Online Appendix:

EU Metro Regions

As discussed in the text, we use the recent EC/OECD specification of metropolitan regions that provide a consistent definition for the whole EU. Details on how these are constructed can be found in OECD (2019). The following text, taken from p.3 of that report, provides a short definition.

A functional urban area can be defined in four steps:

1. Identify an urban centre: a set of contiguous, high density (1,500 residents per square kilometre) grid cells with a population of 50,000 in the contiguous cells;
2. Identify a city: one or more local units that have at least 50 percent of their residents inside an urban centre;
3. Identify a commuting zone: a set of contiguous local units that have at least 15 percent of their employed residents working in the city;
4. A functional urban area is the combination of the city with its commuting zone.

We use the version that defines metropolitan-regions ('metros') in terms of NUTS3 or aggregates of NUTS3, as appropriate. Table A1 provides a list of the metro-regions by country, while table A2 provides basic descriptive statistics.

Table A1:
Metros by country

AT	Lübeck	**FI**	Palermo	Ploieşti
Graz	Magdeburg	Helsinki	Parma	Timisoara
Innsbruck	Mainz	Tampere	Prato	**SE**
Linz	Mannheim-Ludwigshafen	Turku	Reggio nell'Emilia	Göteborg
Salzburg	Mönchengladbach	**FR**	Roma	Malmö
Wien	München	Amiens	Taranto	Stockholm
BE	Münster	Angers	Torino	Uppsala
Antwerpen	Neubrandenburg	Annecy	Venezia	**SI**
Bruxelles / Brussel	Nürnberg	Besanþon	Verona	Ljubljana
Charleroi	Offenburg	Bordeaux	**LT**	Maribor
Gent	Oldenburg	Brest	Kaunas	**SK**
Liège	Osnabrück	Caen	Vilnius	Bratislava
BG	Paderborn	Clermont-Ferrand	**LU**	Košice
Burgas	Pforzheim	Dijon	Luxembourg	**UK**
Plovdiv	Regensburg	Grenoble	**LV**	Aberdeen
Sofia	Reutlingen	Le Mans	Riga	Belfast
Varna	Rosenheim	Lille - Dunkerque - Valenciennes	**MT**	Blackburn - Blackpool - Preston
CY	Rostock	Limoges	Valletta	Bournemouth
Lefkosia	Ruhrgebiet	Lyon	**NL**	Bradford
CZ	Saarbrücken	Marseille	Amsterdam	Brighton and Hove
Brno	Schweinfurt	Montpellier	Arnhem - Nijmegen	Bristol
Ostrava	Schwerin	Mulhouse	Breda	Cambridge
Plzen	Siegen	Nancy	Eindhoven	Cardiff

Praha	Stuttgart	Nantes	Enschede	Cheshire West and Chester
DE	Ulm	Nice	Groningen	Colchester
Aachen	Wetzlar	Nimes	Leeuwarden	Coventry
Aschaffenburg	Wiesbaden	Orléans	Leiden	Derby
Augsburg	Wuppertal	Paris	Rotterdam	Doncaster
Bayreuth	Würzburg	Pau	Tilburg	Dundee
Berlin	Zwickau	Perpignan	Utrecht	Edinburgh
Bielefeld	**DK**	Poitiers	Zwolle	Exeter
Bocholt	Aalborg	Reims	s' Gravenhage	Glasgow
Bonn	København	Rennes	**PL**	Ipswich
Braunschweig-Salzgitter-Wolfsburg	Odense	Rouen - Le Havre	Bialystok	Kingston upon Hull
Bremen	Århus	Saint-Etienne	Bielsko-Biala	Kirklees
Bremerhaven	**EE**	Strasbourg	Bydgoszcz - Torún	Leeds
Darmstadt	Tallinn	Toulouse	Czestochowa	Leicester
Dresden	**EL**	Tours	Gdansk	Liverpool
Düren	Athina	**HR**	Katowice	London
Düsseldorf	Thessaloniki	Grad Zagreb	Kielce	Manchester
Erfurt	**ES**	Split	Kraków	Medway
Flensburg	A Coruña	**HU**	Lublin	Middlesbrough
Frankfurt am Main	Alicante/Alacant - Elche/Elx	Budapest	Lódz	Newcastle upon Tyne
Freiburg im Breisgau	Barcelona	Debrecen	Olsztyn	Northampton
Gießen	Bilbao	Miskolc	Opole	Norwich
Görlitz	Cádiz	Pécs	Poznan	Nottingham
Göttingen	Córdoba	Székesfehérvár	Radom	Oxford
Halle an der Saale	Granada	**IE**	Rzeszów	Plymouth
Hamburg	Guipúzcoa	Cork	Szczecin	Portsmouth
Hannover	Madrid	Dublin	Tarnów	Sheffield
Heidelberg	Murcia - Cartagena	**IT**	Warszawa	Southampton
Heilbronn	Málaga - Marbella	Bari	Wroclaw	Stoke-on-Trent
Hildesheim	Oviedo - Gijón	Bergamo	**PT**	Sunderland
Ingolstadt	Palma de Mallorca	Bologna	Coimbra	Swansea
Iserlohn	Pamplona/Iruña	Brescia	Lisboa	West Midlands urban area
Kaiserslautern	Santander	Cagliari	Porto	
Karlsruhe	Sevilla	Catania	**RO**	
Kassel	Valencia	Firenze	Brasov	
Kiel	Valladolid	Genova	Bucuresti	
Koblenz	Vigo	Messina	Cluj-Napoca	
Konstanz	Vitoria/Gasteiz	Milano	Constanta	
Köln	Zaragoza	Napoli	Craiova	
Leipzig		Padova	Galati	
			Iasi	

Table A2

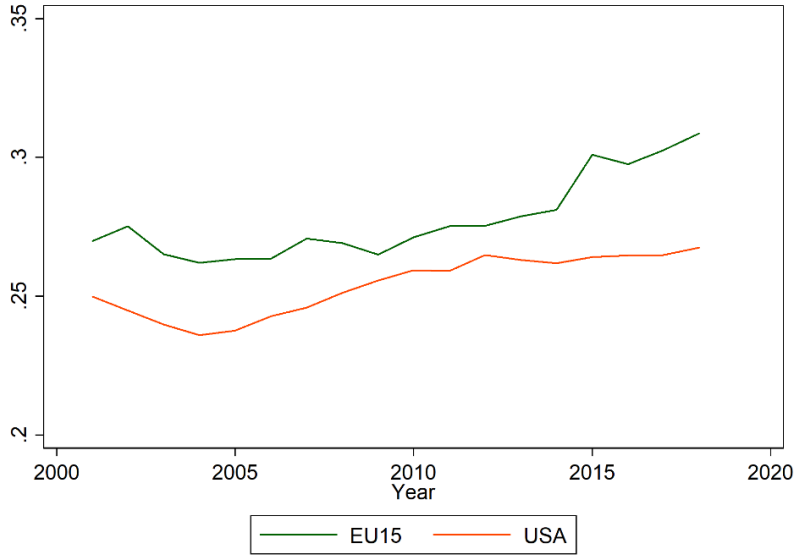
Summary statistics EU metros

	Obs.	Mean	Std.dev.	Min	Max
Year 1980					
Population (1000)	215	985	1,252	205	11,206
GDP per capita	215	7,879	2,464	2,476	19,608
Employment (1000)	215	422	607	91	6,016
Year 1990					
Population (1000)	215	1,015	1,282	212	11,254
GDP per capita	215	16,580	4,375	8,384	30,685
Employment (1000)	215	457	654	100	6,417
Year 2000					
Population (1000)	226	1,044	1,328	226	11,932
GDP per capita	226	23,364	5,983	11,538	48,663
Employment (1000)	226	491	690	89	6,616
Tertiary share (%)	212	21.4	6.5	3.3	38.5
Worklessness share (%)	211	30.7	9.7	8.5	58.7
Year 2005					
Population (1000)	279	1,042	1,270	236	12,316
GDP per capita (1000)	279	24,522	8,197	6,254	57,328
Employment (1000)	279	493	657	98	6,692
Tertiary share	271	23.0	7.4	7.8	42.3
Worklessness share	264	31.0	9.5	0.9	57.1
Year 2015					
Population (1000)	279	1,088	1,366	248	13,839
GDP per capita	279	30,182	9,839	11,210	76,152
Employment (1000)	260	522	725	96	7,874
Tertiary share (%)	260	30.3	8.5	11.57	52.4
Worklessness share (%)	260	28.2	11.6	-4.3	57.3

Notes: We summarize the data for 1980-2000 for EU15 metros and 2000-15 for EU28 metros. Until 1990 we lack data for 11 East-German metros. The share of tertiary education is imputed using NUTS2 level data and is available only since 2000. Worklessness is computed using employment data and population counts for the age group 15-64 which is available since 2000. We lack data on employment for metros in Lithuania and Poland. A negative value of workessness share applied in Luxembourg where cross border commuting is common.

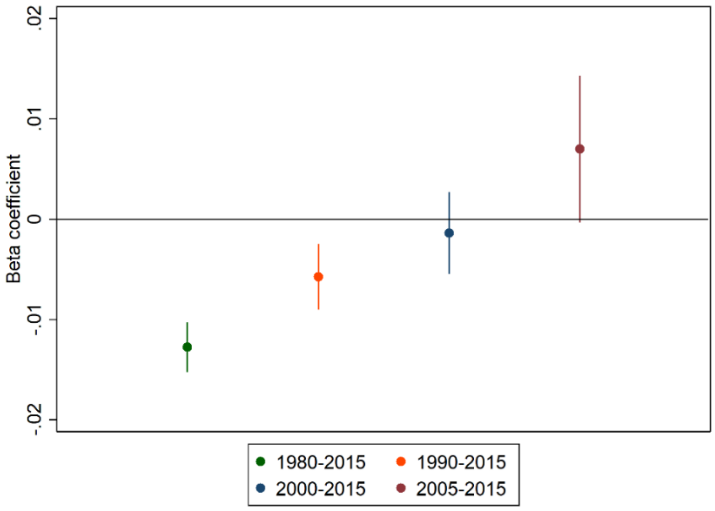
Spatial Disparities in Europe: Additional Figures

Figure A1
Coefficient of Variation of GDP per capita – Metropolitan areas EU15, and US



Source: Authors
Notes: Calculations based on OECD data and the definition of OECD metro areas.

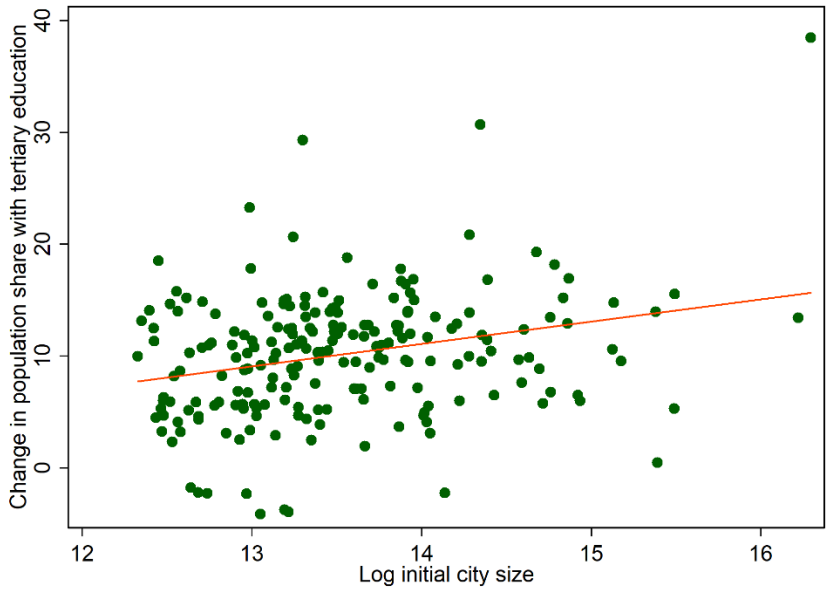
Figure A2: Beta Convergence– EU15 Metro Regions



Notes: Authors' own calculations. We report the coefficients and 95% confidence intervals for standard beta convergence regressions. For the EU28, we can only compute the beta coefficient for 2005 to 2015. Consistent with the CV, we observe significant beta convergence (coefficient 0.031, significant at the 1 percent level) as the metros of the new EU member states catch up to the EU15.

Figure A3

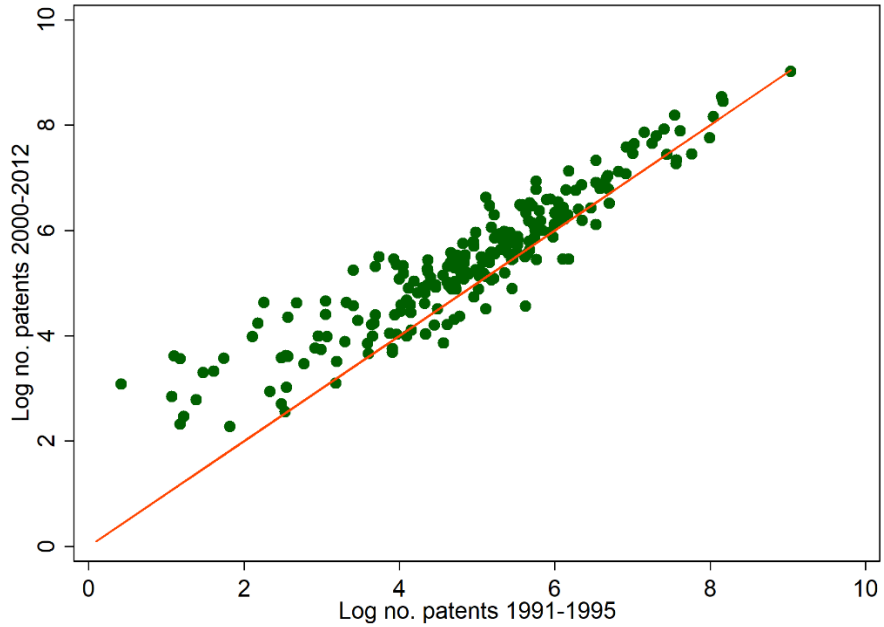
Change in the share of population with tertiary education 2015-2000 – EU15 Metros



Notes: The coefficient for the linear regression illustrated by the straight line is 1.99 (significant at the 1 percent level). With country fixed effects the coefficient is 1.36. If we use the log of initial population with tertiary education instead of log of population the coefficient is 1.62 (with country fixed effects).

Figure A4

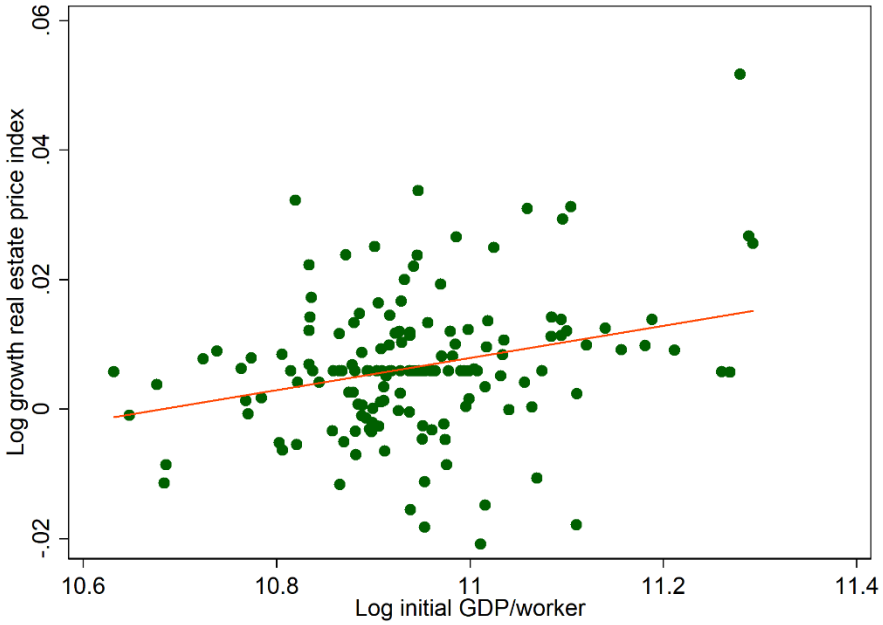
Change in the number of patents 2010(12)-1985(81) – EU15 Metros



Notes: The straight line represents the 45-degree line.

Figure A5

Change in real estate price index and initial productivity – EU15 Metro areas



Notes: The coefficient for the linear regression illustrated by the straight line is 0.025 (significant at the 1 percent level). The scatter plot and the regression are conditional on country fixed effects. We use the period 2005-2015. For Italy we only have data until 2011.

Evidence on Agglomeration Economies

Table A3: **Micro level evidence on agglomeration economies – EU15 in 2015**

VARIABLES	(1) Log income	(2) Log income	(3) Log income
Log age	4.633***	3.724***	3.726***
	(0.0703)	(0.0677)	(0.0677)
Log age ^2	-0.611***	-0.473***	-0.473***
	(0.0108)	(0.0104)	(0.0104)
Female	-0.188***	-0.230***	-0.230***
	(0.00442)	(0.00424)	(0.00424)
City	0.115***	0.0646***	0.0529***
	(0.00489)	(0.00469)	(0.00617)
Tertiary Education		0.397***	0.388***
		(0.00436)	(0.00531)
Tertiary Education x City			0.0260***
			(0.00887)
Constant	1.677***	3.014***	3.013***
	(0.114)	(0.109)	(0.109)
Observations	81,349	81,349	81,349
R-squared	0.395	0.451	0.451

Notes: City is unity if the individual lives in a high-density area according to Eurostat's Degree of urbanisation (DEGURBA) classification. Tertiary is unity if the individual has completed the first stage of tertiary education (not leading directly to an advanced research qualification) or the second stage of tertiary education (leading to an advanced research qualification). We drop self-employed and family workers. Standard errors in parentheses; all specifications include country fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table A4: **Micro level evidence on sorting by education – EU15 in 2015**

VARIABLES	(1) City	(2) City	(3) City
	Linear models		Logit
Tertiary Education	0.0942***	0.107***	0.0913***
	(0.00200)	(0.00192)	(0.00195)
Log age	-0.0292*	-0.00830	-0.0274*
	(0.0154)	(0.0146)	(0.0154)
Log age ^2	-0.000394	-0.00328	-0.000701
	(0.00236)	(0.00223)	(0.00236)
Constant	0.387***	0.347***	
	(0.0244)	(0.0231)	
Observations	275,585	275,585	275,585
R-squared	0.010	0.116	
Country fixed effects	No	Yes	No

Notes: City is unity if the individual lives in a high-density area according to Eurostat's Degree of urbanisation (DEGURBA) classification. Tertiary indication is unity if the individual has completed the first stage of tertiary education (not leading directly to an advanced research qualification) or the second stage of tertiary education (leading to an advanced research qualification). Column 3 reports the marginal effects evaluated at the mean of each variable. Standard errors in parentheses; all specifications include country fixed effects. *** p<0.01, ** p<0.05, * p<0.1

EU NUTS2 Regions

Although we have reservations about the use of NUTS2 regions, as discussed in the main text, convergence across NUTS2 regions is an important EU policy aim. One important headline indicator of disparities, because it determines eligibility for the most important EU regional funds, is whether a NUTS2 region has GDP per capita less than 75 percent of the EU average. In the EU15 in 2015, 46 NUTS2 regions out of 204, home to 19 percent of the population, were 75 percent of the average GDP per capita. In the EU28, the corresponding figures were 72 out of 262 and 26 percent of the population. For comparison, 6 US states, home to 6 percent of the population, have GDP per capita less than 75 percent of the US average.

In 2015, the coefficient of variation (CV) in GDP per capita was 0.31 for EU15 NUTS2 regions and 0.37 for EU28 NUTS2 regions.[1] As for metros, variation across EU15 and EU28 countries explains around half of this variation (43 percent and 51 percent, respectively).[2] For the EU 15, regional disparities fell in the 1980s, stabilised in the 1990s before falling again from around 2000 to the mid-2000s (see figure A6).[3] Overall, the coefficient of variation fell from 0.31 in 1980 to 0.26 in 2003. The double-dip recession of 2009 and 2012 reversed this long-term trend and by 2015 regional disparities were almost back to their 1980 levels. For the EU28 we have a much shorter time series. Starting in 2004,

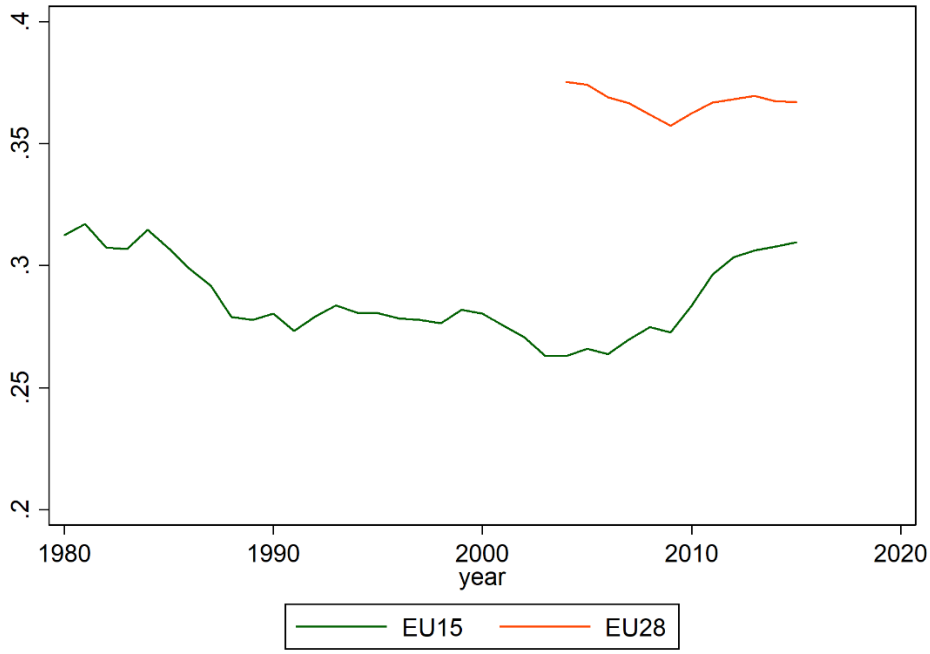
[1] As discussed in the main text, in 2015, aggregating the five London NUTS2 reduces the EU15 coefficient of variation by 29 percent from 0.44 to 0.31. For the population weighted version of the coefficient of variation the reduction is 18 percent. We therefore aggregate the London NUTS2.

[2] These figures are based on decomposing the squared coefficient of variation.

[3] The figures report the unweighted coefficients of variation. The overall levels and trends for the EU15 and EU28 are largely unchanged if we weight by population.

when the new members joined the EU, the coefficient of variation fell from 0.38 to a low of 0.36 in 2009 and then remained at similar levels until 2015.

Figure A6
Variance coefficient of GDP per capita – NUT2 regions



Notes: Authors own calculations based on NUTS2 regions as described in the text.

Data Sources

Our main data is from Eurostat, the EU Joint Research Centre's (EUJRC) regional database, and the OECD's metropolitan database. Access to these databases is obtained via the links and contacts provided in the references below.[4] We use the 2016 NUTS3 level classification. For data provided according to the 2010 or 2013 NUTS classification we apply the mapping provided by EUJRC to assign the corresponding 2016 NUTS3 regions (https://urban.jrc.ec.europa.eu/nutsconverter/#/). We exclude the French overseas territories, the Canary Islands, the autonomous regions Ceuta and Melilla, and the autonomous regions Azores and Madeira. We restrict the data to the EU15 for the period 1980-2003 and cover the EU28 from 2004 to 2015.

Information about tertiary education rates, used to produce column 2 of Table 1, is provided by Eurostat at NUTS2 level and we assign each NUTS3 region the education rate of the corresponding upper tier NUTS2 region.

Information about real estate price indices, used to produce Figure 3b, is available for France, Germany, Italy, Spain, and England. We collect this information from several sources. Data for France comes from Meilleurs Agents and covers Paris, top10 and top50 cities between 2007 and 2015. We obtained this data directly from the webpage cited in the references. The index for

[4] The EUJRC have updated their data since this paper was accepted and the original files used to produce these figures are no longer available online. The older version used to produce the paper can be obtained by contacting EUJRC.

Germany is based on the Regional Real Estate Price Indices for Germany (RWI-GEO-REDv1) constructed by Boelmann and Schaffner (2019) and covers real estate advertisement data for individual units between 2007 and 2019 which we assigned to NUTS3 regions. These data are confidential but may be obtained with Data Use Agreements with the Research Data Center Ruhr at the RWI (https://en.rwi-essen.de/forschung-und-beratung/fdz-ruhr/datenangebot/regionaldaten/rwi-geo-red). Information for Italy is obtained from the Osservatorio Mercato Immobiliare at the Agenzia delle Entrate. This dataset contains transaction-level data on residential real estate sales in Italian provinces between 2007 and 2011. The data are confidential but may be obtained with Data Use Agreements with the Agenzia delle Entrate (for contact information see link in the references below). For Spain we use the Indice de Mercados Immobiliarios Espanoles provided by TINSA on the city level for 2001 to 2015. These data are directly obtained from their website. The data for English cities (we lack Scotland, Northern Ireland, and Wales) is based on Hilber and Mense (2019) covering Local Planning Authorities between 2000 and 2015. The data are confidential and can only be obtained via the authors.

Micro level information on earnings, education and residential information, used to estimate the mincer regressions reported in the text, comes from the European Union Statistics on Income and Living Conditions (EU-SILC) provided by Eurostat. We focus in our analysis on the cross-section for 2015 while the results are robust to using different years (in principle the data is available since 2004 with some differences in the coverage of countries). These data are confidential. Eurostat grants access to the dataset for scientific purposes Researchers interested in access to the data find the relevant information to apply for access at https://ec.europa.eu/eurostat/documents/203647/771732/How_to_apply_for_microdata_access.pdf.

Datasets

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