# The Impact of Broadband on Local Economic Activity (in Rural Areas):

## Evidence from German Municipalities

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# Introduction

## Broadband on the Political Agenda:

- Public involvement in broadband provision for rural areas in most OECD countries.
- In the United States, investment goal (2009) of USD 7.2 billion as part of the stimulus package from 2009
- From 2008 to 2013, €454 million from public funds are made available to German municipalities to close “white spots” in rural areas. In addition, the communes raise own funds to finance the projects.
- The German government (2009) names broadband internet as a crucial location factor in securing jobs and attracting businesses in rural areas
- Local decision makers invest in telecommunication infrastructure to keep local businesses from moving and to attract citizens (Mücke and Sturm, 2010)
- Study effects on employment as a direct benefit to citizens

# Introduction

## How can Broadband Affect Local Employment?

Positive association between broadband and employment at the regional level (Crandall & al., 2007; Koellinger, 2006)

1. Labor demand:
    - Productivity shock increases demand for labor BUT new technology facilitates substitution of labor → overall positive if income effect outweighs substitution effect (OECD, 2008)
    - Broadband might affect businesses' location decisions (Gillett et al., 2006; Mack et al., 2011)
2. Labor supply:
    - Broadband infrastructure enables telecommuting (Autor, 2001), which might increase participation
    - Improved job matching since asymmetries and search costs are reduced (Stevenson, 2009; Mang 212)

→ So far, no causal effects of broadband infrastructure on local labor markets have been established

# Introduction

## How are the Benefits Distributed within the Economy?

1. **Rural areas benefit over-proportionately from broadband („death of distance“)**

   - Broadband reduces transport costs for large batches of information
     → agglomeration advantages become less important (Cairncross, 1997)
   - New distribution channels via the internet allow to serve more distant markets

   Empirical evidence in favor of death of distance:

   - Kolko (2011): Broadband expansion is associated with local employment growth, but employment growth is larger in less densely populated areas
   - Ioannides et al. (2008): ICT increases dispersion of activity → city sizes become more uniform

# Introduction

## How are the Benefits Distributed within the Economy?

**2. Urban areas should benefit more from broadband**

- ICT is complementary to human capital. It allows for a more efficient production of knowledge (exchange of information) (Autor et al, 2003; Michaels and van Reenen, 2011)
- High-skilled labor is concentrated in large cities. → The impact on rural areas might be small

Empirical evidence in favor of the argument:

- Forman & al (2010): Areas with a priori high wealth, education, population and IT-intensive industry experience highest wage growth from internet use

# Methodology

## Fixed-Effects Model

Municipality fixed effects due to time invariant local characteristics:

$$y_{i,t} = \delta_i + \tau_t + \beta_1 BB_{i,t} + \beta_2 X_{i,t} + \varepsilon_{i,t}$$

i = municipality (West Germany only)
t = 2005 to 2009
y = employment rate
BB = broadband availability, percentage of households with DSL access; „Broadband Atlas“ (Ministry of Economics and Technology)
X = municipality characteristics
(population density, industrial area, business tax rate)

# Data

## Dependent variable:

- The number of employees subject to social insurance contributions in a municipality. Employees are counted according to the place they are registered to work in.
- Included are all workers, employees and trainees with monthly earnings > 400 € on average
- Not included are the self-employed, family members working on a voluntary basis, civil servants and the short-term employed
- Calculated as: # employees/#working age population (aged 15-65)
- Source: German Federal Statistical Office

# Data

## Variable of Interest:

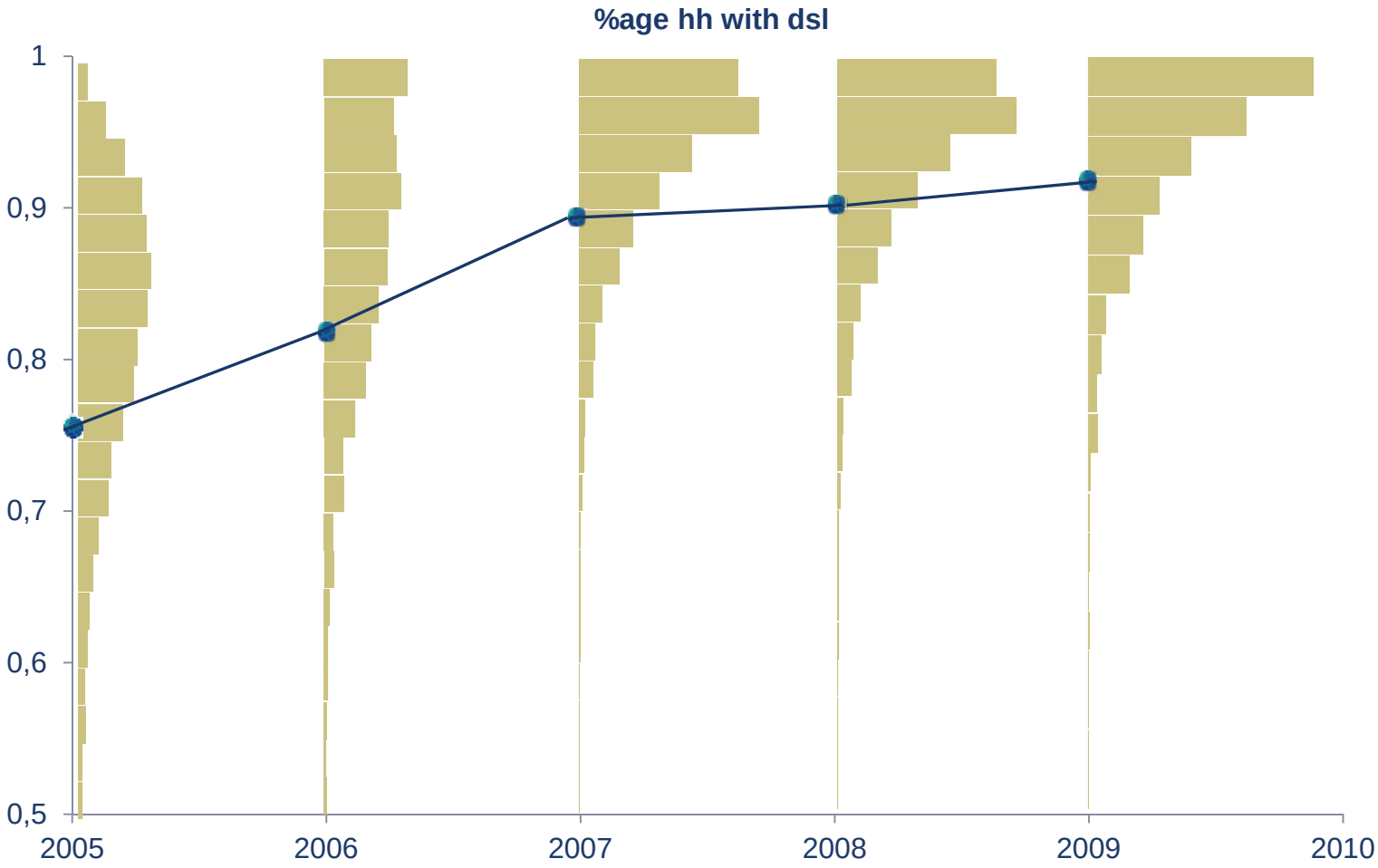
- BB describes the percentage of households with DSL *access*, i.e. households that could have broadband if they chose to subscribe (availability, not use)
- Source: „Broadband Atlas“ (launched by Federal Ministry of Economics and Technology in 2005)

DSL-availability in 2008


Source: Ministry of Economics and Technology, 2008

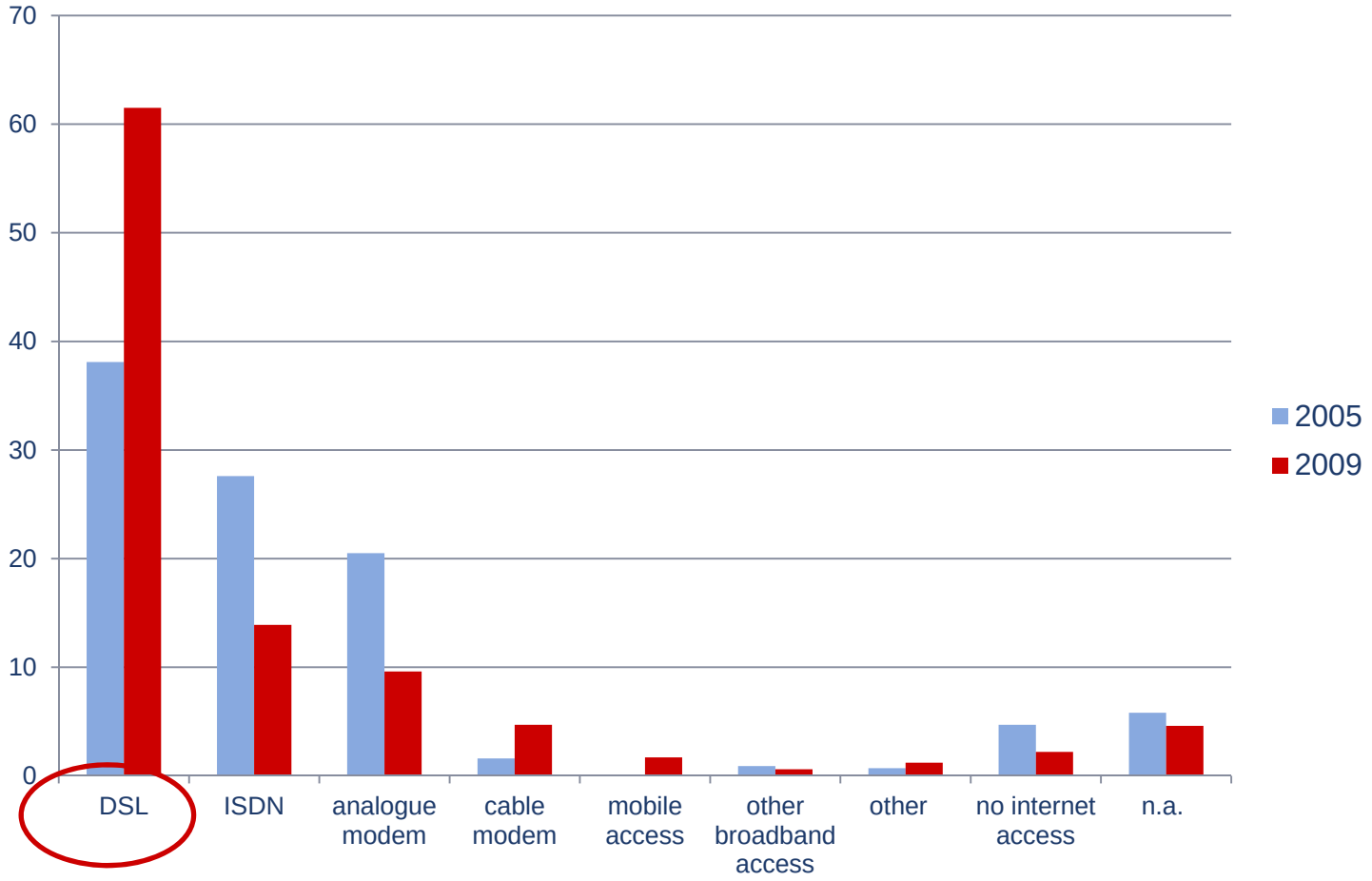
# Data

**Mean and distribution of the percentages of households with DSL access**
(by year, over German municipalities)



# Data

## Internet Access Technologies in Germany over time



# Data

## Descriptive Statistics (in 2005 and 2009)

| | | 2005 | | 2009 | |
|---|---|---|---|---|---|
| **All Municipalities** | **Obs.** | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** |
| Employment rate (in %) | 8,460 | 28.50 | (26.65) | 30.45 | (31.44) |
| Share of households with DSL | 8,460 | 0.75 | (0.21) | 0.92 | (0.14) |
| Population size | 8,460 | 7,691.06 | (36,269.08) | 7,659.51 | (36,809.84) |
| Area (in *km*2) | 8,460 | 28.71 | (34.07) | 28.71 | (34.07) |
| Population density (per *km*2) | 8,460 | 208.67 | (291.90) | 207.08 | (292.86) |
| Tax rate (in%) | 8,460 | 338.34 | (31.39) | 341.39 | (31.62) |
| Industrial area (*m*2 per capita) | 8,460 | 37.44 | (560.66) | 38.19 | (332.88) |
| Distance to regional center (in km) | 8,460 | 24.40 | (12.79) | 24.40 | (12.79) |

# Results

## Dependent variable: Employment rate

| | (I) | (II) | (III) | (IV) | (IV) |
|---|---|---|---|---|---|
| DSL | 3.974*** | 0.370* | 0.368* | 0.389* | 0.385* |
| | (0.177) | (0.207) | (0.207) | (0.207) | (0.207) |
| Density | | | -0.024*** | -0.024*** | -0.024*** |
| | | | (0.005) | (0.005) | (0.005) |
| Tax rate | | | | -0.016*** | -0.016*** |
| | | | | (0.004) | (0.004) |
| Industrial area (p.c.) | | | | | 175.9*** |
| | | | | | (20.763) |
| Year FE | | yes | yes | yes | yes |
| Municipality FE | | yes | yes | yes | yes |
| Observations | 41,605 | 41,605 | 41,605 | 41,605 | 41,605 |
| No. of municipalities | 8,321 | 8,321 | 8,321 | 8,321 | 8,321 |
| R-squared | 0.014 | 0.043 | 0.043 | 0.044 | 0.058 |

Notes: Estimations are based on the full sample. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

# Subsamples

## The Effects of Broadband in Rural areas

To see how the benefits of broadband differ across municipalities, subsamples are constructed to reflect different degrees of rurality:

A. Subsamples based on quartiles of distance to the next „regional metropolis“.

→ Regional metropolis= city with a high degree of centrality with special importance for surrounding region (e.g. specialized hospitals, academic institutions or museums)
→ Calculated as linear distance between a municipality center and the center of its closest regional metropolis.

B. Subsamples based on quartiles of the population density distribution

# Results – Subsamples

## Dependent variable: Employment rate

| | Distance to reg. metropolis (in km) | | | Population density (per *km2*) | | |
|---|---|---|---|---|---|---|
| | [< 14.68] **(I)** | [14.68; 31.80] **(II)** | [> 31.80] **(III)** | [> 225.37] **(IV)** | [225.37; 64.11] **(V)** | [<64.11] **(VI)** |
| DSL | 0.594 | -0.392 | 1.532*** | -0.183 | 0.334 | 0.986*** |
| | (0.377) | (0.268) | (0.472) | (0.438) | (0.322) | (0.381) |
| Density | -0.021*** | -0.021*** | -0.039*** | -0.018*** | -0.056*** | -0.320*** |
| | (0.005) | (0.008) | (0.014) | (0.004) | (0.014) | (0.057) |
| Tax rate | -0.039*** | -0.006 | -0.010 | -0.034*** | -0.021*** | 0.000 |
| | (0.005) | (0.005) | (0.009) | (0.005) | (0.006) | (0.007) |
| Industrial area (p.c.) | 219.2*** | 302.3*** | 97.53*** | 541.3*** | 262.6*** | 125.7*** |
| | (53.856) | (31.443) | (37.567 | (73.905) | (38.726) | (31.626) |
| Year FE | yes | yes | yes | yes | yes | yes |
| Municipality FE | yes | yes | yes | yes | yes | yes |
| Observations | 10,405 | 20,800 | 10,400 | 10,401 | 20,803 | 10,401 |
| R-squared | 0.128 | 0.056 | 0.023 | 0.152 | 0.046 | 0.026 |
| No. of municipalities | 2,080 | 4,160 | 2,080 | 2,080 | 4,160 | 2,080 |
| Percentiles | 0 - 25 | 25 - 75 | 75 - 100 | 0 - 25 | 25 - 75 | 75 - 100 |

Notes: Subsamples in columns (I) to (III) are based on the distance to the next regional metropolis and in columns (IV) to (VI) on population density. The dependent variable is the local employment rate. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

# Results – Subsamples

## Dependent variable: Employment rate

| | Distance | Pop. density |
|---|---|---|
| | [< 14.68] | [<64.11] |
| | **(I)** | **(II)** |
| DSL | 3.673*** | 4.569*** |
| | (1.371) | (1.646) |
| DSL 2 | -2.638** | -2.897* |
| | (-1.292) | (1.503) |
| Density | -0.317*** | -0.039*** |
| | (0.057) | (0.014) |
| Tax rate | 0.000 | -0.010 |
| | (0.007) | (0.009) |
| Industrial area (p.c.) | 125.725*** | 96.803*** |
| | -31.620 | (37.562) |
| Year FE | yes | yes |
| Municipality FE | yes | Yes |
| Observations | 10,400 | 10,400 |
| R-squared | 0.027 | 0.023 |
| No. of municipalities | 2,080 | 2,080 |

Notes: Subsample in column (I) to is based on the distance to the next regional metropolis and in column (II) on population density. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

# Conclusion

- Overall, broadband availability has a rather small effect on local employment: A 10 percentage point increase in Broadband is associated with a 0.04 percentage point increase in the local employment rate
- A positive effect is found for rural municipalities: If broadband increases by 10 percentage points, the local employment rate increases by 0.1 to 0.15 percentage points
- Evidence, that non-linearities in the effect of broadband infrastructure exist. This allows no conclusion about effect of broadband in urban areas where broadband provision was already high in 2005
- Short-term effects!
- Broadband availability vs. broadband usage (reduced form)

Thank you for your attention!

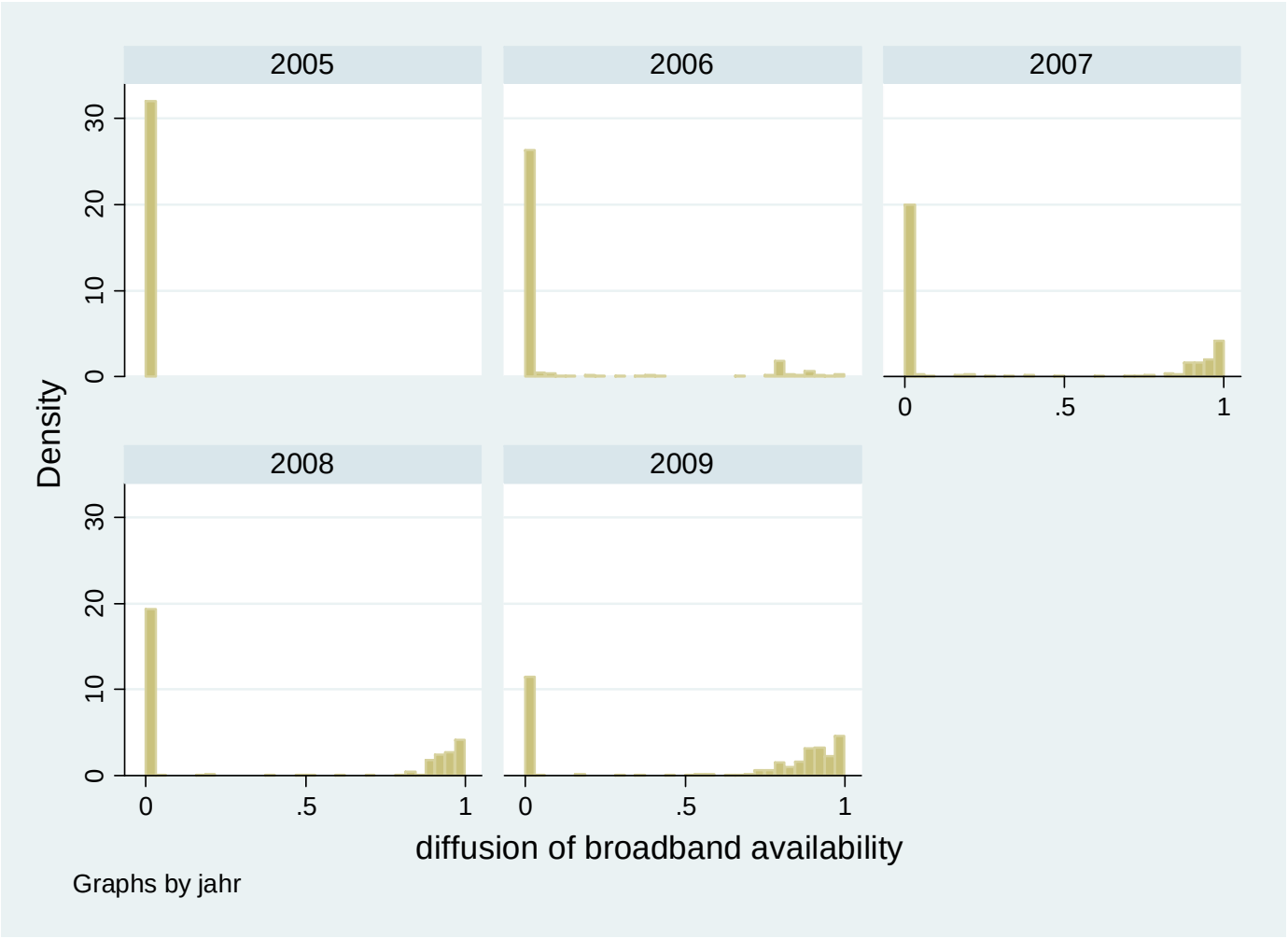
# Results – Subsamples II

## Dependent variable: Employment rate (manufacturing sector)

| | | Distance to reg. metropolis (km) | | | Population density (per *km*2) | | |
|---|---|---|---|---|---|---|---|
| | | [< 14.68] | [14.68; 31.80] | [> 31.80] | [> 225.37] | [225.37; 64.11] | [<64.11] |
| | (I) | (II) | (III) | (IV) | (V) | (VI) | (VII) |
| DSL | 0.099 | 0.039 | 0.144 | 0.067 | 0.379 | 0.280** | 0.017 |
| | (0.071) | (0.204) | (0.111) | (0.089) | (0.253) | (0.131) | (0.049) |
| Density | -0.007*** | -0.010*** | 0.000 | -0.009*** | -0.009*** | 0.012** | 0.001 |
| | (0.002) | (0.002) | (0.003) | (0.002) | (0.002) | (0.006) | (0.007) |
| Tax rate | -0.004*** | -0.003 | -0.005** | -0.003* | -0.007** | -0.005** | 0.000 |
| | (0.001) | (0.003) | (0.002) | (0.002) | (0.003) | (0.002) | (0.001) |
| Industrial area (p.c.) | 36.280*** | 242.086*** | 54.492*** | 13.061* | 155.874*** | 115.575*** | 8.116** |
| | (7.033) | (33.150) | (14.012) | (6.697) | (43.307) | (17.265) | (3.950) |
| Year FE | yes | yes | yes | yes | yes | yes | yes |
| Municipality FE | yes | yes | yes | yes | yes | yes | yes |
| Observations | 30,010 | 7,276 | 14,844 | 7,890 | 7,510 | 14,234 | 8,266 |
| R-squared | 0.230 | 0.062 | 0.039 | 0.030 | 0.122 | 0.061 | 0.001 |
| No. of municipalities | | 2,080 | 4,160 | 2,080 | 2,080 | 4,160 | 2,080 |
| Percentiles | 0 - 100 | 0 - 25 | 25 - 75 | 75 - 100 | 0 - 25 | 25 - 75 | 75 - 100 |

Notes: Subsamples in columns (II) to (IV) are based on the distance to the next regional metropolis and in columns (V) to (VI) on population density. The dependent variable is the local employment rate in the manufacturing sector. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

# The Distribution of DSL in Initially Unprovided Municipalities



# Results – Subsamples II

## Descriptive Statistics (in 2005 and 2009)

| | | 2005 | | 2009 | |
|---|---|---|---|---|---|
| **Initially unprovided municipalities** | **Obs** | **Mean** | **Std. Dev.** | **Mean** | **Std. Dev.** |
| Employment rate (in %) | 357 | 16.57 | (26.40) | 18.02 | (30.18) |
| Share of households with DSL | 357 | 0 | 0 | 0.55 | (0.44) |
| Population size | 357 | 649.10 | (636.66) | 634.01 | (625.52) |
| Area (in *km*2 | 357 | 11.93 | (12.84) | 11.94 | (12.84) |
| Population density (per *km*2) | 357 | 71.34 | (77.51) | 69.67 | (78.75) |
| Tax rate (in%) | 357 | 337.13 | (27.76) | 339.56 | (26.51) |
| Industrial area (m2 per capita) | 357 | 28.14 | (67.92) | 30.21 | (73.06) |
| Distance to regional center (in km) | 357 | 33.07 | (12.86) | 33.07 | (12.86) |

# Results – Subsamples II

## Dependent variable: Employment rate

| | (I) | (II) | (III) | (IV) |
|---|---|---|---|---|
| Dsl | -0.211 | 0.569 | -0.366 | 1.633*** |
| | (0.347) | (0.646) | (0.824) | (0.455) |
| Density | -0.0197*** | -0.0482*** | -0.0634** | -0.0928** |
| | (0.004) | (0.017) | (0.032) | (0.043) |
| Tax rate | -0.00853** | -0.0419*** | 0.00639 | -0.00625 |
| | (0.004) | (0.009) | (0.012) | (0.018) |
| Industrial area (p.c.) | 194.1*** | -9.094 | 771.6*** | 207.3*** |
| | (21.880) | (59.830) | (160.469) | (68.927) |
| Year FE | yes | yes | yes | yes |
| Municipality FE | yes | yes | yes | yes |
| Constant | 36.53*** | 48.66*** | 30.58*** | 27.95*** |
| | (1.763) | (3.793) | (5.543) | (7.236) |
| Observations | 29,510 | 8,905 | 1,540 | 2,100 |
| R-squared | 0.062 | 0.029 | 0.131 | 0.032 |
| Initial level of *dsl* | 100 - 75 | 75 - 50 | 50 - 25 | 25 - 0 |

Notes: Subsamples are based on the level of DSL provision in 2005. * p < 0.10; ** p < 0.05; *** p < 0.01.