Can internet infrastructure help reduce regional disparities? Evidence from Turkey

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RELEVANCE
Night map, Turkey (2012)
Why may regional disparities be a source of concern?

- congestion due to migration from lagging regions to richer ones,
Why may regional disparities be a source of concern?

- congestion due to migration from lagging regions to richer ones,
- environmental concerns,
Why may regional disparities be a source of concern?

- congestion due to migration from lagging regions to richer ones,
- environmental concerns,
- crime,
Why may regional disparities be a source of concern?

- congestion due to migration from lagging regions to richer ones,
- environmental concerns,
- crime,
- high residential rents,
Why may regional disparities be a source of concern?

- congestion due to migration from lagging regions to richer ones,
- environmental concerns,
- crime,
- high residential rents,
- perception of fairness and loss of trust within the population, etc.
Information, communication, and economic geography

- the reduction of the information gap between markets,
Information, communication, and economic geography

- the reduction of the information gap between markets,
- stimulating capital flows,
Information, communication, and economic geography

- the reduction of the information gap between markets,
- stimulating capital flows,
- creating new patterns of homogenization, homogenizing of institutions and culture,
Information, communication, and economic geography

- the reduction of the information gap between markets,
- stimulating capital flows,
- creating new patterns of homogenization, homogenizing of institutions and culture,
- generating productivity spillovers to other inputs of production,
Information, communication, and economic geography

- the reduction of the information gap between markets,
- stimulating capital flows,
- creating new patterns of homogenization, homogenizing of institutions and culture,
- generating productivity spillovers to other inputs of production,
- attracting resources to a regional economy from other economies,
Information, communication, and economic geography

- the reduction of the information gap between markets,
- stimulating capital flows,
- creating new patterns of homogenization, homogenizing of institutions and culture,
- generating productivity spillovers to other inputs of production,
- attracting resources to a regional economy from other economies,
- creating locational advantages as a result of being in digital networks,
Information, communication, and economic geography

- the reduction of the information gap between markets,
- stimulating capital flows,
- creating new patterns of homogenization, homogenizing of institutions and culture,
- generating productivity spillovers to other inputs of production,
- attracting resources to a regional economy from other economies,
- creating locational advantages as a result of being in digital networks,
- changing the NEG equilibrium through decreasing the costs of communication,
Information, communication, and economic geography

- the reduction of the information gap between markets,
- stimulating capital flows,
- creating new patterns of homogenization, homogenizing of institutions and culture,
- generating productivity spillovers to other inputs of production,
- attracting resources to a regional economy from other economies,
- creating locational advantages as a result of being in digital networks,
- changing the NEG equilibrium through decreasing the costs of communication,
- increasing the demand for product variety and attracting firms to the region, etc.
THEORETICAL BACKGROUND
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Theoretical background

(1)

\[
\frac{1}{T} \ln \left( \frac{y_{i,t_0+T}}{y_{i,t_0}} \right) = \alpha - \left( \frac{1 - e^{-bT}}{T} \right) \ln(y_{i,t_0}) + \varepsilon_i
\]

(2)

\[
\ln(y_{i,t_0+T}) = \theta + (1 + \beta) \ln(y_{i,t_0}) + \nu_i
\]
REGIONAL PATTERNS OF INCOME PER CAPITA IN TURKEY
Can internet infrastructure help reduce regional disparities? Evidence from Turkey

Regional patterns of income per capita in Turkey

**Sigma convergence represented by the coefficient of variation, and TPI (millions), 1990-2011**

Cebbis & de Crombrugghe (2014) p.8/23
Local Moran’s I: shows the extent of significant local spatial clustering around individual regions for 1990, 1999, and 2011 ($l_i = z_i \sum_j w_{ij} z_j$).

Moran significance map.
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Regional patterns of income per capita in Turkey

Low−High
High−High
Low−Low
High−Low
Not significant

Celibis & de Crombrugghe (2014) p.9/23
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Celbis & de Crombrugghe (2014)
EMPIRICAL APPROACH
Can internet infrastructure help reduce regional disparities? Evidence from Turkey

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SAR:

\[ \ln(y_{i,t_0+T}) = \alpha + \rho \sum_{j=1}^{N} w_{ij} \ln(y_{j,t_0+T}) + (1+\beta) \ln(y_{i,t_0}) + \nu_i \]  

(Celbis & de Crombrugghe (2014) p.13/23)
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- SAR:

\[
\ln(y_{i,t_0+T}) = \alpha + \rho \sum_{j=1}^{N} w_{ij} \ln(y_{j,t_0+T}) + (1 + \beta) \ln(y_{i,t_0}) + \nu_i
\]  

(3)

- SEM:

\[
\ln(y_{i,t_0+T}) = \alpha + (1 + \beta) \ln(y_{i,t_0}) + \nu_i
\]

where \( \nu_i = \lambda \sum_{j=1}^{N} w_{ij} \nu_j + \zeta_i \)  

(4)

Celbis & de Crombrugghe (2014) p.13/23
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► SAR:

\[ \ln(y_{i,t_0+T}) = \alpha + \rho \sum_{j=1}^{N} w_{ij} \ln(y_{j,t_0+T}) + (1 + \beta) \ln(y_{i,t_0}) + \nu_i \] (3)

► SEM:

\[ \ln(y_{i,t_0+T}) = \alpha + (1 + \beta) \ln(y_{i,t_0}) + \nu_i \]

where \( \nu_i = \lambda \sum_{j=1}^{N} w_{ij} \nu_j + \zeta_i \) (4)

► GSM:

\[ \ln(y_{i,t_0+T}) = \alpha + \rho \sum_{j=1}^{N} w_{ij} \ln(y_{j,t_0+T}) + (1 + \beta) \ln(y_{i,t_0}) + \nu_i \]

where \( \nu_i = \lambda \sum_{i=1}^{N} c_{ij} \nu_j + \zeta_i \) (5)

Cebis & de Crombrugghe (2014)
... and panel variants with regional characteristics, fixed regional effects, year dummies, and interaction between internet infrastructure and past GVA per capita:

$$\sum_{k=1}^{m} \gamma_k x_{k,it} = \gamma_1 \ln c_{it} + \gamma_2 \ln y_{i,t-1} \times \ln c_{it} + \gamma_3 \ln a_{it} + \gamma_4 r_{it}$$

so marginal effect of $\ln y_{i,t-1}$ is now defined as $e^{-b(\ln c_{it})T}$ (i.e. the speed of convergence is a function of internet infrastructure)
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ESTIMATION RESULTS
Can internet infrastructure help reduce regional disparities? Evidence from Turkey

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**Table 2.2**

**Cross-sectional estimation results**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ln y0</strong></td>
<td>0.865***</td>
<td>0.744***</td>
<td>0.907***</td>
<td>0.769***</td>
</tr>
<tr>
<td></td>
<td>(0.0472)</td>
<td>(0.0695)</td>
<td>(0.0253)</td>
<td>(0.0714)</td>
</tr>
<tr>
<td><strong>α</strong></td>
<td>1.322***</td>
<td>-0.563</td>
<td>1.047***</td>
<td>-0.334</td>
</tr>
<tr>
<td></td>
<td>(0.318)</td>
<td>(0.890)</td>
<td>(0.167)</td>
<td>(0.741)</td>
</tr>
<tr>
<td><strong>β</strong></td>
<td>-0.135***</td>
<td>-0.256***</td>
<td>-0.0934***</td>
<td>-0.231***</td>
</tr>
<tr>
<td></td>
<td>(0.0472)</td>
<td>(0.0695)</td>
<td>(0.0253)</td>
<td>(0.0714)</td>
</tr>
<tr>
<td><strong>ρ</strong></td>
<td>0.381**</td>
<td>0.325**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.174)</td>
<td>(0.164)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>λ</strong></td>
<td>-1.403**</td>
<td>-0.856</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.596)</td>
<td>(0.757)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Convergence speed</strong></td>
<td>0.0121</td>
<td>0.0246</td>
<td>0.00817</td>
<td>0.0219</td>
</tr>
<tr>
<td><strong>Half-life</strong></td>
<td>57.23</td>
<td>28.16</td>
<td>84.87</td>
<td>31.62</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td><strong>Log-likelihood</strong></td>
<td>25.55</td>
<td>28.41</td>
<td>27.38</td>
<td>29.06</td>
</tr>
<tr>
<td><strong>AIC</strong></td>
<td>-47.11</td>
<td>-48.83</td>
<td>-46.76</td>
<td>-48.11</td>
</tr>
<tr>
<td><strong>BIC</strong></td>
<td>-44.59</td>
<td>-43.79</td>
<td>-41.73</td>
<td>-41.82</td>
</tr>
</tbody>
</table>

*Stata module for spatial models: SPAUTOREG (see footnote 28).*
*SAR: Spatial Autoregressive Model.*
*SEM: Spatial Error Model.*
*GSM: General Spatial Model.*

Standard errors in parentheses:  * p < 0.10, ** p < 0.05, *** p < 0.01
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Celbis & de Crombrugghe (2014) p.17/23

<table>
<thead>
<tr>
<th>Table 2.3</th>
<th>Panel estimation results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) Base Model</td>
</tr>
<tr>
<td>$\ln y_{i,t-1}$</td>
<td>0.987***</td>
</tr>
<tr>
<td></td>
<td>(0.00503)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>-0.0126***</td>
</tr>
<tr>
<td></td>
<td>(0.00503)</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.141</td>
</tr>
<tr>
<td></td>
<td>(0.103)</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.323***</td>
</tr>
<tr>
<td></td>
<td>(0.128)</td>
</tr>
<tr>
<td>Convergence speed</td>
<td>0.0127</td>
</tr>
<tr>
<td>Half-life (years)</td>
<td>54.79</td>
</tr>
<tr>
<td>Observations</td>
<td>338</td>
</tr>
<tr>
<td>Observations per region</td>
<td>13</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>641.8</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>No</td>
</tr>
<tr>
<td>Year Dummies</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Stata module for spatial models: XSMLE (see footnote 28).
SAR: Spatial Autoregressive Model.
SEM: Spatial Error Model.
GSM: General Spatial Model.
Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
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Table 2.4
Panel estimation results

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Model</td>
<td>SAR</td>
<td>SEM</td>
<td>GSM</td>
</tr>
<tr>
<td>$ln y_{i,t-1}$</td>
<td>1.002***</td>
<td>0.997***</td>
<td>1.001***</td>
<td>0.999***</td>
</tr>
<tr>
<td></td>
<td>(0.0702)</td>
<td>(0.0599)</td>
<td>(0.0601)</td>
<td>(0.0606)</td>
</tr>
<tr>
<td>$ln y_{i,t-1} \times ln c_u$</td>
<td>-0.0204***</td>
<td>-0.0199***</td>
<td>-0.0201***</td>
<td>-0.0200***</td>
</tr>
<tr>
<td></td>
<td>(0.00565)</td>
<td>(0.00472)</td>
<td>(0.00476)</td>
<td>(0.00482)</td>
</tr>
<tr>
<td>$ln c_u$</td>
<td>0.145***</td>
<td>0.142***</td>
<td>0.143***</td>
<td>0.142***</td>
</tr>
<tr>
<td></td>
<td>(0.0377)</td>
<td>(0.0312)</td>
<td>(0.0316)</td>
<td>(0.0319)</td>
</tr>
<tr>
<td>$ln a_u$</td>
<td>0.0795**</td>
<td>0.0784**</td>
<td>0.0767**</td>
<td>0.0768**</td>
</tr>
<tr>
<td></td>
<td>(0.0343)</td>
<td>(0.0306)</td>
<td>(0.0308)</td>
<td>(0.0308)</td>
</tr>
<tr>
<td>$\rho$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0538</td>
<td></td>
<td>0.0243</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.104)</td>
<td></td>
<td>(0.126)</td>
<td></td>
</tr>
<tr>
<td>$\lambda$</td>
<td></td>
<td>0.100</td>
<td>0.0808</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.154)</td>
<td>(0.185)</td>
</tr>
<tr>
<td>Observations</td>
<td>338</td>
<td>338</td>
<td>338</td>
<td>338</td>
</tr>
<tr>
<td>Observations per region</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>681.3</td>
<td>681.4</td>
<td>681.5</td>
<td>681.5</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year Dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Stata module for spatial models: XSMLE (see footnote 28).
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**Table 2.5**

**Convergence factors, speeds, and associated half-lives**

*(Base model)*

<table>
<thead>
<tr>
<th>Percentile of $c$</th>
<th>Convergence factor</th>
<th>Convergence speed</th>
<th>Half-life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>-0.138</td>
<td>0.148</td>
<td>4.671</td>
</tr>
<tr>
<td>5%</td>
<td>-0.158</td>
<td>0.172</td>
<td>4.019</td>
</tr>
<tr>
<td>25%</td>
<td>-0.199</td>
<td>0.222</td>
<td>3.126</td>
</tr>
<tr>
<td>50%</td>
<td>-0.213</td>
<td>0.240</td>
<td>2.893</td>
</tr>
<tr>
<td>75%</td>
<td>-0.224</td>
<td>0.254</td>
<td>2.734</td>
</tr>
<tr>
<td>95%</td>
<td>-0.235</td>
<td>0.268</td>
<td>2.588</td>
</tr>
<tr>
<td>99%</td>
<td>-0.241</td>
<td>0.276</td>
<td>2.510</td>
</tr>
</tbody>
</table>
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### Table 2.6
Model comparison versus GSM

<table>
<thead>
<tr>
<th></th>
<th>Base model (FE)</th>
<th>SAR</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Absolute convergence cross-sectional models</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR test p-value</td>
<td>0.030</td>
<td>0.256</td>
<td>0.067</td>
</tr>
<tr>
<td>Wald test p-value</td>
<td>0.020</td>
<td>0.258</td>
<td>0.047</td>
</tr>
<tr>
<td>(b) Absolute convergence panel models</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR test p-value</td>
<td>0.059</td>
<td>0.049</td>
<td>0.836</td>
</tr>
<tr>
<td>Wald test p-value</td>
<td>0.035</td>
<td>0.029</td>
<td>0.837</td>
</tr>
<tr>
<td>(c) Conditional convergence panel models</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR test p-value</td>
<td>0.799</td>
<td>0.667</td>
<td>0.848</td>
</tr>
<tr>
<td>Wald test p-value</td>
<td>0.797</td>
<td>0.662</td>
<td>0.847</td>
</tr>
</tbody>
</table>

SAR: Spatial Autoregressive Model.
SEM: Spatial Error Model.
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CONCLUSION
When convergence was conditioned on region specific characteristics, the convergence speeds were estimated are much higher.
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Observed evidence for conditional $\beta$-convergence with reasonable speed among Turkish regions during the period 1999-2011.
When convergence was conditioned on region specific characteristics, the convergence speeds were estimated are much higher.

- Observed evidence for conditional $\beta$-convergence with reasonable speed among Turkish regions during the period 1999-2011.
- Internet infrastructure contributes to a regional economy in three ways:
  - by positively impacting on per-capita income,
  - by increasing the speed of convergence of a region to its steady-state,
  - by contributing to make region-specific steady-states more alike.
When convergence was conditioned on region specific characteristics, the convergence speeds were estimated much higher.

Observed evidence for conditional $\beta$-convergence with reasonable speed among Turkish regions during the period 1999-2011.

Internet infrastructure contributes to a regional economy in three ways:

- by positively impacting on per-capita income,
- by increasing the speed of convergence of a region to its steady-state,
- by contributing to make region-specific steady-states more alike.

Air transport capacity was also found to play a contributing role to a regional economy.
When convergence was conditioned on region specific characteristics, the convergence speeds were estimated are much higher.

Observed evidence for conditional $\beta$-convergence with reasonable speed among Turkish regions during the period 1999-2011.

Internet infrastructure contributes to a regional economy in three ways:

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Air transport capacity was also found to play a contributing role to a regional economy.

The economic geography of Turkey is defined by a strong core-periphery pattern.
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Air transport capacity was also found to play a contributing role to a regional economy.

The economic geography of Turkey is defined by a strong core-periphery pattern.

However, controlling for spatial effects did not change any of our main findings.
Thank you very much.

Q & A