

A Retrospective Study of State Aid Control in the German Broadband Market

Tomaso Duso^{1,2,4} Mattia Nardotto^{1,4} Jo Seldeslachts^{1,3,4}

¹DIW, Berlin

²DICE Düsseldorf

³KU Leuven

⁴Berlin Centre for Consumer Policies (BCCP)

3rd Annual BECCLE Competition Policy Conference
April 27-28 2017

State Aid in Broadband Markets

- EU countries allocated large amounts of money (state aid) on the development of broadband infrastructure
 - ▶ Rationales for market failure
 - ★ Universal services provision: In rural areas private investment would not be profitable
 - ★ Externalities: Broadband infrastructure exert substantial positive externalities on several other economic activities such as investment, productivity, and employment
 - ▶ Between 2007 and 2015 Germany allocated almost 7.9 billion euros in a range of national and regional schemes
 - ★ Basic services in rural regions with limited coverage (our focus)
 - ★ Investment in new generation access (NGA) networks
- In EU, subsidies allocated by national governments are subject to state aid control
 - ▶ Only allowed if they are expected to effectively solve a market failure
 - ▶ **AND** do not impair competition within the European Union (EU)
- First complete ex-post evaluation of state aid control, in broadband markets (but also overall)
 - ▶ State aid effectiveness – Broadband availability
 - ▶ State aid competitive effects – Number of firms

The German basic broadband aid schemes

- Three schemes: one for entire Germany (N115/2008), additional schemes for Bavaria (N237/2008) and Lower Saxony (N266/2008)
 - ▶ Provide incentives to private operators to offer affordable broadband DSL services in rural areas of Germany to close the digital divide
 - ▶ We investigate the total effect of all of the above mentioned schemes
- How did the schemes work:
 - ▶ Regional authorities (generally municipalities) applied for the aid
 - ▶ Necessary condition was the existence of 'white areas' within the municipality
 - ▶ The schemes were supposed to be technology-neutral
 - ★ Only DSL, mobile, and to a smaller extent WMAX were effectively supported
 - ▶ Aid was allocated to the operators designated as beneficiaries via tenders
 - ▶ The aid intensity for each project was related to the so called 'profitability gap' but had to be below 200.000 EUR

Methodology and Results: A snapshot

- Methodology: DiD based on regional differences
 - ▶ Compare municipalities receiving state aid to similar municipalities that did not, before and after the implementation of the aid
 - ★ To account for potential endogeneity on observables, we use matching procedure
 - ★ To account for spatial spillovers, we use a spatial autoregressive model
- Data: panel of virtually all West German municipalities (2010-2015)
 - ▶ Outcomes: broadband availability (% covered population) & number of ISPs
 - ▶ Treated municipalities and total amount of the aid
 - ▶ Relevant demand and supply conditions
 - ★ Demographics and regional statistics
 - ★ Broadband network & geo-conformation data
- Main results
 - ▶ The aid significantly increased broadband availability in aid-receiving areas by 15-28% depending on speed and model \Rightarrow ca. 3 years advantage in broadband development
 - ▶ Number of Internet Service Providers (ISPs) operating in aid-receiving municipalities has significantly increased compared to other areas

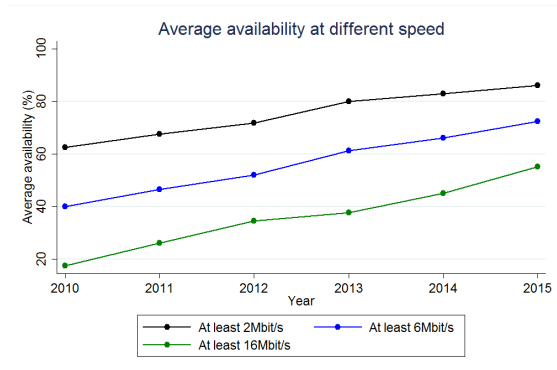
Related Literature

- Broadband subsidies – cross-countries, aggregated data
 - ▶ Belloc et al. (TelPol 2012) & Wallsten (2005)
- Evaluation of industrial policies – Micro-level
 - ▶ Criscuolo et al. (NBER 2012) & Aghion et al. (AEJ:Macro 2015)
- Broadband markets – structural and micro-level data
 - ▶ Entry: Fan & Xiao (RAND 2015), Wilson (2016), Skiti(2016)
 - ▶ Demand & simulations: Nevo et al. (E'trica 2016), Malone et al. (2016)
 - ▶ Akerman et al. (QJE, 2015), Canzian et al. (2015)
 - ▶ Briglauer et al. (2016)

Broadband Data

- Source: 'Breitbandatlas' collected by TÜV Rheinland Consulting GmbH for the German Federal Ministry for Transport and Digital Infrastructure
 - ▶ Unit of observation: municipality; Time: yearly data (2010-2015)
- Broadband Availability: Substantially increased over time

Figure: Broadband coverage at different speeds (population coverage)



Source: Our elaboration on Breitbandatlas data.

Internet Service Providers (ISP)

- Number of ISPs substantially increased over time
 - ▶ 248 different ISPs in our database, with a entry of 144 ISPs over 2010-2015
 - ▶ Only 14 operators are active in more than 200 municipalities (DT, Vodafone, Telefonica, Kabel Deutschland) 206 ISPs active in less than 200 municipalities

Table: Frequencies of the number of ISPs in 2010 and 2015, by technology

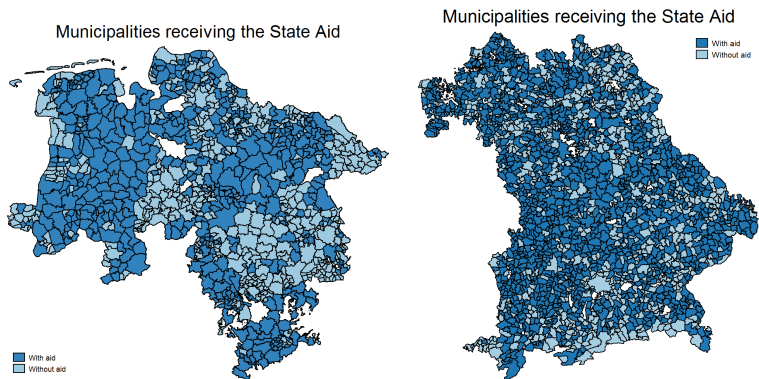
Num. ISPs	DSL		Cable		LTE		FTTH	
	2010	2015	2010	2015	2010	2015	2010	2015
0	4.5	0.2	68.7	54.6	77.1	0.2	98.7	90
1	54.5	0.1	30.5	17	21.5	1.2	1.3	9.3
2	17.8	35.3	0.8	25.6	1.4	24	0	0.6
3	11.8	37.5	0	2.6	0	52.9	0	0.1
4	10.3	18.2	0	0.2	0	20	0	0
5	1	7.2	0	0	0	1.7	0	0
6	0.1	1.3	0	0	0	0	0	0
7	0	0.2	0	0	0	0	0	0

Source: Our elaboration on Breitbandatlas data.

State aid data

- Impossible to get precise nation-wide information on aid receivers. Only data for Lower Saxony and Bavaria

Figure: Municipalities receiving State Aid in Lower Saxony (left) and Bavaria (right)



Source: Our elaboration on data from the Bavarian State Ministry for Economics, Media, Energy and Technology, as well as the Lower Saxony Ministry for Economics, and Transportation.

German Municipalities

Table: Descriptive Statistics - Full sample

	Mean	Std. Dev.	Min.	Max.
Total population	7,580	31,767	65	1,429,584
Average income in 2007 (1,000 EUR)	32	6.5	11.8	212.3
College degree	25.9	8.3	0	70.3
Population between 24 and 65 y.o. (%)	54.4	2.7	31.7	74.7
Population Density (people per km ²)	210.9	293.9	2.4	4601.2
Unemployment rate	5.6	2	1.4	18.2
Ruggedness index	38.3	32.8	0.5	289.5
Area for firms and industry (%)	0.7	1.2	0	16.4
Distance to the MDF from pop centroid (in m)	2,798	1,807	11.5	14,833
Number of MDFs within municipality	0.7	1.8	0	56
DSL Coverage(1 Mbit) in 2005	76.3	20.6	0	100

Source: Our elaboration on data from the Regional Statistical Data Catalog of the Federal Statistical Office and the statistical offices of the Länder and Falck et al. (2014).

The Difference-in-Differences Approach

- Compare treated municipalities (aid recipients) to control municipalities before and after
 - ▶ Exploit regional variation within a common national regulatory framework

$$y_{mt} = \alpha + \gamma post_t + \delta treat_m \times post_t + \lambda X_{mt} + \mu_m + \varepsilon_{mt}, \quad (1)$$

- Before and after
 - ▶ Programs started in 2008-2009 but it took long time to be implemented
 - ▶ Compare 2010 to 2015
 - ▶ No other significant program implemented
- Treated and control municipalities
 - ▶ Treated: Aid-receiving municipalities in Bavaria and Lower Saxony
 - ▶ Control: Other municipalities in Bavaria and Lower Saxony
 - ★ Run several robustness checks with different control groups

Extensions

- 1 Matching procedure to reduce endogeneity due to potential selection on observables
 - ▶ Estimate the probability to receive the state aid (propensity score)
 - ▶ Match aid-recipients with non aid-recipients based on the propensity score
 - ▶ Check the balance of observable characteristics [more](#)
 - ▶ Use only matched municipalities for the DiD regression
- 2 The network nature of the broadband industry makes spacial spillovers across municipalities likely to exist
 - ▶ Extension of our basic framework to account for spatial correlation within a spacial autoregressive model

$$\begin{aligned}y &= \rho W y + X \beta + u \\ u &= \lambda M u + \varepsilon\end{aligned}\tag{2}$$

- ▶ Now β measures the direct impact, while the equilibrium effect is given by $(I - \rho W)^{-1} \beta$

Average Treatment Effect – Coverage

Table: Model for Coverage.

	Dependent variable: broadband coverage								
	Full sample Diff-in-diff			Matched sample Diff-in-diff			Full sample Spatial model		
	2MB/s (1)	6MB/s (2)	16MB/s (3)	2MB/s (4)	6MB/s (5)	16MB/s (6)	2MB/s (7)	6MB/s (8)	16MB/s (9)
State aid × Year ₂₀₁₅	20.21*** (0.90)	27.57*** (1.08)	24.67*** (1.10)	14.83*** (1.05)	22.26*** (1.28)	22.14*** (1.29)			
Year ₂₀₁₅	12.02*** (2.75)	23.09*** (3.30)	37.15*** (3.31)	10.87*** (3.02)	22.57*** (3.75)	36.84*** (3.82)			
State aid							19.95*** (1.00)	27.46*** (1.16)	24.62*** (1.14)
ρ							0.82*** (0.26)	0.34 (0.32)	0.28 (0.30)
λ							-0.97*** (0.36)	-0.71* (0.39)	-0.28 (0.37)
Direct effect							20.1	27.48	24.63
Total effect							109.91	41.59	34.42
Demogs+Tech	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry sector	YES	YES	YES	YES	YES	YES	YES	YES	YES
R ²	0.515	0.615	0.685	0.467	0.570	0.661			
Observations	6018	6018	6018	4172	4172	4172	3009	3009	3009

Average Treatment Effect – Number of firms

Table: Model for Entry.

	Dependent variable: Number of ISPs						Matched sample						Full sample					
	Diff-in-diff						Diff-in-diff						Spatial model					
	All ISPs	DSL	Cable	HSDPA	LTE	FTTH	All ISPs	DSL	Cable	HSDPA	LTE	FTTH	All ISPs	DSL	Cable	HSDPA	LTE	FTTH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
State aid × Year ₂₀₁₅	0.19*** (0.04)	0.13*** (0.03)	0.05*** (0.02)	-0.03 (0.03)	-0.06* (0.03)	0.06*** (0.01)	0.23*** (0.05)	0.16*** (0.04)	0.07*** (0.02)	0.01 (0.04)	-0.02 (0.04)	0.05*** (0.01)						
Year ₂₀₁₅	1.48*** (0.14)	1.13*** (0.10)	0.03 (0.05)	2.05*** (0.09)	3.13*** (0.10)	-0.08* (0.04)	1.35*** (0.16)	1.11*** (0.12)	-0.02 (0.06)	1.92*** (0.11)	3.08*** (0.12)	-0.05 (0.04)						
State aid													0.19*** (0.04)	0.13*** (0.03)	0.05*** (0.02)	-0.03 (0.03)	-0.06* (0.03)	0.05*** (0.01)
ρ													0.70** (0.28)	-0.30 (0.35)	1.16*** (0.21)	0.18 (0.45)	0.61*** (0.29)	1.36*** (0.29)
λ													-0.62** (0.30)	0.12 (0.41)	-1.08*** (0.34)	-0.29 (0.44)	-0.51 (0.34)	-1.35** (0.58)
Direct effect													0.19	0.13	0.05	-0.03	-0.06	0.05
Total effect													0.63	0.1	-0.32	-0.04	-0.15	-0.15
Demogs+Tech	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry sector	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R ²	0.844	0.775	0.219	0.869	0.920	0.114	0.844	0.784	0.224	0.868	0.919	0.122						
Observations	6018	6018	6018	6018	6018	6018	4172	4172	4172	4172	4172	4172	3009	3009	3009	3009	3009	3009

Average Treatment Effect – Number of firms

Dependent variable: market entry						
	Full sample Diff-in-diff					
	All ISPs (1)	DSL (2)	Cable (3)	HSDPA (4)	LTE (5)	FTTH (6)
State aid \times Year ₂₀₁₅	0.19*** (0.04)	0.13*** (0.03)	0.05*** (0.02)	-0.03 (0.03)	-0.06* (0.03)	0.06*** (0.01)
Year ₂₀₁₅	1.48*** (0.14)	1.13*** (0.10)	0.03 (0.05)	2.05*** (0.09)	3.13*** (0.10)	-0.08* (0.04)
State aid						
ρ						
λ						
Direct effect						
Total effect						
Demogs+Tech	YES	YES	YES	YES	YES	YES
Industry sector	YES	YES	YES	YES	YES	YES
R ²	0.844	0.775	0.219	0.869	0.920	0.114
Observations	6018	6018	6018	6018	6018	6018

Heterogenous Treatment Effect

The effect of the aid has been heterogeneous:

- Availability: large effect in more disadvantaged areas (i.e., lower coverage, less industrialized, farther from the MDF)
[more](#)
- Competition: larger entry in better markets (closer to the MDF, more industrialized)
[more](#)
- Size of the aid matters: [more](#)
 - ▶ Small (zero) gains from small grants
 - ▶ Large gains from middle size grants
 - ▶ Moderate extra gains from larger grants
- Effect for DSL comes from the fringe while for cable it comes from the incumbents
[more](#)

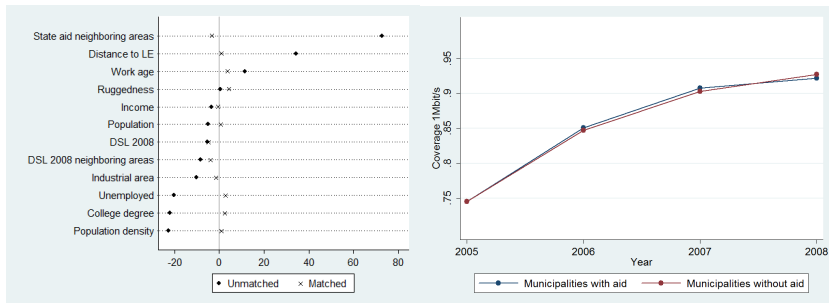
Conclusions

- Empirical analysis of state control based on DiD
 - ▶ Extremely rich micro dataset
 - ▶ Good variation in observables
 - ▶ Several robustness checks delivering consistent findings
 - ★ Reducing endogeneity through PS matching
 - ★ Accounting for spatial spillovers
- Overall, the aid program has met its targets:
 - ▶ Broadband availability has increased significantly (between 15% and 28%)
 - ▶ Entry increased in most technologies (but not in LTE which received large subsidies!)
 - ★ Evidence of across-technology spillovers
 - ▶ Spatial spill-overs are important: they increase the effectiveness of the aid
 - ▶ The effect of the aid has been heterogeneous
- Further step is to look at the welfare effects
 - ▶ Need to estimate consumers' preferences
 - ▶ Estimate structural entry model for different technologies

Thank you for your attention!

Extension I: Matching on Observables

- We reject the null of different means between treated and controls after matching
- We observe a pre-treatment common trend in the outcome



Source: Our elaboration on Breitbandatlas data.

▶ Back

Heterogenous Treatment Effect: cont'd

Table: Heterogeneity Did Full sample.

	Coverage			Entry in different tech					
	2MB/s	6MB/s	16MB/s	All ISPs	DSL	Cable	HSDPA	LTE	FTTH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<i>Above median Industry</i>									
State aid × Year ₂₀₁₅	20.43*** (1.29)	28.16*** (1.56)	24.37*** (1.60)	0.13** (0.06)	0.06 (0.05)	0.02 (0.02)	-0.04 (0.04)	-0.12** (0.05)	0.02 (0.02)
Year ₂₀₁₅	10.99** (4.45)	22.48*** (5.37)	37.83*** (5.51)	1.50*** (0.22)	1.05*** (0.18)	-0.00 (0.07)	1.84*** (0.15)	2.64*** (0.16)	-0.00 (0.06)
<i>Below median industry</i>									
State aid × Year ₂₀₁₅	20.01*** (1.30)	27.24*** (1.51)	25.02*** (1.50)	0.21*** (0.06)	0.19*** (0.04)	0.07*** (0.02)	-0.05 (0.05)	0.07 (0.05)	0.08*** (0.01)
Year ₂₀₁₅	20.71*** (5.12)	37.35*** (5.76)	51.19*** (5.51)	1.69*** (0.23)	1.51*** (0.17)	0.16* (0.09)	2.37*** (0.16)	3.41*** (0.16)	-0.05 (0.07)
Demogs+Tech	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry sector	YES	YES	YES	YES	YES	YES	YES	YES	YES

▶ Back

Heterogeneous treatment effect: Size of the Aid

Table: Amount of the Aid. Did Full sample.

	Coverage			Entry in different tech					
	2MB/s (1)	6MB/s (2)	16MB/s (3)	All ISPs (4)	DSL (5)	Cable (6)	HSDPA (7)	LTE (8)	FTTH (9)
Aid of 50mln or less	9.59*** (1.45)	12.55*** (1.66)	8.93*** (1.63)	0.16*** (0.06)	0.06 (0.05)	0.00 (0.02)	0.01 (0.04)	-0.15*** (0.05)	0.02 (0.02)
Aid between 50mln and 100mln	21.23*** (1.44)	27.80*** (1.66)	25.88*** (1.63)	0.25*** (0.06)	0.14*** (0.05)	0.06** (0.02)	-0.07 (0.04)	-0.06 (0.05)	0.06*** (0.02)
Aid of 100mln or more	25.91*** (1.20)	36.30*** (1.37)	33.29*** (1.35)	0.18*** (0.05)	0.17*** (0.04)	0.08*** (0.02)	-0.03 (0.04)	0.00 (0.04)	0.08*** (0.01)
Demogs+Tech	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry sector	YES	YES	YES	YES	YES	YES	YES	YES	YES
R ²	0.536	0.644	0.732	0.900	0.814	0.330	0.882	0.954	0.221
Observations	6018	6018	6018	6018	6018	6018	6018	6018	6018

▶ Back

Heterogeneous treatment effect: Incumbents vs. Fringe

Table: Entry of players. Did Full sample.

			Entry of:							
	Big ISPs	Fringe ISPs	Big ISPs DSL	Fringe ISPs DSL	Big ISPs Cable	Fringe ISPs Cable	Big ISPs HSDPA	Big ISPs LTE	Big ISPs FTTH	Fringe ISPs FTTH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
State aid \times Year ₂₀₁₅	-0.03 (0.03)	0.22*** (0.03)	-0.04 (0.02)	0.17*** (0.02)	0.06*** (0.01)	-0.00 (0.01)	-0.03 (0.03)	-0.06* (0.03)	0.00 (0.00)	0.05*** (0.01)
Year ₂₀₁₅	1.57*** (0.10)	-0.10 (0.09)	1.10*** (0.08)	0.03 (0.07)	0.06 (0.05)	-0.03* (0.02)	2.05*** (0.09)	3.13*** (0.10)	0.02* (0.01)	-0.09** (0.04)
Demogs+Tech	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry sector	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R ²	0.862	0.399	0.772	0.404	0.221	0.034	0.869	0.920	0.021	0.111
Observations	6018	6018	6018	6018	6018	6018	6018	6018	6018	6018

▶ Back