Socio-Demographic Change and Urban Governance
as Drivers of Land Use:
Comparing United States and Europe

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Abstract

This paper estimates the local effects of urban governance structure and socio-demographic characteristics on land use patterns of large urban areas in the contexts of US and Europe. In particular, we exploit data on more 180 metropolitan areas across the years 2000, 2006 and 2012. Our proxy of the governance structure of metropolitan areas is the number of administrative units with decision power on land use. We estimate the effect of governance on land use controlling for polycentricity, that accounts for the interplay between municipalities within a metropolitan area. Although our model highlights differences between the two broad regions, we find that the fragmentation index is a major driver of urban expansion in both areas, United States and Europe. Evidence suggests that a concentration of the administrative power on land use or a coordination of planning policies at a metropolitan scale results in a lower land consumption.

1 Introduction

Urban sprawl has become an increasingly common feature of the modern cities in almost all regions of the world, although with substantial differences among geographical contexts and institutional settings. Nowadays, more than a half of the world population lives in metropolitan areas and the total urban population will soon approach 80% of the total, with significant impacts on land use. This trend poses great challenges to the management of the cities of tomorrow, especially of the metropolitan areas, and yet little is known about how the governance of metropolitan cities affects the dynamics of land use.

The spatial expansion of cities comes in tandem with negative effects such as the degradation of natural resources (Jaeger & Schwick 2014), the loss of soil biodiversity (Mcdonald et al. 2008, Turbé et al. 2010), the reduction of groundwater regeneration (Siedentop & Fina 2012), the interruption of ecosystem services supply (Mcdonald et al. 2008), and the loss of soil carbon storage (Seto et al. 2012). For this reason urban expansion is commonly perceived as undesirable and many refer to urban sprawl as the enlargement of cities and attribute a negative meaning. Economists contend that the spatial expansion of cities is, at least in part, a result of market forces driving people choices about housing and commuting (Brueckner & Fansler 1983). In the tradition of the AMM (Alonso Mills and Muth) model, under the hypothesis of monocentric urban development, the relationship between the spatial extent of cities and its determinants can be tested regressing the total urbanized area on population, median income, transportation costs and the value of agricultural land (Wheaton 1974). Paulsen (2012) tests the validity of this model empirically for the US cities and finds that the four variables explain 80% of the total variation is urban spatial size. Similar results are found for Europe (Oueslati et al. 2015) and other regions of the world.

The contribution of this work to the literature is twofold. Firstly, we specifically test for the influence of metropolitan governance structure on the spatial extent of cities. Even though several contributions exist in the literature examining the role of planning policies, such as zoning or imposing height limits Wassmer (2006), the role of administrative governance is relatively less examined empirically. Secondly, we use OECD data to compare very diverse institutional settings such as Europe and the US, that have never been compared directly previously.

The indicator we use for urban governance relies on the metropolitan governance survey of the OECD (Ahrend et al. 2014) in which statistical comparison across different metropolitan areas in the OECD suggests that a better governance, as proxy by a lower number of administrative authorities with decision power on land use in the area, is associated negatively to land use change. We further explore this hypothesis by including the governance indicator in the AMM-based model regression, thus controlling for other determinants of the spatial size of cities. We also include an indicator of policentricity to disentangle the simultaneous effect of the urban form and the governance structure on the spatial extent of cities.

We expect a positive relationship between the administrative fragmentation in a city and its spatial size as a result of the lower competition for land between between municipalities. To attract households and firms, small municipalities surrounding the metropolitan core may commit to facilitate the construction of low-density neighbourhoods lowering the housing price per square meter, thus allowing households to live in larger houses and commute to the core. While in literature there are other arguments supporting both a centralised structure (a better coordination and the improved provision of services, a less costly negotiation for large infrastructural projects) and a decentralised one (a lower distance between governments and citizens, an easier and less costly monitoring, and a more heterogeneous supply of tax and services combinations), we believe that the land-use based competition between municipalities represents the prevalent effect in this case.

Empirical results confirm the suggested relationship between governance and the spatial extent of cities. Treating Europe and the US as different samples we are also able to unfold substantial structural differences in the determinants of the spatial size of metropolitan areas in the two contexts, finding that the impact of governance is significantly larger in the US compared to Europe.

In the remaining of the paper we present the differences between the institutional and regulatory frameworks concerning land use and planning policies in Europe and the US in the next section. Section 3 presents the data and Section 4 the empirical approach. Results are illustrated and discussed in Section 5 and Section 6 concludes the work with final remarks.

2 Institutional Setting

Within the contexts of the US or Europe, the administrative level of land-use planning and environmental regulation steers development differentially. Moreover, local authorities can play different roles on this matter subject to the national framework.

The OECD argues that planning in the United States differs from most other OECD countries (OECD 2017). Specifically, the majority of the US states does not enforce any legislation to regulate local land planning. The effect is a great diversification of planning regulation between local authorities within states.

It is well established that European cities feature more compact forms than their North American counterparts. In the last two decades, this has inspired several movements in the US (i.e. the Smart Growth and the New Urbanism movements), which advocate policies to reduce sprawl and urban expansion in general in American cities (Huang et al. 2007).

In their book, Gottdiener et al. (2014) identify four principal aspects of the long-lasting legacy of the colonialism age as the sources of the differences between today North American and European metropolises.

The first legacy of colonial dependency was the spread of what Gottdiener and colleagues call *privatism*, which is defined as the believe that the citizen's main responsibility lays is the pursuit of self-interest. Its origin is found in the fact that democracy arrived later in colonies and obligations were towards the colonial power rather than the city itself. In contrast, residents of ancient Athens were compelled to satisfy the needs of the city that gave them birth. These opposite attitudes shaped citizens' minds and its effects are still visible nowadays.

Another legacy of colonial dependency are weak city governments and limited city political power. Historically, this is explained as the absence of independent city economic rights during the colonial period, when cities were not granted chartered rights. This situation was in contrast with their European counterparts, which in the Middle Ages had strong economies based on trade that could be administered with their own currency and regulations.

A third legacy of colonial dependency consisted in the absence of city walls. Subsequently, this feature encouraged urban expansion and sprawl, which is still very much a characteristic of US cities.

Gottdiener and colleagues conclude their analysis of colonial legacies with a matter linked to the previous point. In fact, the vastness and openness of land around cities also had a qualitative effect on land use. Specifically, it affected the way urban expansion was managed. Cheap and abundant land combined with no planning regulations from the administrations created the conditions for land speculators to follow their interests seeking political collaborations. Unlike European generally continuous land-use patterns, this produced urbanisation patterns characterised by discontinuity in American metropolises.

These arguments justify the distinction in the analysis of land-use planning in the Unites States versus other areas where either the state or a lower administrative body plays a stronger regulatory role. In particular, we select Europe as a term of comparison to identify differences in governance effects between two regions that overall share similar levels of economic growth and socio-economic perspectives.

3 Data

Metropolitan area data are drawn from the OECD Metropolitan Area Database for the years 2000, 2006 and 2012[1]. This dataset includes information about population, land area, GDP, urban form and territorial organisation for metropolitan areas with more than 500,000 inhabitants. We extract data for North America and Europe only, which accounts for 70 US cities and 110 European ones.

For Europe, 20 countries out of 28 are included in the dataset. The eight excluded countries are: Bulgaria, Croatia, Cyprus, Latvia, Lithuania, Luxembourg, Malta and Romania.

The outcome variable used in this study is the total urbanised area, defined as the land area (km^2) covered by buildings or infrastructures for urban use. Figure 1 shows the distribution of the metropolitan areas and provide some visual information on the amount of urbanised land in 2006.

Figure 1 about here

Table 1 provides detailed summary statistics, by geographical region and year of observation, at the metropolitan area level for the variables that vary with time: the degree of urbanisation, population, GDP per capita and local governments per thousand population.

On average, the 70 metropolitan areas in the US include four times the urbanised land of the 110 EU metropolitan areas. Population values are also greater for the North American cities, where US metropolitan areas have on average 50% more population than European metropolises that are, however, characterised by a higher average density of pupulation. As expected, GPD per capita is also higher for the American population.

The complexity of governance in a metropolitan area is measured as the number of governments per thousand population. The variable provides a quantitative information on the level of the administrative fragmentation of the metropolis and is inspired by a OECD suggestion, that defines it "indicator of horizontal fragmentation" (Bartolini 2015). In the US, there is a lower degree of fragmentation compared to Europe, with on average 5 local governments against the average 8 local governments per 100 thousand inhabitant per metropolitan area in Europe. This variable varies little over

[1]Data for the United States is available for different years: 2001, 2006 and 2011. For this region, therefore, we match 2001 and 2011 US data with 2000 and 2012 data, respectively.

Table 1: Summary statistics.

	United States†			Europe		
Year	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.
Urbanised area (km^2)						
2000	1,640.15	1,350.39	70	375.96	360.79	110
2006	1,725.37	1,411.73	70	386.67	366.9	110
2012	1,788.97	1,454.59	70	448.48	402.88	110
Population (thousand)						
2000	2,146.86	2,835.32	70	1,443.10	1,579.77	110
2006	2,279.51	2,934.02	70	1,490.59	1,664.75	110
2012	2,433.91	3,052.25	70	1,548.34	1,765.28	110
GDP per capita						
2000	50,405.11	11,173.76	70	34,371.34	10,149.83	110
2006	55,144.55	11,473.26	70	38,386.89	10,091.78	110
2012	54,389.98	12,718.99	70	38,589.78	10,009.94	110
Local governments per thousand population						
2000	0.05	0.05	70	0.08	0.1	110
2006	0.05	0.05	70	0.08	0.1	110
2012	0.05	0.05	70	0.07	0.09	110

† For the US, the values of urbanised area for years 2000 and 2012 actually are the values for years 2001 and 2011, respectively. The values of GDP per capita for year 2000 are the values of GDP for year 2001.

time due to the fact the variation is introduced only by the population, whereas the number of local governments remains fixed across the relatively short period of time observed in this study, between 2000 and 2012.

Table 2 describes the policentricity indicator by region and city size. The indicator is a dummy variable equal to 1 when the metropolitan structure shows more than one centre and zero otherwise. OECD define polycentricity as the number of cores by metropolitan area, where a city core consists of a high-density cluster of contiguous grid cells of 1 km^2 with a density of at least 1,500 inhabitants per km^2[2]. It is worth observing that there are no polycentric cities in the US with population below 1.5 millions. Although a monocentric layout characterises the majority of all metropolitan areas, only 3% of North American cities are polycentric versus the 22% of the European cases. Thus, polycentricity seems to have a European connotation that adds to the structural differences between the two regions.

[2] See http://measuringurban.oecd.org.

Table 2: Number of metropolitan areas by polycentricity indicator and population size in 2012.

Size	Monocentric	Polycentric	Total
United States			
$< 1.5m$ (L)	39	0	39
$\geq 1.5m$ (XL)	29	2	31
Total	68	2	70
Europe			
$< 1m$ (L)	53	8	61
$\geq 1m$ (XL)	33	16	49
Total	86	24	110

4 Econometric model

To measure to what extent urban governance affects land use consumption for the regions of the United States and Europe we estimate the standard city size model (Brueckner & Fansler 1983) in the equation 1, where UA_{it} is the urbanised area (km^2) per metropolitan area i in year t. The primary independent variables are the population size (POP), the GDP per capita ($GDPPC$), for which we expect positive coefficient estimates. The term γ_t represents time effects for the three years of observations: 2000, 2006 and 2012. The last term, ε_{it} represents the idiosyncratic disturbance element.

$$\begin{aligned} UA_{it} = \beta_i + \beta_1 POP_{it} + \beta_2 GDPPC_{it} + \\ + \beta_3 LOCGOV_{it} + \beta_4 POLY_{it} + \gamma_t + \varepsilon_{it}, \end{aligned} \tag{1}$$

The model is augmented with the fragmentation index ($LOCGOV$) to test the hypothesis that the associated coefficient β_3 is different from zero. In particular we expect a positive coefficient.

With respect to the original specification proposed by Brueckner & Fansler (1983), we exclude information about transportation costs and agricultural land values because we miss in the dataset comparable information between European and US cities. However we benefit of the panel structure of the database and allow city-specific effects β_i that should capture the missing information and mitigate the problem of mispecification.

Finally we add the indicator of policentricity ($POLY$) to control for any possible deviation in the men value of urbanised area in metropolitan areas that do not show the monocentric structure assumed in the AMM model on which the (Brueckner & Fansler 1983) empirical specification grounds.

A factor that may moderate the effect of governance on urbanisation is the size category of the the metropolitan area. Some recent studies introduce a population size cutoff and test the monocentric model for the different size categories. Spivey (2008) finds that the largest US cities are a better sample for testing the standard Mills-Muth model for monocentric cities. In a different study, Paulsen (2012) introduces a city size cutoff at 500 thousand population and investigates the difference in growth patterns across small or large regions. He finds that in bigger metropolitan regions the elasticity of urbanised land area with respect to population is lower than in smaller cities. Although these studies find evidence of different growth dynamics that characterise different cities in terms of size, they exclusively look at North American metropolitan areas.

This study is the first that explores the effect of governance on urban expansion comparing different regions. To this purpose, we introduce an indicator for large (L) and extra large (XL) metropolitan areas, provided that the dataset includes exclusively areas with more than 500,000 inhabitants.

As shown in Table 1, there are substantial differences in population size between the United States and Europe, where the former holds a population 50% larger than the latter on average. To account for this contrast, we select two different size cutoffs. For the United States, L and XL correspond to metropolitan areas with population below 1.5 millions or equal and above 1.5 millions, respectively. For Europe, L and XL correspond to metropolitan areas with population below 1 million or equal and above 1 million, respectively.

Bearing in mind this distinction in the definition of size thresholds, we estimate the following OLS equation for the two regions, United States and Europe.

$$\begin{aligned} UA_{it} = {} & \alpha_i + \alpha_1 POP_{it} * size_{it} + \\ & + \alpha_2 GDPPC_{it} * size_{it} + \alpha_3 LOCGOV_{it} * size_{it} + \\ & + \alpha_4 POLY_{it} * size_{it} + \alpha_5 * size_{it} + \lambda_t + \epsilon_{it}, \end{aligned} \tag{2}$$

where POP, $GDPPC$, $LOCGOV$ and $POLY$, which are the same as of equation (1), are interacted with the indicator of size, that is equal to 1 for XL metropolitan areas and equal to 0 for L areas. The dummy variable $size_{it}$ varies with time (although by a small degree) due to the fact that it is built on population, which changes over time. The term λ_t represents time effects for the same three years of observations: 2000, 2006 and 2012. Also in this equation, the last term ϵ_{it} represents the error element.

Thanks to equation (2) we are able to understand whether the structural

Table 3: Estimated effects of urban governance on urban land use, by geographical region.

	United States	Europe
Population (thousand)	0.493***	0.202***
	(0.038)	(0.010)
GDP per capita	0.010**	0.005***
	(0.005)	(0.002)
Local gov/1,000 pop	1027.543	227.469***
	(1061.796)	(82.096)
Polycentricity	-2092.779*	-41.571
	(1190.211)	(37.106)
Intercept	74.945	-88.018*
	(193.997)	(45.331)
Time effects	✓	✓
Observations	210	330
Adjusted R^2	0.879	0.865

Cluster-robust standard errors in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

differences between US and European cities are due to either the institutional context, metropolis size or both.

5 Results and Discussion

The empirical specification adopted in this paper allows city-specific effect in a panel data setting and preliminary tests on the correlation between these effects and the independent variables are run to choice between the two most common specifications of the individual effects, the fixed effects (FE) and the random effects (RE). In this context, the standard procedure is to run the Hausman test that compares the coefficient sets of the two specification to establish whether or not this difference is statistical significant. The nature of our data impedes proceeding this way as far as the *POLY* variable does not vary over time dropping in a FE specification but not in a RE one and the two coefficient vectors have different dimensions. We thus estimate the FE specification using the Mundlack-Chamberlain device (Mundlak 1978, Chamberlain 1982), that is assuming correlated random effects and estimating a pooled model with city-specific mean values of time-varying variables. The $F-test$ on the joint significance of coefficients related to the city-specific mean variables is used to test the null hypothesis of zero correlation between the city-specific effects and the explanatory variables. The results of this test in our case does not allow rejecting the null hypothesis and we thus opt for the RE specification.

Table 3 shows the results of the estimated panel regressions described in equation (1). The adjusted R^2 are high for both, the United States and Europe, hence the model seems to explain a substantial variation in urbanised area in both samples. For both, this variation is captured by only three variables. In his empirical paper, Paulsen (2012) describes a similar model that features the same characteristic of a high R^2, yet determined by only three variables. This similarity confirms the fact that the stylised monocentric Mills-Muth model indeed captures the main drivers of urban land growth.

Looking at the estimated coefficients, an increment by thousand population in an US city is linked with an increase of around 50 hectares of urbanised land. To check whether these estimates on population and urbanisation are qualitatively relevant, we match them with existing results. For the North American region, we use the results of the study by Paulsen (2012), which analyses a sub-sample of cities above 500 thousand population using a different dataset. Provided that our sample includes only those areas, we are able to supply a meaningful comparison of estimates. Paulsen (2012) estimates a yearly increment of 834 square foot (ft^2) in urban land per person. If we convert our estimate of 0.493 km^2 more urban land per thousand inhabitants over the six years of our analysis period gap, we obtain a yearly increment of 884 ft^2 in urban land per person. The difference in these estimates is 50 ft^2, which correspond to 4.6 m^2.

We do the same for the region of Europe and use the study by Oueslati et al. (2015) as a means of comparison. Although their study uses data on European cities, they do not differentiate by city size. We translate their elasticity of urban land with respect to population into yearly square foot change per person using the sample mean population and urban area provided by the authors in the paper and we obtain an increment of 412 ft^2. In our study, the estimate of 0.202 km^2 for the European population of Table 3 is converted into 362 ft^2 more yearly urban land per person. Strikingly, although our estimated value for Europe is lower than what the literature suggests, also in this case the difference in the estimates is 50 ft^2 (i.e. 4.6 m^2). These equivalences together provide some evidence to further validate our model described in equation (1).

The other estimated values reported in Table 3 refer to GDP per capita and the two indexes of governance. As expected, urban land grows with GDP, where the United States experience an increment of one hectare correspondent to an increase in one point of GDP per capita. Our results also show that Europe has a correspondent growth half the size, with an additional half a hectare for each extra point of GDP per capita.

We expect the two indexes of governance to be positive. The first, which is the number of local governments per thousand population, is a measure of fragmentation. We endorse the centrist approach which advocates that lower degrees of administrative fragmentation lead to better performance on public transport systems, environmental issues and urban sprawl (Ahrend et al. 2014). Higher values of this measure are usually associated with a worse allocation of land (Bartolini 2015). We would assume, therefore, that an increase in the number of local governments leads to urban land growth. The second index is the indicator of polycentricity, which is equal to one if the metropolitan area includes more than one core. The rationale behind it is the same as the one described above about administrative fragmentation. Therefore, a polycentric metropolitan area should consume more urban land compared to a monocentric one, all else being equal (Ahrend et al. 2014).

For the United States, the number of local governments per thousand population does not seem to contribute to the model of urban land use. The second indicator of governance, although statistically significant at the 90% level, is negative against the intuition explained above. This tells that US metropolitan areas with more than one city core consume less urban land compared to cities with only one core. To put this result into scale, it is worth recalling the portion of polycentric cities in the US, accounting for only the 3% of the total (i.e. 2 out of 70 areas, see Table 2).

For Europe, the picture is more intuitive. Whereas the coefficient of the polycentricity indicator is not statistically significant, the index of fragmentation is positive and significant at the 99% level. For this region, one extra local government per thousand population is associated with about 22,750 hectares of further urban land. This high value is justified by the fact that in Europe one local government per thousand population corresponds to 1,250% of the average value (see Table 1, where on average there are 0.08 local governments per thousand population).

Table 4 reports the estimates of equation (2). If the adjusted R^2 were already high in the estimations reported in Table 3, here we find extremely high values. Accounting for size-related structural heterogeneity, this model explains 96% and 94% of the variation for the regions of United States and Europe, respectively.

For both the US and Europe we find significant structural differences between groups of metropolitan areas of different size based on Anova tests

Table 4: Estimated effects of urban governance on urban land use with indicators for two levels of the metropolitan area size, by region.

	United States		Europe	
	L	XL	L	XL
Population (thousand)	0.851***	0.449***	0.204***	0.192***
	(0.103)	(0.042)	(0.072)	(0.012)
GDP per capita	0.001	0.011	0.001	0.007***
	(0.002)	(0.010)	(0.001)	(0.002)
Loc gov/1,000 pop	1474.592***	4534.986*	173.503***	471.157*
	(538.391)	(2351.250)	(46.157)	(255.889)
Polycentricity	0.000	-1860.802*	1.348	-85.536
	(.)	(1076.211)	(21.837)	(61.500)
Intercept	27.559	-1644.905	25.412	-158.787
	(128.235)	(1308.272)	(60.559)	(111.090)
Time effects	✓		✓	
Observations	210		330	
Adjusted R^2	0.961		0.943	

Cluster-robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Note: L and XL refer to the size of the metropolitan area. For the United States, L and XL correspond to cities with < 1.5 and ≥ 1.5 million population, respectively. For Europe, L and XL correspond to cities with < 1 and ≥ 1 million population, respectively.

(not reported). And for both we find that the average land consumption is bigger in larger metropolitan areas. This evidence supports the argument that smaller cities are relatively less efficient in allocating land, probably as the result of the greater availability of non-urban land to be converted and of the lower institutional attention to the issues related to land-take. Not only the difference between the two regions remain significant after accounting for size-related heterogeneity, it also widens especially in cities of smaller size. As a result, the marginal land consumption estimates in the sample of US metropolitan areas with less than 1.5 million inhabitants is as four times larger than the one estimated in the sample of US metropolitan areas with less than 1 million inhabitants. Splitting for size, the income effect turns insignificant in all models except for the case of very large cities in Europe.

Results concerning administrative fragmentation also significantly differ across size groups in both regions. Oppositely to the previous case, the larger the city the bigger the effect of increasing the number of administrative units by 1 on the total land consumption, in both regions. For both, the US and Europe, in extra large cities the estimated marginal consumption of land per new municipality is about three times bigger that the one estimated in large cities. In addition, comparing the results of the two models, whereas for North American cities fragmentation does not contribute to explain urban land growth, adding a city size interaction term changes the scenario.

To our knowledge this is the first study that compares metropolitan areas of different sizes from different regions. We find that population size moderates the effect of governance on urban land growth. In both regions, the Us and Europe, an increase in administrative fragmentation is associated with an increase in urbanisation at different magnitudes depending on the city size.

6 Conclusion

This study adds to the literature on the impact of governance on urban land consumption. We use data on North American and European big cities (above 500 thousand population) to disentangle the relationship between land use and the governance of the metropolitan area, as proxy by the number of administrative decision centres scaled by population.

There are three main contributions to this rich field of research. Firstly, we investigate the role of city size within the relationship between governance and land use. We find that, even for big cities, size is a moderator of this relationship. At least for the US, we find that a statistically significant effect is unfolded only if sub-sampling by city size.

Secondly, comparing US versus European cities, we are the first to contemporaneously analyse different settings. We find that European cities are more compact than their North American counterpart. Although this is something already established, this finding validates our model, which is able to quantitatively estimate this effect.

Lastly, for both regions, we find that administrative fragmentation is related with an increase in urbanisation in all cities, large and extra large. This result supports the centrist idea that better governance is associated with a lower number of decisional centres.

To conclude, we provide comparative empirical evidence that a more efficient land use planning is obtained when urban governance is characterised by a simpler and less fragmented administrative structure.

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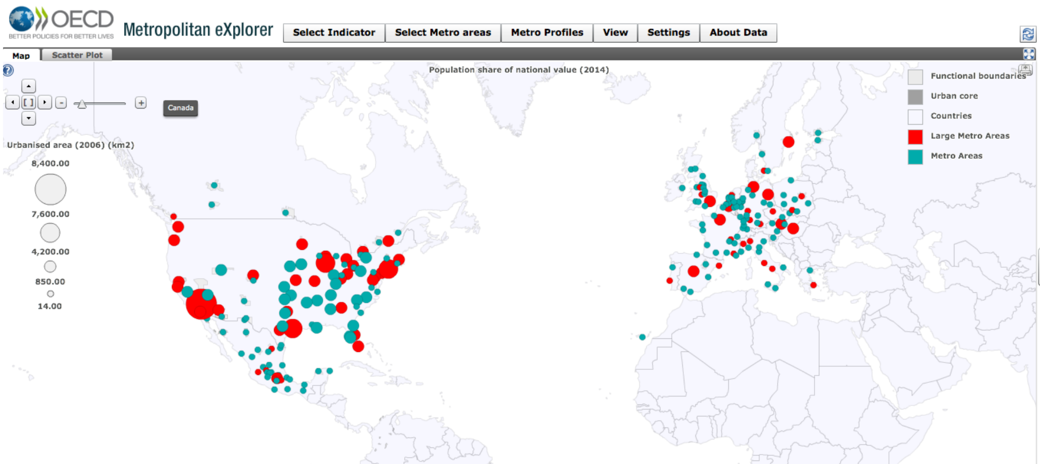

Figure 1: Location of OECD metropolitan areas included in this study. The size of the bubbles indicate the level of urbanised area in 2006 for each metropolitan area. Metro or large metro areas refers to metropolitan areas with a population between 500,000 and 1.5 million or a population of 1.5 million or more, respectively. Source: Metro eXplorer, OECD, https://measuringurban.oecd.org.