
Voter participation 2002		0.528***	0.540***	0.483***	0.489***
		[18.22]	[20.20]	[14.51]	[15.07]
Population			0.000***	0.000**	0
			[3.11]	[2.54]	[0.40]
Surface area (km²)			-0.115***	-0.117***	-0.097***
			[7.83]	[8.04]	[5.80]
Share of population age 18 to 30			-0.047	-0.003	0.031
			[0.75]	[0.04]	[0.53]
County level variables:					
GDP per capita				0.054	0.049
				[1.02]	[0.93]
Number of firms per 1000 inhabitants				0.02	-0.402
				[0.02]	[0.35]
Dummy rural hinterland					-1.710**
					[2.06]
Dummy rural zone					-2.098**
					[2.36]
Constant	72.671***	34.808***	36.222***	39.142***	40.001***
	[112.36]	[15.51]	[15.39]	[14.81]	[15.95]
Observations	7230	7230	7092	6335	6335
R-squared	0.05	0.41	0.45	0.39	0.41

Notes: OLS estimations for municipalities without own main distribution frame in 2005. Voter Participation is defined as the number of votes relative to eligible voters. The DSL rate is measured as the percentage of households in a municipality for which DSL is available. Robust t statistics in brackets (clustered at the county level). * significant at 10%; ** significant at 5%; *** significant at 1%

5 Instrumental-Variable Estimations

5.1 Instrumental-Variable Results

In this section, the results of the instrumental-variables estimations are presented and discussed. As described in Section 3, the distance between a municipality and its nearest mdf is used as an instrumental-variable to predict DSL availability in a municipality. Table 3 shows the results of the instrumental-variable estimations. Models 1, 2 and 3 of Table 3 correspond to Models 3, 4 and 5 of Table 2. The left columns of the three models represent the first stage of the two stage least squares estimation with the DSL rate as the dependent variable. In all three models, the coefficient of the instrumental-variable, the distance from a municipality to the nearest main distribution frame, is negative and significant at the 1% level. The coefficients indicate that for a municipality being one kilometre further away from a main distribution frame corresponds to between a 6.7 and 7.2 percentage point lower DSL rate. The F-statistic of excluded instruments is between 158.2 and 185.1 and, thus, shows that the instrument is strong.

The right columns of the three models represent the second stage of the two stage least squares estimation with the voter participation as the dependent variable. In all three models, the coefficient of the DSL rate on voter participation is positive, however not statistically different from zero. To compare the instrumental-variable coefficients to the OLS coefficients, the Durbin-Wu-Hausman test is run. The null hypothesis of an exogenous regressor cannot be rejected in any of the three models. This indicates that the instrumental-variable estimates do not differ significantly from the OLS estimates of the effect of DSL availability on voter participation. Given the result of the Durbin-Wu-Hausman test and being aware that instrumental-variable estimates are less efficient than OLS estimates, the OLS estimates are preferred and cautiously interpreted as the causal effect of DSL availability on voter participation.

Table 3: The Effect of DSL Availability on Voter Participation: Instrumental-Variable Results

	Model 1		Model 2		Model 3	
Dependent variable:	DSL rate	Voter participation	DSL rate	Voter participation	DSL rate	Voter participation
2SLS:	first	second	first	second	first	second
DSL rate		0.009		0.015		0.007
		[0.72]		[1.28]		[0.60]
Distance to nearest mdf	-6.721***		-7.174***		-6.945***	
	[12.60]		[13.63]		[13.12]	
Voter participation 2002	0.638***	0.545***	0.461***	0.484***	0.457***	0.492***
	[6.10]	[20.14]	[4.08]	[14.70]	[4.20]	[15.53]
Population	0.004***	0.000***	0.003***	0.000**	0.002***	0
	[8.12]	[2.85]	[8.13]	[2.29]	[6.72]	[0.59]
Surface area	-0.124*	-0.118***	-0.053	-0.118***	0.020	-0.099***
	[1.96]	[7.96]	[0.75]	[8.06]	[0.30]	[5.89]
Share of population age 18 to 29	-1.394***	-0.061	-1.169***	-0.007	-1.005***	0.023
	[5.34]	[0.95]	[4.98]	[0.11]	[4.22]	[0.38]
County level variables:						
GDP per capita			0.704***	0.056	0.694***	0.054
			[2.63]	[1.04]	[2.61]	[1.00]
Firms relative to population			-5.313	0.003	-7.429*	-0.458
			[1.14]	[0.00]	[1.66]	[0.40]
Dummy rural hinterland					-2.730	-1.737**
					[1.25]	[2.11]
Dummy rural zone					-9.971***	-2.176**
					[4.09]	[2.40]
Constant	56.966***	36.543***	60.120***	39.264***	69.984***	40.305***
	[5.78]	[15.07]	[5.64]	[14.47]	[2.85]	[15.29]
Observations	7092	7092	6335	6335	6335	6335
R^2	0.20	0.45	0.22	0.39	0.23	0.41
F test of excluded instruments	158.15		185.12		171.56	
Durbin-Wu-Hausman test of exogeneity		0.548		0.07		0.43

Notes: Models include only municipalities without their own main distribution frame. Voter Participation is defined as the number of votes relative to eligible voters. The DSL rate is measured as the percentage of households in a municipality for which DSL is available. Robust z statistics in brackets (clustered at the county level); * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: The Effect of DSL Availability on Voter Participation: Instrumental-Variable Results with Regional Fixed Effects

	Model 1		Model 2	
Dependent variable:	DSL rate	Voter participation	DSL rate	Voter participation
2SLS:	first	second	first	second
DSL rate		0.005		0.005
		[0.73]		[0.67]
Distance to nearest mdf	-6.211***		-6.228***	
	[11.41]		[10.68]	
Voter participation 2002	-0.143	0.649***	-0.145*	0.624***
	[1.63]	[23.57]	[1.67]	[21.93]
Population	0.002***	0	0.002***	-0.000*
	[5.72]	[0.27]	[5.18]	[1.81]
Surface area	0.107**	-0.008	0.126**	-0.009*
	[2.26]	[1.55]	[2.49]	[1.77]
Share of population age 18 to 30	-0.052	0.013	-0.024	-0.002
	[0.27]	[0.42]	[0.13]	[0.07]
County level variables:				
GDP per capita	0.101	0.017		
	[0.97]	[0.91]		
Firms relative to population	-9.722***	-1.462***		
	[2.91]	[2.88]		
Dummy rural hinterland	-0.273	-0.769***		
	[0.16]	[2.95]		
Dummy rural zone	-3.996**	-0.980***		
	[2.26]	[4.31]		
State dummies	yes	yes		
County dummies			yes	yes
Constant	113.296***	25.447***	115.001***	25.532***
	[15.64]	[10.69]	[16.82]	[10.93]
Observations	6335	6335	6335	6335
R^2	0.34	0.69	0.42	0.73
F test of excluded instruments	129.73		114.79	
Durbin-Wu-Hausman test of exogeneity		0.37		0.54

Notes: Models include only municipalities without their own main distribution frame. Voter Participation is defined as the number of votes relative to eligible voters. The DSL rate is measured as the percentage of households in a municipality for which DSL is available. Robust z statistics in brackets (clustered at the county level); * significant at 10%; ** significant at 5%; *** significant at 1%.

The Models in Table 4 correspond to Model 3 of Table 3 and additionally include a full set of state (Model 1) or county dummies (Model 2). Thus, identification is only based on variation within states (*Bundesländer*) or counties. In the first stage, the coefficient of the instrumental-variable is approximately 6.2 and significant at the 1 percent level. The second stage shows a positive, yet not significant, coefficient of the DSL rate on voter participation that is very close to the coefficient of Model 3 of Table 3. Again, based on the Durbin-Wu-Hausman test, the OLS estimates cannot be excluded.

5.2 Individual Party Results

The internet may not only influence political participation through voter participation on the whole, but it may also have an effect on individual parties that may be more or less able to exploit the opportunities it offers. For example, internet use is not equally distributed over the voters of different parties. The share of voters with internet access lies between 60% and 62% for the centre-left *SPD*, the conservative parties *CDU/CSU* and the left wing *Die Linke*. In contrast, internet access is higher for voters of the ecological party *Die Grünen* (84%) and the liberal *FDP* (77%) (Forschungsgruppe Wahlen 2005). Thus, an increase in DSL availability may affect different parties differently.

Further, especially small parties might benefit from the possibilities the internet offers, since they get less coverage by the traditional media than the large, established parties. By using online campaigns etc. they might reach more people, spread their ideas and eventually increase their vote shares. However, it might also be the case that the large parties possess the know-how and resources to reap the benefits online campaigns and media provide.

To address the question whether the availability of DSL has an effect on the results of the individual parties, the value-added model described above was employed again. The vote shares of the individual parties were taken as the dependent variables and the vote shares of the respective parties in the last election included on the right hand side. The results from these estimations, however, did not show a clear picture.[3] In most specifications, the coefficient of the DSL rate is not significant with the only exception being the sum of the small parties (*Sonstige*), where the results suggest a negative effect of DSL availability. Unfortunately, based on the data available for this analysis, the information for the small parties cannot be disaggregated and so it remains unclear whether the effect is driven by an even loss of all small parties or whether the losses of one or few parties drive the result. To answer this question, additional data on the vote shares of the small parties would be needed.

5.3 Robustness Tests and Discussion

For the distance to the nearest mdf to be a valid instrument it must not affect the dependent variable in any other way than through DSL availability. This implies that the choice of the location of the mdf was not affected by municipality characteristics that may also influence voter behaviour. An enquiry at Deutsche Telekom that was the monopolist at the time of the roll-out of the voice-telephony network and has, thus, set up the mdfs, led to the information that location choices were made based on technical and cost reasons, e.g. how many customers could be connected to the voice telephony network. Thus, if mdfs were set up in municipalities with e.g. a higher population density, the instrument might capture an agglomeration effect. If mdfs were set up in a "regional centre", a municipality that is more densely populated and may therefore also have more firms, shops, etc., then the distance to the nearest mdf might really capture the distance to this "regional centre". Parties might hold election campaign events in these "regional centres" and also other activities or information events regarding public policies might take place there. Therefore, a shorter distance to such a "regional centre" may correspond to more exposure to information about politics and voter participation might be higher in the municipalities around the "regional centre" with the mdf. Thus, the instrumental-variable results would be upward biased.

[3] Detailed results are available from the author upon request.

To test whether this is a cause for concern, the instrumental-variable estimations are repeated using only a subsample of municipalities in which such agglomeration effects can be ruled out. Table 5 shows additional estimations that correspond to the specification of Model 3 in Table 3, but impose restrictions on the sample of municipalities. The samples include only municipalities without an mdf and are further restricted based on own characteristics relative to characteristics of the municipality in which the nearest mdf stands. In Model 1, the sample is restricted to municipalities that use the mdf in a municipality that has at most the same population density as itself. Using only the municipalities which are connected to an mdf in a less densely populated municipality excludes the municipalities around "regional centres". The sample in Model 2 is based on the same reasoning. The sample is restricted to the municipalities where the municipality with the nearest mdf has at most one mdf. The idea behind this restriction is to rule out agglomeration effects such as that the municipality without an mdf might be close to a larger town and connected to its mdf.

Also in these specifications, the distance to the nearest mdf proves to be a strong instrument. Being one kilometre further away from an mdf leads to a between 5.5 and 7.5 percentage point lower DSL rate. The F test of excluded instruments lies between 60.36 and 189.67, thus shows that also in these subsamples the instrument is strong.

The second stage estimation of Model 1 shows a statistically significant positive effect of the DSL rate on voter participation. However, based on the Durbin-Wu-Hausman test exogeneity cannot be rejected and thus the OLS coefficient cannot be excluded. In Model 2, where the neighbouring municipalities have exactly one mdf, the coefficient of the DSL rate is not statistically different from zero. The Durbin-Wu-Hausman test shows that the instrumental-variable estimates do not differ significantly from the OLS estimates of the effect of DSL availability on voter participation. Since using these subsamples does not change the results, this provides confidence that the instrument does not capture agglomeration effects but indeed variation in DSL availability.

Table 5: The Effect of DSL Availability on Voter Participation: Instrumental-Variable Results with Additional Sample Restrictions

	Model 1		Model 2	
Dependent variable: SLS:	DSL rate first	Voter participation second	DSL rate first	Voter participation second
DSL rate		0.052**		-0.0002
		[2.48]		[0.02]
Distance to nearest mdf	-5.529***		-7.474***	
	[7.97]		[13.80]	
Voter participation 2002	0.483***	0.469***	0.431***	0.495***
	[3.43]	[12.15]	[3.77]	[15.78]
Population	0.002***	0	0.003***	0
	[6.27]	[1.09]	[7.09]	[0.33]
Surface area	-0.181**	-0.049***	0.029	-0.111***
	[1.87]	[2.70]	[0.40]	[5.89]
Share of population age 18 to 30	-1.566***	0.18	-0.996***	0.016
	[4.17]	[1.62]	[4.07]	[0.27]
County level variables:				
GDP per capita	0.817***	0.012	0.683**	0.07
	[3.11]	[0.18]	[2.38]	[1.28]
Firms relative to population	-3.212	-1.129	-8.987**	-0.734
	[0.58]	[0.97]	[1.97]	[0.63]
Dummy rural hinterland	-1.182	-2.116***	-2.225	-1.787**
	[0.51]	[2.61]	[0.98]	[2.16]
Dummy rural zone	-9.230	-1.855**	-9.126***	-2.258**
	[3.20]	[2.14]	[3.67]	[2.45]
Constant	57.667***	37.319***	66.610***	40.776***
	[5.07]	[10.94]	[6.51]	[15.34]
Observations	1509	1509	5513	5513
R^2	0.26	0.41	0.23	0.40
F test of excluded instruments	60.36		189.67	
Durbin-Wu-Hausman test of exogeneity		1.63		1.65

Note: Models include only municipalities without an own main distribution frame. Additional sample restrictions are based on the characteristics of the neighbouring municipality with the nearest main distribution frame. Model 1 contains the municipalities where the neighbouring municipalities have at most the same population density. Model 2 contains the municipalities whose neighbouring municipalities do not have more than one mdf. Robust z statistics in brackets (clustered at the county level); * significant at 10%; ** significant at 5%; *** significant at 1%.

There are two important caveats to the analysis: first, the effect of DSL availability on political participation is identified using variation in DSL availability between municipalities without their own mdf. Therefore, based on the results from this analysis, one can only make a statement for this subgroup of municipalities. Since these municipalities are more often part of a county that is classified as a rural zone or rural hinterland, the results are valid for rural rather than agglomerated areas.

Second, for the interpretation of the results, one has to be aware that the DSL rate is measured as the DSL availability, i.e. the percentage of households in a municipality for which a DSL connection is available. In reality not the pure availability of DSL but its use will affect the outcome variable:

$$V_{i2005} = \delta_1 DSLuse_{i2005} + \delta_2 V_{i2002} + \delta_3 X_{i2005} + \delta_4 Y_{j2005} + v_{ij} \ . \quad (2)$$

However, DSL use is not observed on the municipality level. Only DSL availability is observed, which influences DSL use:

$$DSLuse_{i2005} = \gamma_1 DSLavailability_{i2005} + \gamma_2 V_{i2002} + \gamma_3 X_{i2005} + \gamma_4 Y_{j2005} + u_{ij} \ . \quad (3)$$

Hence, the two stage process towards DSL use via availability is estimated as a reduced form:

$$V_{i2005} = \delta_1 \gamma_1 DSLavailability_{i2005} + \beta_2 V_{i2002} + \beta_3 X_{i2005} + \beta_4 Y_{j2005} + v_{ij} + u_{ij} \ . \quad (1')$$

The estimated coefficient $\delta_1\gamma_1$ has to be interpreted as the effect of DSL availability on political participation and cannot be interpreted as the effect of DSL use. The coefficient measures the intention to treat effect and not the treatment effect. Since the take-up rate for a DSL subscription γ_1, given DSL is available, is below one, the estimated coefficient is a proportional effect that is smaller than the effect of DSL use. While from the economist's view the effect of internet use on unemployment is an interesting question, from a policy perspective the effect of internet availability may actually be more interesting since availability is the parameter that can be influenced through policy interventions.

As shown above, the results indicate that if a municipality gets connected to the DSL network and for 79 percent of the households (the median of DSL availability) becomes available, voter participation increases by 1.17 percentage points. This is the effect of increased availability, not use which is considerably lower. In 2005, 27 percent of all households had a DLS connection (Bundesnetzagentur 2006), therefore connecting a municipality to the DSL network implies that approximately 20 percent of the household use a DSL connection.[4] The effect of DSL availability on voter participation operates via DSL use. Thus, the increase of voter participation by 1.17 percentage points is driven by just 20 percent of the households actually using DSL.

6 Conclusion

This paper addressed the question whether DSL availability influences political participation, measured by two different dependent variables: the overall voter participation and the vote shares for individual parties. The identification strategy is based on the comparison of municipalities that are similar in many respects, but differ with regard to DSL availability. This difference is determined by impediments to the roll-out of DSL networks that have their source in the structure of the pre-existing voice-telephony networks: the distance between a municipality and the nearest main distribution frame. The results indicate that an increase of the DSL rate by one standard deviation increases voter participation by about 7 percent of a standard deviation.

Several caveats have to be considered when interpreting the results. First, the variation that is used to identify the effect mainly comes from the differences in DSL availability between the subgroup of municipalities without their own main distribution frame. Second, data on DSL diffusion in Germany only contains information on DSL availability and not on actual use. Thus, this analysis cannot answer the question what is the effect of using the internet.

[4] The subscriber rate of 27 percent is relative to all households and not relative to households for which DSL is available.

However, from a policy perspective, the effect of DSL availability on political participation is an interesting aspect since availability can be influenced through policy interventions. Hence, this analysis is suited to give advice to policy makers that are interested in the effects of the roll-out of DSL networks to rural areas.

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