Trade Costs and Income in European Regions

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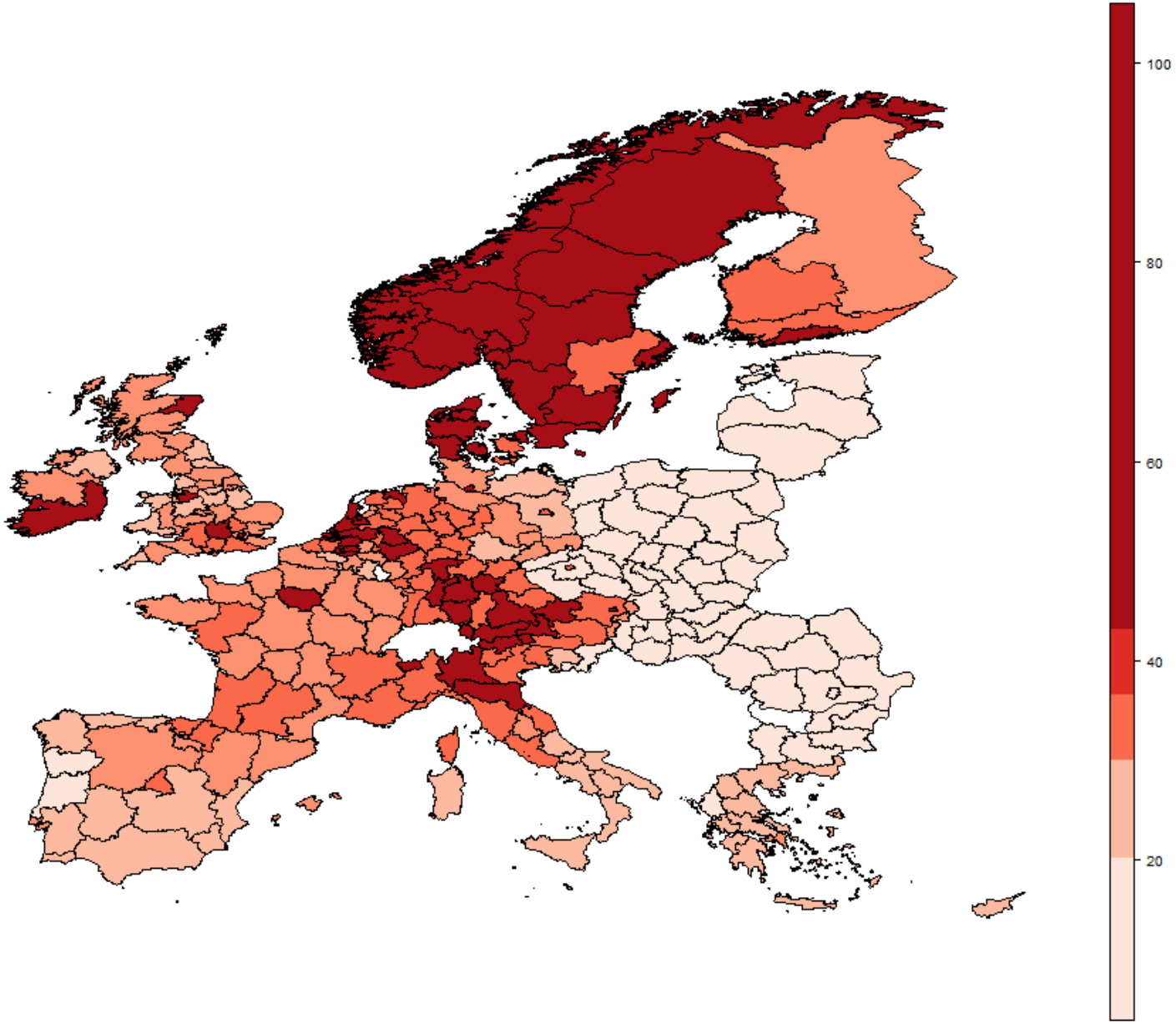

Figure: Income Levels 2010 (GVA per capita) in European NUTS2 regions in Thousands of Euros
Source: Cambridge Econometrics

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Research Question

- Does **economic geography** play a role in explaining differences in **regional income (wages)** across Europe?
  - ▷ Level of factors' income of a country is related to its proximity to large markets: "market access" (Head and Mayer, 2011)
- If so, how robust is this relationship with respect to additional controls and possible alternative explanations?

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Outline

- The theoretical model
- Two-step estimation strategy
  1. The trade equation
  2. The wage equation
- Data
  - Regional (NUTS-2) bilateral trade data
- Estimation results
- Concluding remarks

Selection of theoretical model

- New Economic Geography
  - ▷ General equilibrium framework
  - ▷ Economic landscape is the outcome of agglomeration and dispersion forces which arise as a consequence of behaviour of economic agents

- Agglomeration can be explained with
  1. Location choice of regionally mobile workers due to real wage differences: Krugman (1991)
  2. Location choice of firms due to access to consumers and inputs: Krugman and Venables (1995)

- Location choice is based on differences in profitability of a region
  $\Rightarrow$ relative location of workers or firms $\Rightarrow$ differences in income

Footloose Entrepreneur Model of Economic Geography

Properties:

- Model based on Forslid and Ottaviano (2003)
- The Footloose Entrepreneur Model:
  - Analytically solvable version of a Core-Periphery model
  - More realistic assumptions regarding factor mobility
- Production side
  - Two sectors of production (A constant-return and M increasing-return)
  - Scale effects at the firm level: internal increasing returns to scale
  - Monopolistic competition in the "manufacturing" M sector
  - L regionally immobile, H regionally mobile
- Demand side
  - CES preferences for manufactured goods, love for variety
- Role of space
  - Many symmetrical regions, space is homogeneous
  - Trade costs – iceberg specification
- Equilibrium condition
  - Free entry- and exit drives profits to zero

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Short-run equilibrium

$$w_{H,r} = \kappa \underbrace{\sum_s E_s P_s^{\sigma-1} \tau_{rs}^{1-\sigma}}_{\text{access to consumer markets}} \tag{1}$$

$$P_s = \left[\sum_r^R n_r p_{rs}^{1-\sigma} \right]^{1/(1-\sigma)} \qquad p_{rs} = p_r \tau_{rs}$$

$w_{H,r}$	manufacturing wage rate in region r
E_s	region s's expenditure on manufacturing varieties
P_s	price index for the manufacturing varieties in region s
τ_{rs}	iceberg trade costs between region r and s
σ	constant elasticity of substitution
n_r	number of varieties produced in region r
p_{rs}	delivered price of variety r

Wage equation (I/II)

- Rewriting the wage equation gives

$$w_{H,r} = \kappa * MA_r \tag{2}$$

- Given the current location of firms (i.e., given the market size) and given they make zero operating profits, Eq. (2) shows the maximum a firm can pay their entrepreneurs (M factors) as a function of market access MA
- Three forces are at work in this model
  - **Market size effect (+):** $E_s P_s^{\sigma-1} \nearrow \Rightarrow w_{H,r} \nearrow$
    Income is spent locally, increasing sales, profits, higher nominal wages and therefore even more H_r
  - **Market-crowding effect (–):** $H_r \nearrow \Rightarrow w_{H,r} \searrow$
    Higher number of entrepreneurs leads to fiercer competition, smaller market share, decreasing prices and profits
  - **Cost-of-living effect (+):** $H_r \nearrow \Rightarrow P_r \searrow$ and $w_{H,r} \nearrow$
    A higher number of entrepreneurs means a higher number of varieties, therefore reducing the price index and increase real wages

Wage equation (II/II)

Main goal:

- Estimate wages as function of market access

$$\ln(w_{H,r}) = \gamma + \varphi \ln(MA_r) + \varepsilon_r \tag{3}$$

Problem:

- Market access is not observable: has to be constructed

Proposed solution:

- Use similarity of trade equation to obtain estimates of market access
- 2 stages process developed by Redding and Venables (2004)

The Trade Equation (I/II)

Value of demand by region s for all varieties produced in r (export value) is defined as

$$n_r p_r x_{rs} = \underbrace{n_r p_r^{1-\sigma}}_{\text{supply capacity}} \quad \tau_{rs}^{1-\sigma} \quad \underbrace{E_s P_s^{\sigma-1}}_{\text{market capacity}} \tag{4}$$

and can be reformulated in order to correspond to the multiplicative gravity specification of regional trade

$$n_r p_r x_{rs} = \frac{(n_r p_r \bar{x}) \mu E_s}{E} \left(\frac{\tau_{rs}}{P_s \Pi_r} \right)^{1-\sigma} \tag{5}$$

where $\Pi_r^{1-\sigma} \equiv \sum_s \mu \frac{E_s}{E} P_s^{\sigma-1} \tau_{rs}^{\sigma-1}$ is the outward multilateral trade resistance term and P_s the inward multilateral resistance term (Anderson and Wincoop, 2003).

The Trade Equation (III/III)

- Assuming that $n_r p_r \bar{x} \propto E_r$ and $\mu E_s \propto E_s$, as well as taking the logarithms on both sides, we obtain the following econometric specification of the trade equation

$$\ln\left(\frac{\tilde{x}_{rs}}{E_r E_s}\right) = c + (1-\sigma)\ln\left(P_s\right) + (1-\sigma)\ln\left(\Pi_r\right) + (1-\sigma)\ln\left(\tau_{rs}\right) + \varepsilon_{rs} \quad (6)$$

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The Trade Equation (III/III)

- τ_{rs} is approximated by a time-invariant distance deterrence function D_{rs} construed to include spatial, institutional and cultural separation factors:

$$D_{rs} = d_{rs}^{\gamma_1} \exp(\gamma_2 b_{rs} + \gamma_3 c_{rs} + \gamma_4 l_{rs}) \tag{7}$$

- Variables:
  - Geographical distance measured in terms of i) great circle distance, ii) population-weighted great circle distance and iii) travel time (in sec.) between regions (d_{rs})
  - Border effect (institutional barrier) proxied by a intra–national dummy variable (b_{rs})
  - Country Contiguity (c_{rs})
  - Cultural barriers proxied by a language area dummy variable (l_{rs})
- The empirical trade equation is written:

$$\ln\left(\frac{\tilde{x}_{rs}}{GVA_r GVA_s}\right) = \kappa + \delta_1 \xi_r + \delta_2 \xi_s + \gamma_1 \ln(d_{rs}) + \gamma_2 b_{rs} + \gamma_3 c_{rs} + \gamma_4 l_{rs} + \varepsilon_{rs}$$

Trade Data

- Key aspects
  - Constructed bi-regional trade data
  - 240 NUTS2 regions (2006 classification)
  - Year: 2010
  - Six broad sectors, CPA 2002 classification
- Source
  - Constructed by Thissen et al. (2013a,b,c)
  - Provided by the JRC-IPTS (Sevilla), European Commission - RHOMOLO Model
    - Based on an collaboration between IPTS and COST Action IS1104: "The EU in the new complex geography of economic systems: Models, tools and policy evaluation"

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Trade Data

- Construction
  - Consistent national trade data set
    - WIOD national supply and use tables, 2000 as starting point
    - Adjusted for re-exports (only partly done by WIOD)
    - Consistency of bilateral flows (exports A to B = imports B from A)
    - Total exports and imports add up to reported national accounts (WIOD)
  - Regional supply and use tables (goal: total exports and imports per region per product)
    - Regional data on production, investment, income (Eurostat)
    - National numbers (WIOD) multiplied with regional shares $\Rightarrow$ full consistency
    - Structure of the regional tables is the same as nationals (weighted with regional data)
  - Trade between regions
    - Constrained quadratic minimization
    - PBL regional trade data set as prior see (Thissen et al. (2013a))
    - Consistency and adding-up constraints

Results Trade Equation (I/III)

Table: Pseudo-Poisson Maximum Likelihood Estimation of the trade equation for (1) logged great circle distance (2) logged population-weighted great circle distance, (3) logged travel time. Observations $n = 240 \times 240 = 57,600$. Number of 0s$= 54$

	(1) GCD	(2) POPGCD	(3) TT
Dependent Variable: Exports from r to s weighted by GVA_r and GVA_s			
Distance d_{rs}	-0.959^{***}	-1.378^{***}	-0.951^{***}
	(0.0404)	(0.112)	(0.0400)
Border b_{rs}	-1.880^{***}	-1.740^{***}	-1.910^{***}
	(0.270)	(0.319)	(0.262)
Contiguity c_{rs}	-0.857^{***}	-0.454^{**}	-0.854^{***}
	(0.182)	(0.210)	(0.178)
Language l_{rs}	-0.083	0.198	-0.089
	(0.115)	(0.128)	(0.120)
α	9.641^{***}	13.940^{***}	13.380^{***}
	(0.400)	(0.923)	(0.434)
R^2	0.607	0.532	0.609

Notes All models include exporter (240) and importer (240) fixed effects.
Model specification: (1) logged great circle distance, (2) logged population-weighted great circle distance, (3) logged travel time. b_{rs}: 1 if separated by a country border, c_{rs}: 1 if share a common border, l_{rs}: 1 if different spoken languages.
*** p<0.01, ** p<0.05, * p<0.1

Construction of MA

- Estimated parameters of the trade equation are then used to construct measure(s) of MA.
- Following Redding and Venables (2004), MA is obtained by

$$\widehat{MA}_r = \underbrace{\hat{\xi}_r(D_{rr})^{\hat{\gamma}} GVA_r}_{\text{domestic market access}} + \underbrace{\sum_{s \neq r} \hat{\xi}_s(D_{rs})^{\hat{\gamma}} GVA_s}_{\text{foreign market access}} \tag{9}$$

  where $\hat{\boldsymbol{\gamma}} = \hat{\gamma}_1, \hat{\gamma}_2, \ldots, \hat{\gamma}_5, \hat{\gamma}_6$.

- We construct three measures of MA:
  - ▷ $MA^{(GCD)}$ built with great circle distance as a proxy of geographical distance
  - ▷ $MA^{(POPGCD)}$ with population-weighted great circle distance
  - ▷ $MA^{(TT)}$ with travel time

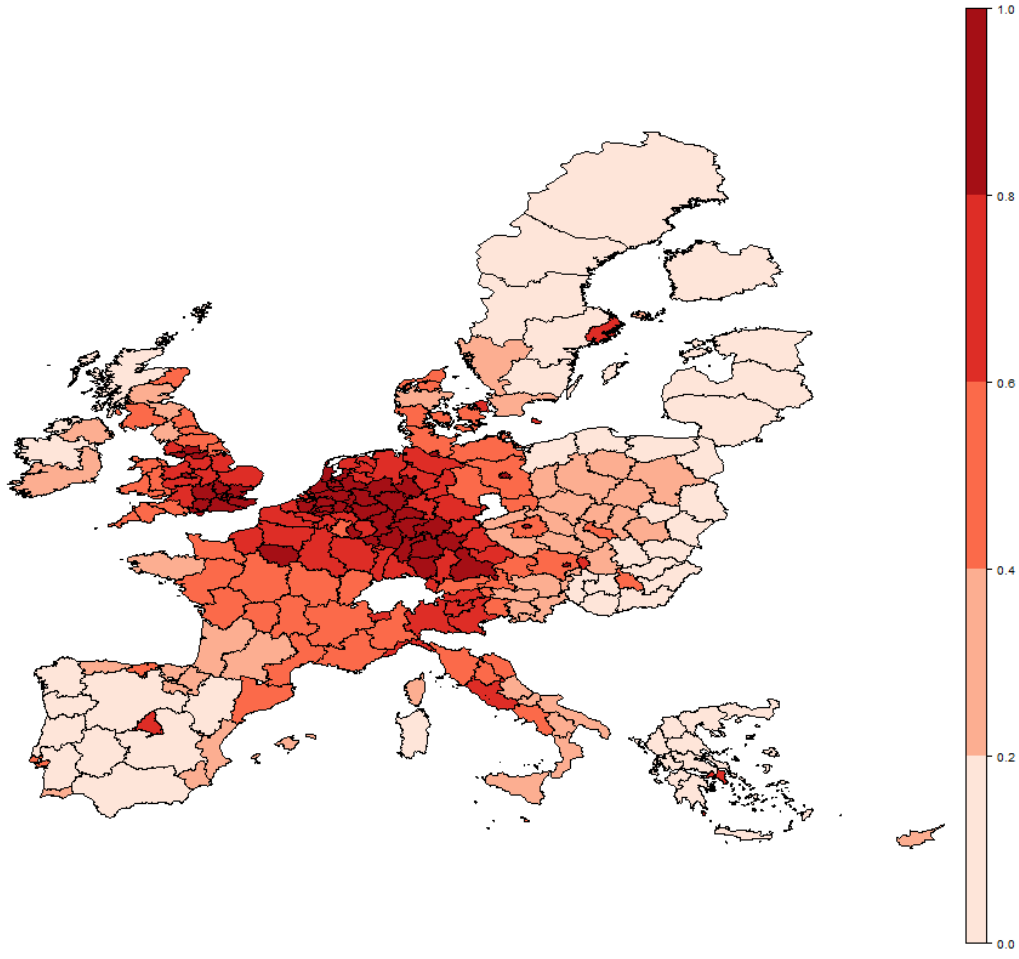

Figure: Market access (POSET mean of three measures), sector CDE as defined in Eq. (9)

	MA	Domestic MA	Foreign MA	DMA/MA
MA (GCD)	84194.720	45067.670	39127.050	0.419
MA (POPGCD	614979.300	383124.300	231855.000	0.418
MA (TT)	36141.550	21346.700	14794.850	0.399

The Wage Equation

- We estimate the wage equation defined in Eq. (3) by OLS, using GVA per capita weighted by Average Working Hours as a proxy of $w_{H,r}$

- Controlling for human capital accumulation effect on wages and for country labour market characteristics we add a set of control variables:
  - ▷ Share of tertiary Education, Patents issued in 2010
  - ▷ Product market regulation (POSET index)
  - ▷ Unemployment rate, Net replacement rate

- This yields the following specification:

$$\ln(GVA_r^{(p.c.)}) = \gamma + \varphi \ln(\widehat{MA}_r) + \boldsymbol{x}_r\boldsymbol{\theta} + \varepsilon_r \tag{10}$$

- Additionally, controlling for simultaneity bias in the definition of MA, we use the following set of instruments
  - ▷ Weighted distance to importing partners
  - ▷ Weighted real exchange rate
  - ▷ Distance to Luxembourg

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The Wage Equation

$$\ln(GVA_r^{(p.c.)}) = \underset{(0.442)}{-4.759^{***}} + \underset{(0.038)}{0.407^{***}} \ln(\widehat{\bar{MA}}_r) + \varepsilon_r$$

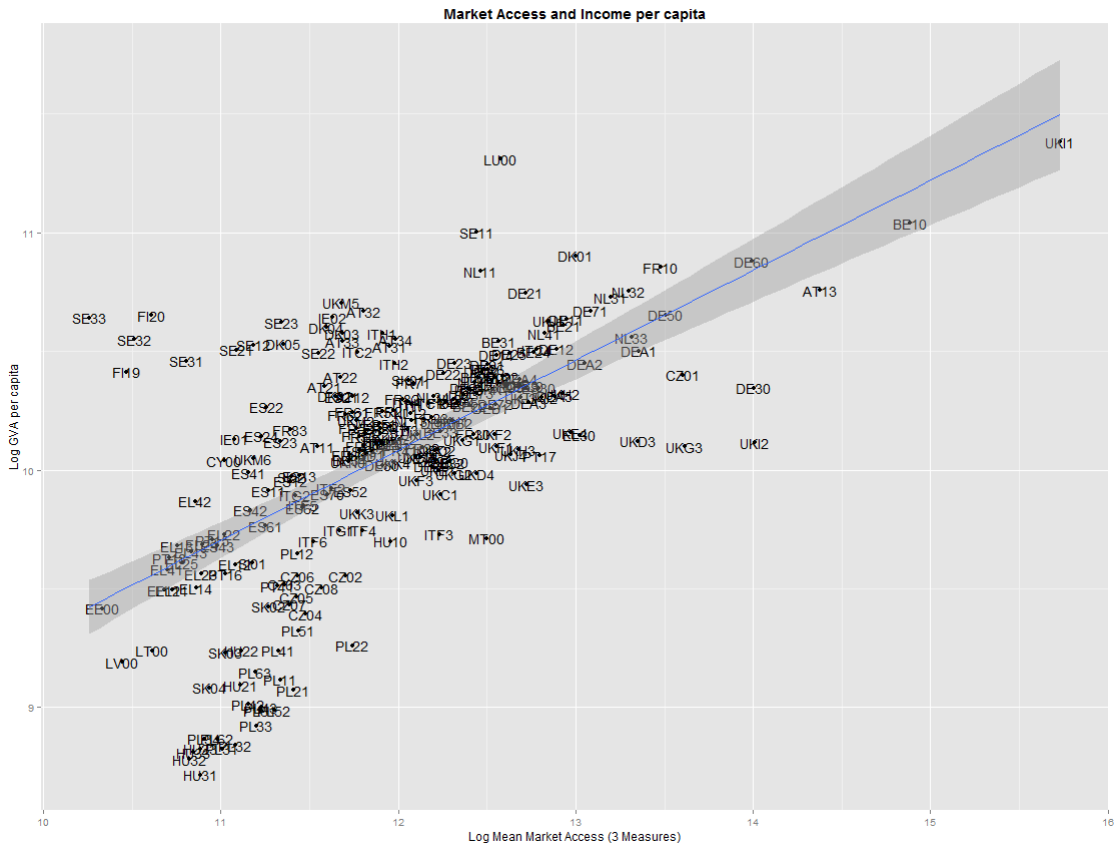

Figure: Market access (mean of three measures), sector CDE as defined in Eq. (9)

Table: OLS estimation of the Wage equation with three market access measures. Observations: 229

MA Proxy:	(1) GCD	(2) POPGCD	(3) TT
Dependent Variable: GVA p.c. (weighted by Average Working Hours)			
Market Access	$0.153***$	$0.195***$	$0.194***$
	(0.044)	(0.038)	(0.039)
Tertiary Education	$0.298***$	$0.242***$	$0.244***$
	(0.079)	(0.075)	(0.073)
Product Market Regulation	$-0.387***$	$-0.337***$	$-0.345***$
	(0.120)	(0.109)	(0.113)
Patents issued in 2010	$1.263***$	$1.268***$	$1.250***$
	(0.293)	(0.268)	(0.285)
Unemployment	$-1.312**$	$-1.395***$	$-1.448***$
	(0.544)	(0.497)	(0.504)
Net Replacement Rate	$0.856***$	$0.838***$	$0.821***$
	(0.089)	(0.085)	(0.082)
R^2	0.711	0.735	0.732

Notes: All models include a constant. Table reports the parameter estimates for the three different market access measures obtained from the stage one with (1) GCD: great circle distance as proxy of geographical distance (in km.), (2) POPGCD: population-weighted great circle distance (in km.) and (3) TT: travel time (in seconds). Bootstrapped standard errors (500 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table: 2SLS estimation of the Wage equation with three measures of market access measures. Observations: 229

MA Proxy:	(1) GCD	(2) POPGCD	(3) TT
Dependent Variable: GVA p.c. (weighted by Average Working Hours)			
Market Access	0.270**	0.210***	0.225***
	(0.120)	(0.075)	(0.075)
Tertary Education	0.245***	0.201***	0.195***
	(0.073)	(0.069)	(0.069)
Product Market Regulation	−0.175	−0.316**	−0.297*
	(0.250)	(0.158)	(0.166)
Patents issued in 2010	0.881*	1.233***	1.172***
	(0.456)	(0.318)	(0.305)
Unemployement	−1.436***	−1.385***	−1.462***
	(0.552)	(0.525)	(0.535)
Net Replacement Rate	0.867***	0.839***	0.818***
	(0.096)	(0.091)	(0.091)
Hansen-J	0.660	0.442	0.442
Endogenous test	0.083*	0.622	0.396
C-D F test	14.715	14.703	13.680
R^2	0.696	0.735	0.730

Notes: All models include a constant. Table reports the instrumented parameter estimates for the three different market access and the three Harris market potential measures obtained with (1) great circle distance (in km.), (2) population-weighted great circle distance (in km.) and (3) travel time (in minutes) as measure of geographical distance. Instruments are Weighted distance to Importing partners, weighted Real Exchange Rate and Distance to Luxembourg. Ter.Educ.: tertiary education rate, PMR: product market regulation, Patents: patents issued in 2010, Unemp.: Unemployment rate, NRR: net replacement rate. Bootstrapped standard errors (500 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Robustness Checks

- Possible country disparities in Market Access effect on income
- As seen on the scatterplot:
  - ▷ Scandinavian countries have high income per capita but low Market Access (remote regions)
  - ▷ Market Access effect for CEE countries seems high
- We estimate Eq. (10) and interact MA with three dummies for
  i) CEE countries,
  ii) Scandinavian countries and
  iii) Capital regions
  to determine whether the Market Access effect differs

Table: OLS estimation of the Wage equation with three measures of market access measures and controls for Scandinavian countries, CEE countries and Capitals. Observations: 229

	(1) GCD	(2) POPGCD	(3) TT
Dependent Variable: GVA p.c. (weighted by Average Working Hours)			
Market Access	0.195***	0.213***	0.218***
	(0.031)	(0.034)	(0.036)
Market Access * Eastern Countries	0.318***	0.259**	0.259*
	(0.090)	(0.121)	(0.135)
Market Access * Scandinavian Countries	−0.214*	−0.202**	−0.173
	(0.123)	(0.094)	(0.106)
Market Access * Capitals	−0.086	−0.086	−0.086
	(0.082)	(0.062)	(0.074)
Tertiary Education	0.095	0.069	0.064
	(0.065)	(0.060)	(0.061)
Product Market Regulation	−0.331***	−0.342***	−0.341***
	(0.088)	(0.085)	(0.083)
Patents Issued in 2010	0.783***	0.883***	0.832***
	(0.182)	(0.183)	(0.181)
Unemployment	−0.917**	−1.011***	−1.080***
	(0.413)	(0.358)	(0.372)
Replacement Rate	0.384***	0.412***	0.384***
	(0.090)	(0.079)	(0.087)
F-test EAST	0.000	0.000	0.000
F-test SCAN	0.879	0.900	0.658
R-squared	0.877	0.875	0.875

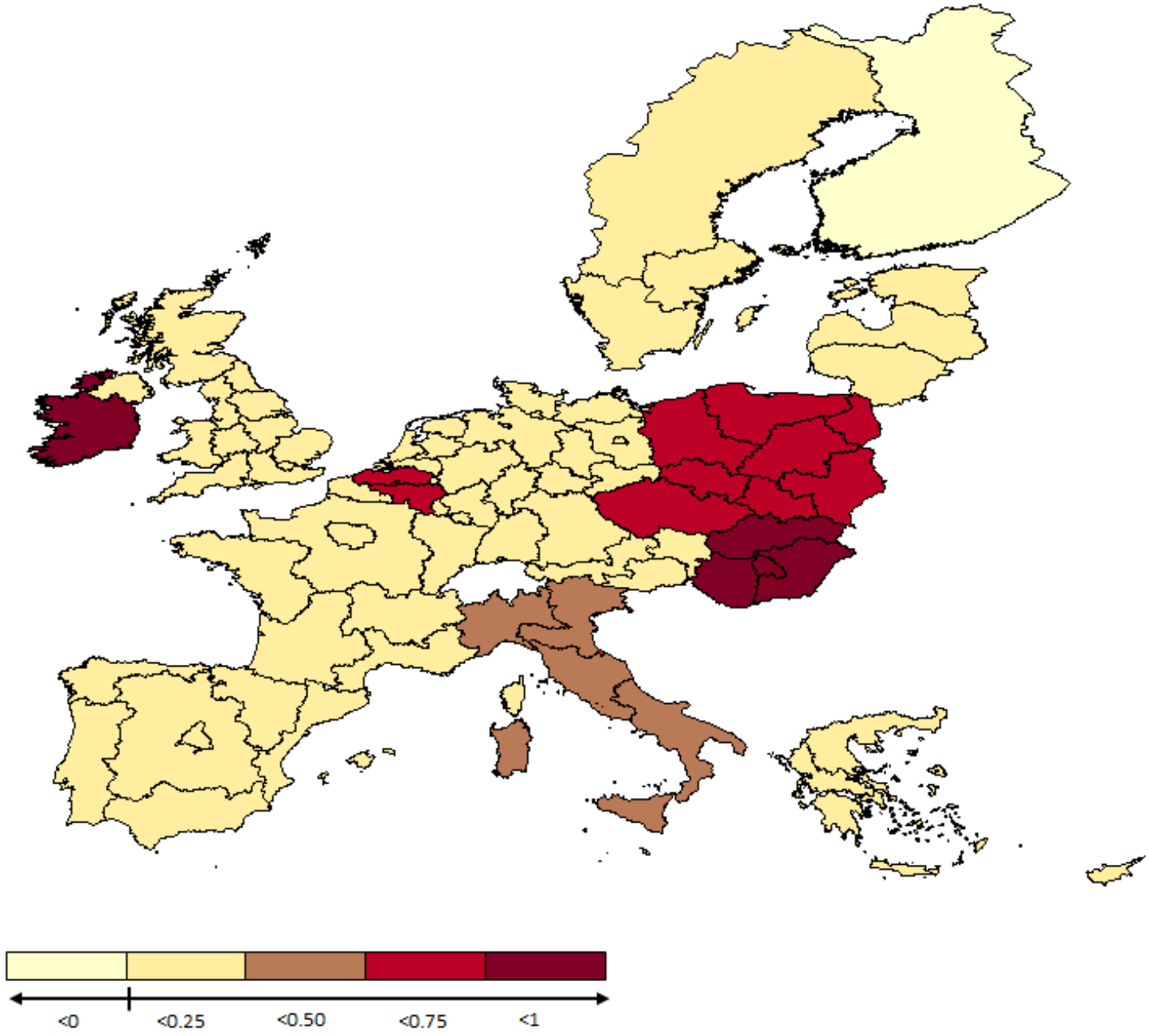

Figure: Country Market Access (POSET mean of three measures)

Concluding Remarks

- Using a new consistent regional trade data set, we were able to show that there seems to be a quite robust role for economic geography in explaining income differences among European regions.
- The results are robust to cross-country variations and to different specifications of the trade equation
- The results are comparable to former empirical studies (using data at the country level): Redding and Venables (2003), Hanson (2005), Breinlich (2006), Hering and Poncent (2009) and Head and Mayer (2011)

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Open Questions

- Spatial econometric analysis using weighted trade costs as a spatial weight matrix
- Indirect channels of market access on wages (physical capital accumulation, human capital accumulation, etc.)
- Effect of Market Access in European Regions over time (panel analysis)

Thank you for your attention.

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