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WHAT MAKES CITIES MORE PRODUCTIVE? EVIDENCE FROM FIVE OECD COUNTRIES ON THE ROLE OF URBAN GOVERNANCE*

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ABSTRACT. In estimating agglomeration benefits across five OECD countries, this paper represents the first empirical analysis that contrasts cross-country evidence on agglomeration benefits with the productivity impact of metropolitan governance structures, while taking into account the potential sorting of individuals across cities. The comparability of results in a multicountry setting is supported through the use of a new internationally harmonised definition of cities based on economic linkages rather than administrative boundaries. The analysis finds that cities with fragmented governance structures tend to have lower levels of productivity. The estimated elasticity for an increase in the number of local jurisdiction is 0.06, which is halved by the existence of a metropolitan governance body. The productivity effect is sizeable and at least as important as the agglomeration benefit found due to city size.

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1. INTRODUCTION AND LITERATURE REVIEW

A country's productivity is, in large part, determined by the productivity of its large cities. Metropolitan areas—urban agglomerations with more than half a million inhabitants—are home to over half of the population of Organisation for Economic Co-operation and Development (OECD) member countries and account for an even larger share of total GDP. Understanding how to increase the productivity of these cities is an urgent challenge. That the economic productivity of a city increases with its size is well documented in many single country studies. A less well-documented relationship is between a city's *governance structure* and the productivity of its residents. Local governance structure might be expected to influence city level productivity in a number of ways. While the increased competition associated with a larger number of local governments might offer productivity advantages, fragmentation may also lead to lower productivity if it is associated with a lack of coordination in infrastructure investment or land use planning.

This paper uses a new database, which relies on an internationally harmonized definition of cities. This allows for a cross-country analysis of the relative impact of city size and governance structures on urban productivity. In order to facilitate comparison, the analysis follows the two-step empirical strategy frequently employed in the agglomeration externality literature that accounts for potential sorting of more productive individuals into certain cities. The results show positive agglomerations benefits, that is, higher productivity of workers living in larger cities. The estimated city-size elasticity varies between 0.02 and 0.05, depending on the specification, implying that a worker is 0.2–0.5 percent more productive in a city with 10 percent more inhabitants. However, it also finds that if this city is 10 percent more fragmented, measured by the number of municipalities, counties, or local authority districts, productivity is 0.6 percent lower. This is unless the city has a coordinating "governance body" which alleviates the fragmentation penalty by about half.

The main novelty of this paper is its use of a functional definition of cities that allows us to determine the number of local governments within an urban agglomeration. Identifying this "administrative fragmentation" allows us to investigate its implications and the role of urban governance on city-level productivity.[1] Administrative fragmentation might improve the functioning of cities, by allowing locally tailored public services and accountability, as well as competition among local governments. For specific public services, a large body of literature has found that efficient provision is often achieved in small and medium-sized administrations rather than in administrations that cover whole metro areas.[2] However, the seminal work by Ostrom Tiebout, and Warren (1961) and the following literature also highlight that coordination and co-operation among the local administrations are essential for well-functioning governance arrangements in large urban agglomerations. Administrative boundaries in cities rarely correspond to current patterns of human settlement and economic activity and are rather based on centuries-old historic borders. This can result in significant coordination problems, in particular in fields such as transport or spatial planning that require not only coordination across different levels of government, but also horizontal coordination across numerous local governments at the same level.

[1]Throughout the paper "city" will be used synonymously with "Functional Urban Area," the functionally defined extent of the urban agglomeration. When specific reference to the core city of a Functional Urban Area is made, this is indicated in the text.

[2]An example is the seminal work by Elinor Ostrom and her contemporaries on efficient provision of police services. See Ostrom (2010) for references, Kalb (2010) provides a recent overview of public service efficiency studies.

Central to our analysis of the impact of urban governance on local productivity is our reliance on the "Functional Urban Area" (FUA) as our unit of analysis. This definition of a "city" is functional—rather than administrative—and follows an internationally consistent and coherent methodology developed by the OECD and the EU.[3] The comparable definition allows the paper to investigate the magnitude and causes of urban productivity in a multi-country setting without the vulnerability to bias resulting from differentially defined national administrative city boundaries. As a result, where existing research on city level productivity has largely been confined to single country studies, this paper combines evidence from five OECD member countries (Germany, Mexico, Spain, United Kingdom, and United States).[4]

This work is primarily contributing to the literature on the impact of urban governance on urban productivity. However, in order to benchmark the relative importance of urban governance this paper also touches upon and draws insights from the rapidly developing literature on agglomeration economies. While the large theoretical literature on agglomeration economies tends to conclude that agglomeration benefits accrue through learning, through knowledge sharing, through specialization, and through deep labor markets (see the reviews of Rosenthal and Strange, 2004; Duranton and Puga, 2004; and Puga, 2010), recent empirical evidence has highlights the importance of controlling for selection effects. Urban productivity arises, in part, from a tendency of more talented individuals to colocate in larger cities (e.g., Combes, Duranton, and Gobillon, 2008; Gibbons, Overman, and Pelkonen 2010).[5] These studies also show that a sizeable share of the urban wage premium can be explained by observable and unobservable worker characteristics. It is therefore critical to account for the sorting of highly skilled individuals into cities when estimating productivity differentials across cities.[6]

The second strand of literature that is relevant to this paper investigates the relationship between the structure of local governance and productivity. The mechanisms which underpin this relation are multiple, and imply quite different effects. In the first place, administrative fragmentation may have a positive impact upon productivity. This may, for example, be the case if a larger number of local governments is associated with more choice in the provision of public services. If increased choice, and the associated competition among local governments, drives up the quality of local public services, then a

[3]See OECD (2012a) for the methodology and http://www.oecd.org/gov/regional-policy/functional-urbanareasbycountry.htm for the defined FUAs for 29 OECD countries.

[4]The methodology used in this study made an analysis covering all OECD countries infeasible, given the constraints to gain access to adequate microdata sources. The data required for this study need to contain information on individual characteristics, earnings, detailed information on the place of residence and they need to represent a large enough sample to guarantee a sufficient number of observations in each city. The five countries studied were selected for their data availability and to maximize the number of available city observations.

[5]This may occur either because the initial distribution of workers' skills differs by city size, or because workers sort by skills (Berry and Glaeser, 2005; Baum-Snow and Pavan, 2012).

[6]A second concern in identifying causal effects is that not only the quality of labor is influenced by city characteristics, but also its quantity. Successful cities that offer high wages attract more workers. Empirically, this issue has been addressed by instrumenting current city size with: historical size or density (following the contribution by Ciccone and Hall, 1996) or factors that make certain locations more attractive (Combes et al., 2010, for example, use topological characteristics). Alternatively, recent studies have used natural experiments based upon political changes (see, e.g., Redding and Sturm, 2008; Brülhart et al., 2012; Ahlfeldt et al., 2015) to identify a causal link. While it has not been possible to implement any of these strategies in a multicountry setting, empirical studies typically find that the bias from differential quality of labor is far more severe than the reverse causality bias in the quantity of labor (Combes et al., 2011; Melo et al., 2009).

positive association between fragmentation and productivity may result (Tiebout, 1956).[7] Furthermore, if the more able and well educated are more informed about the quality of local public services, this Tiebout effect might generate sorting of individuals in the cities with more fragmented administrations (distinct to the sorting impact identified in the agglomeration literature outlined above). With more fragmentation and therefore (*ceteris paribus*) smaller administrations, local governments also face more homogenous demand from their constituencies and a plethora of case studies suggests that they are subject to greater scrutiny and engagement from their residents, and thus offer better local public services.[8]

The impact of administrative fragmentation on productivity may, however, also be negative. FUAs frequently consist of more than a hundred municipalities (OECD, 2013), adding a degree of complexity to the design and implementation of policies that require coordination, which can stymie the productivity of urban agglomerations. Furthermore, local governmental units may fail to take into account the positive externalities associated with the public goods relevant at the level of the FUA (see, e.g., Pinto, 2007). Thus administrative fragmentation can, for example, obstruct transport infrastructure investments and effective land use planning, thereby increasing congestion and reducing a city's attractiveness for individuals and businesses (see Ahrend, Gamper, and Schumann, 2014). Fragmentation may also pose problems in the area of business and environmental regulation if the additional bureaucracy associated with fragmented governance impedes growth through its effect on the ease of doing business.[9]

Negative impacts of fragmentation along these lines have been documented in a number of case studies. For example, in Chicago, considered one of the most fragmented metro areas in the United States, administrative fragmentation was one of the factors that led to an overly complex and not particularly efficient governance structure of public transit providers in the metropolitan area. In the OECD definition, the metropolitan area of Chicago consists of the city of Chicago itself and another about 540 municipalities, which are located in 13 counties in three U.S. states. Despite more than 100 years of history in urban planning, this large degree of fragmentation, is reflected in relatively low levels of integration of the public transit system, and has also contributed to underinvestment into its infrastructure (OECD, 2015). The estimates in this study point toward another price of fragmentation: productivity in Chicago is lower than among its U.S. peers and closer to the average of U.S. metros that are half its size. Similarly, in the Austrian metropolitan area of Vienna, some metro lines end suddenly in areas that have still fairly high population densities, when they have reached the administrative borders of the city of Vienna. In general, policy areas with significant externalities, like transport and land use planning (OECD, 2015), environmental regulation, or policies aimed at promoting growth (Cheshire and Magrini, 2009) are likely to be adversely affected by high coordination costs arising from administrative fragmentation.

While the literature on urban governance in the United States tends to find a positive relationship between administrative fragmentation and economic growth, the existing evidence from Europe points mainly to a negative relationship. This pattern is far from homogenous, though. For example, Akai and Sakat (2002.) for U.S. states and Stansel (2005) for U.S. metropolitan areas, report a positive association between fragmentation and growth—both population growth and income growth—whereas other studies, such as

[7]There is a vast literature investigating the impact on quality of choice in specific public services (e.g., Bayer and Macmillan, 2005, and Rothstein, 2006, for education).

[8]See Ostrom (2010) for a summary of these arguments.

[9]See Djankov et al. (2006), on the impact of business regulation on growth.

Zhang and Zou (1998) and Xie, Zou, and Davoodi (1999), find a negative relation between fiscal decentralization and growth.

Recent studies highlight that the impact of fragmentation tends to differ by government functions and between urban and rural areas. For the United States, Hammond and Tosun (2011) show that metropolitan areas and nonmetropolitan areas are differently affected by administrative fragmentation. Interpreting the number of local governments within a U.S. county as degree of fiscal decentralization, the authors find that the number of *special purpose* districts (local governments formed to deliver a variety of specific public goods and services, e.g., water and waste management) positively affects employment and population growth, but not income growth, in metropolitan counties, while the number of *general purpose* local governments does not affect metropolitan counties in nonmetropolitan counties, however, population and employment growth is negatively associated with the number of general purpose governments. Bartolini (2015) considers the impact of administrative fragmentation on per capita GDP growth across 250 large regions (e.g., the separate states in the United States) in 23 OECD countries. He finds that a larger number of municipalities (per capita) is associated with lower growth in areas that are highly urbanized, but no impact of fragmentation on areas with a large percentage of rural dwellers.[10]

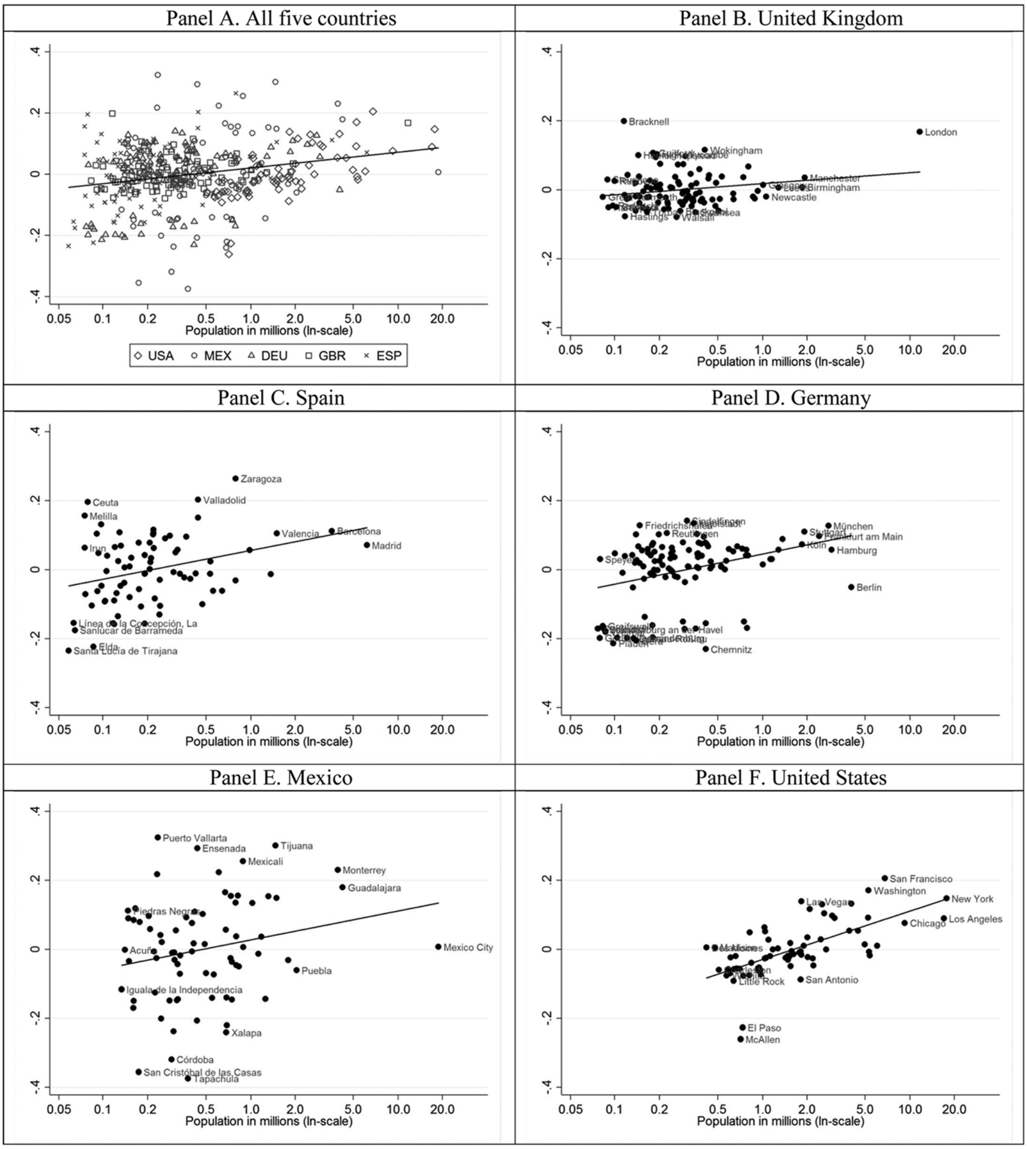
The hypothesis frequently put forward is that a smaller number of jurisdictions and closer match of the highest tier authority with the functional economic region would increase the chances of forming a "territorially competitive club," since the encompassed jurisdictions would face smaller transaction costs and spillover losses to neighboring jurisdictions (Cheshire and Gordon, 1996). Linking this hypothesis with growth promotion, Cheshire and Magrini (2009) examine the impact of government fragmentation on functionally defined urban regions in Europe. Their empirical analysis finds that the proportion of the functional region's population located in the largest administrative jurisdiction is positively associated with economic growth.

The findings of this paper suggest that, in line with the previous literature on agglomeration economies, productivity tends to increase with city size for each of the five countries considered. When the five samples are combined, robust evidence for these agglomeration benefits is found with an estimated elasticity in the range of 0.02–0.05, implying that a 10 percent increase in a city's population is associated with roughly a 0.2–0.5 percent increase in productivity.[11] Within countries, cities with fragmented governance structures have lower levels of productivity. For a given population size, a 10 percent increase in the number of municipalities within a metropolitan area is associated with around 0.6 percent lower productivity, an effect that is mitigated by almost half when a governance body at the metropolitan level exists. The results also provide evidence that proximity to other populous cities affects positively the productivity of a city, implying that—in a certain sense—cities can take advantage of the agglomeration of their neighbors. Port access, skilled human capital and specialization in high-tech manufacturing, finance and business services are also found to contribute to city productivity.

The remainder of the paper is organized as follows: section 2 presents some descriptive evidence, section 3 discusses the methodology adopted in this paper, section 4 presents the estimation results, and section 5 concludes.

[10]Unlike our study, these studies consider fragmentation within an administrative entity (e.g., counties), and not a functionally defined metropolitan area.

[11]Combes et al. (2011) find the same range in their review of the literature.



Note: With the natural logarithm of population on the horizontal axis, the vertical axis plots city productivity, estimated by applying individual wage regressions to national microdata in order to control for workforce composition of cities. Log hourly wages/earnings are regressed on gender (dummy), age, age squared, education (dummies), occupation (dummies) and city-year dummies; the coefficients of the latter are taken to denote productivity differentials. The analysis is conducted at the Functional Urban Area level. Source: Own calculations based on microdata from national surveys.

FIGURE 1: City Size and City Productivity (2007).

2. DESCRIPTIVE EVIDENCE

Figure 1 presents the level of city productivity premiums on the vertical axis and plots these against the size of the city—as measured by its resident population. Panel A combines the five countries studied in this paper while Panels B to F are disaggregated by country. For all countries studied, productivity is higher in larger cities; an upward

trend is identified in each of the country cases, though with varying degrees of steepness. Countries differ also in the extent to which productivity varies across cities of similar size, with city productivity in Germany, the United Kingdom, and the United States being far more homogenous than the productivity across cities in Spain or Mexico.

In the case of the United Kingdom, it is interesting, but perhaps unsurprising, to note that city productivity premiums in London are larger even than those that would be expected given its size. Furthermore, alongside human capital, proximity to London appears to account for much of the performance of the positive outliers. Bracknell, Wokingham, Basingstoke, High Wycombe, and Guilford—all with high levels of tertiary education—are all within a 50-kilometer radius from London (with the exception of Basingstoke, which is located 77 kilometers away). In contrast, there is no specific geographical pattern among the negative outliers, but all have education levels below the U.K. average.[12]

In Spain, city productivity premiums in Madrid are slightly below what would be expected given its size, a result that is, in part, driven by particularly strong city productivity premiums in a number of midsized cities. In Germany, the most noteworthy feature is probably the strong east-west divide, with city productivity premiums in eastern German cities being, on the whole, significantly below the levels found in western German cities of comparable size. In line with this finding, the city productivity premium in Berlin lies in between the trends in eastern and western Germany. It is also noteworthy that a number of midsized German cities have city productivity premiums at levels similar to Munich, Stuttgart, and Frankfurt—the most productive large agglomerations. This probably reflects a number of highly productive SME clusters in the manufacturing sector that—often for historical reasons—are located in smaller agglomerations.

In Mexico, there is a clear north-south divide. Negative outliers are mostly agglomerations in the south of the country, whereas positive outliers are generally located in the north, on or close to the U.S. border. In contrast, some of the negative outliers in the United States are located on or close to the Mexican border. In addition, other underperforming cities (including Chicago and Los Angeles) are relatively sprawled cities with low employment densities and relatively fragmented labor markets.[13]

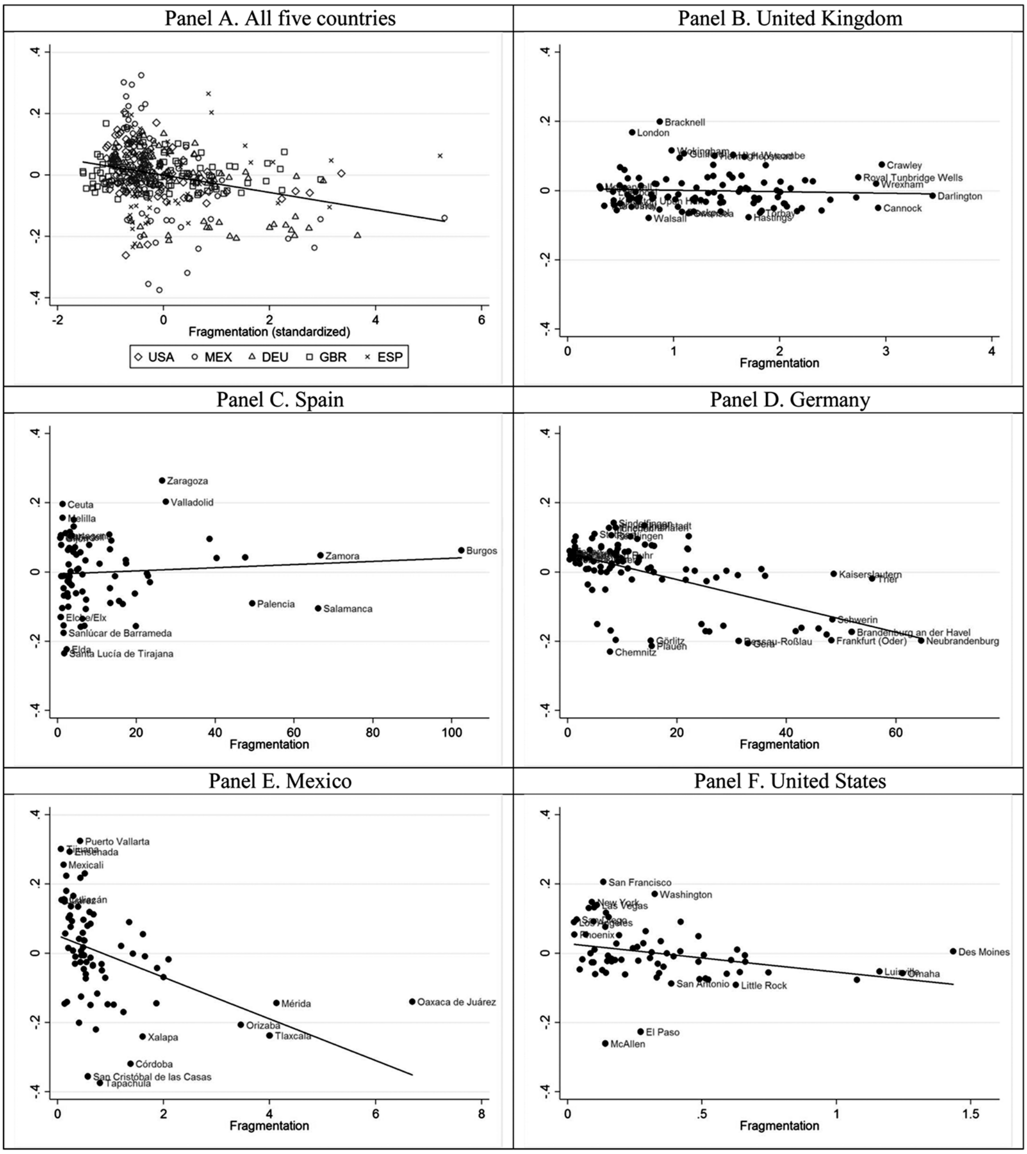
The descriptive country charts in Figure 2 illustrate the degree to which administrative fragmentation is associated with productivity levels in cities. The degree of fragmentation of urban areas is measured by the number of municipalities per 100,000 inhabitants.[14] The charts show a tendency for more fragmented cities to have lower levels of economic productivity. The effect varies across countries and is largest in Mexico (panel E).

For some time, the urban planning literature has highlighted the role of horizontal cooperation and coordination among local governments as a substitute for administrative consolidation in enhancing urban productivity (e.g., Blair, Staley, and Zhang 1996). This substitutability may shed some light on the strength of the impact of fragmentation in Mexico. Mayors of Mexican cities are elected for a three-year term and are prohibited from running for immediate re-election. Furthermore, a large share of civil servants is replaced after each election cycle. This discontinuity in personnel may render it difficult to establish lasting cooperation across municipalities, potentially multiplying effects of

[12]Walsall and Hastings are the two largest negative outliers. The former is an industrial town in West Midlands with particularly low levels of tertiary education at 12 percent, and the latter a southeast town with similarly low tertiary education levels at 15 percent. The average share of university graduates across U.K. cities was 19 percent in 2007.

[13]In the case of Chicago, a relatively fragmented labor market, due to deficiencies in the public transport system, might contribute to its underperformance (*cf.*, OECD, 2012b).

[14]Municipalities for Germany, Mexico, Spain; local authority districts for the United Kingdom, and counties for the United States.



Source: See note of Figure 1. Fragmentation is the number of municipalities per 100,000 inhabitants.

FIGURE 2: Horizontal Administrative Fragmentation and City Productivity.

fragmentation. In contrast, in the other countries, many cities have reasonably well-functioning coordination bodies, which—to some degree—may mitigate problems of fragmentation.

3. METHODOLOGY

Empirical work attempting to quantify the productivity premium, while accounting for selective sorting, has followed two paths. The first is based on the equilibrium location decisions of firms—under the assumption that firms will locate where they are

most productive (see, e.g., Ellison and Glaeser, 1997; Rosenthal and Strange, 2003). The second strand of empirical work, the one followed in this paper, focusses instead on the productivity of workers. Empirical work along these lines has found a relation between urban density and productivity—proxied by wages—that continues to hold after controlling for both observable and (permanent) unobservable individual characteristics (e.g., Glaeser and Maré, 2001).[15]

The main contribution of this paper, in terms of its methodological approach, is the common empirical strategy applied across five OECD countries. This not only ensures that the individual country results are comparable, but allows for pooled regressions on the full sample of cities from five countries. The latter aspect is of critical importance, given the limited number of cities in each country. Pooling helps create a sample with mass not only among small and medium-sized cities or administratively congruent cites, but also among large or very fragmented cities. The harmonized approach is made possible through the use of an internationally comparable definition of "city" that is based on economic linkages, rather than administrative boundaries.

Administrative and functional definitions of cities do not always coincide. Many who work in central London, for example, commute to work from London's surrounding municipalities. Likewise, manufacturing sites that are located on the outskirts of a city could require their workers to commute out. According to an administrative definition, such commuting workers would not live and work in the same urban area, whereas a functional definition avoids this bias. More generally, a sole focus on the central administrative unit of a city will underestimate the population size of an urban area, overestimate the density, and might over- or underestimate its productivity. The empirical analysis of this paper therefore employs the FUA definition of cities.

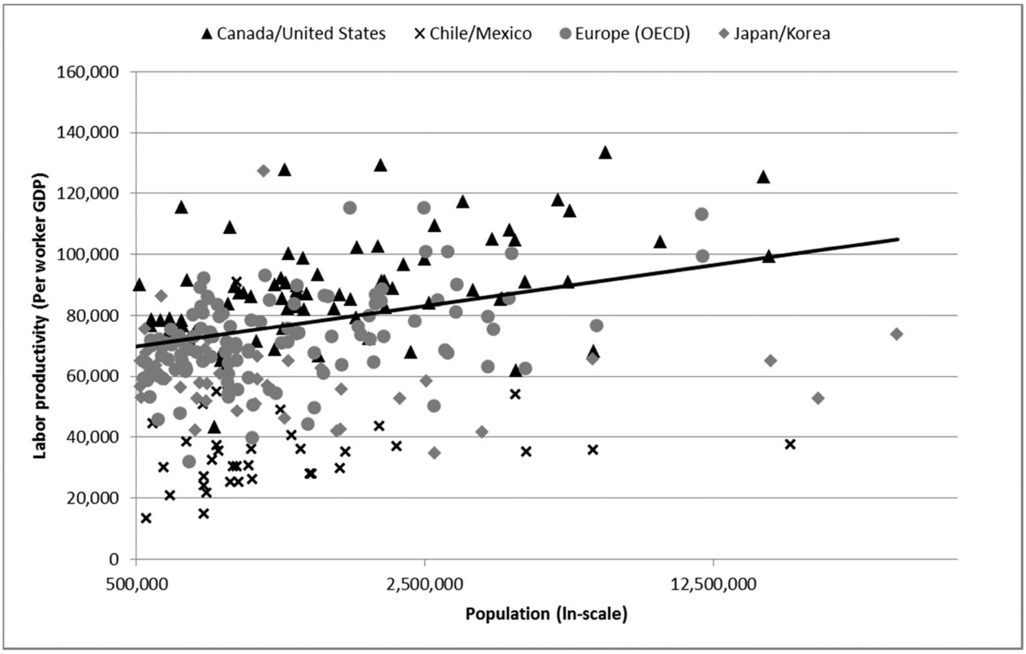
FUAs are based on urban economic functions rather than administrative boundaries using a methodology developed by the OECD and the EU. The definition has been applied in a comparable way across most OECD countries, aggregating contiguous lower spatial units that form part of a common FUA, by taking into account density and population as well as commuting patterns (OECD, 2012a). The results are 1,148 largely self-contained urban labor markets with at least 50,000 inhabitants across 28 OECD member states (OECD, 2012a).[16]

Specifically, municipalities or similarly small administrative units are used to build up the FUAs in a comparable way across countries. Units that include a majority of its population living in high-density contiguous grids of 1,500 inhabitants per square kilometer (km^2) are designated as "urban centers."[17] Urban centers that have more than 15 percent of their population commuting from one to the other are considered to belong to the same FUA. Less densely populated municipalities that have at least 15 percent of their workforce commuting to an urban center are included in the same FUA and form its commuting zone.

[15]Much of the literature uses wages as a proxy for productivity. Under standard wage setting mechanisms, the marginal product of labor should be reflected in wages. Even if higher wages are offset by larger commuting and housing costs (from the perspective of the worker), if there were no productivity advantages in urban areas firms would move to low wage locations.

[16]For the United States, small and medium-sized FUAs (those with 50,000–500,000 inhabitants) and metropolitan areas (FUAs with more than 500,000 inhabitants) are defined based on different spatial units. The boundaries of metro areas match county boundaries, while small and medium-sized FUAs have boundaries that are based on census tracts. The difference arises as the OECD collects additional data on metropolitan areas, which would not be available at the census tract level. To ensure a coherent definition of FUAs in all samples this study considers therefore only FUAs with at least 500,000 inhabitants (metropolitan areas) for the United States.

[17]For Canada and the United States the threshold deviates and is set at 1,000 inhabitants per km^2.



Note: Labor productivity is measured as GDP (millions of US$ constant PPP, constant prices, reference year is 2005) divided by the total number of employees in an FUA. Data refer to 2010 or the closest available year.
Data source: OECD Metropolitan Explorer.

FIGURE 3: City Size and Labor Productivity (2010).

While it is possible to consider aggregate productivity at the FUA level, for example, per worker GDP (Figure 3), the evident positive slope combines agglomeration benefits with other sources of higher productivity in larger cities. Crucially, productivity in larger cities is higher because they tend to attract more skilled and productive workers. To disentangle the agglomeration component and this nonrandom sorting of skilled individuals, a two-step empirical approach is applied separately to national microdata surveys for the five countries in the study (see Combes, Duranton, and Gobillon, 2011, for a theoretical discussion of this methodology).[18] In the first step, the functional EU-OECD definition of cities is matched with large scale administrative or survey-based microdata from each of the five countries. The resulting datasets are then used to estimate productivity differentials—net of individual skill differences and other individual level observables—across cities using an OLS regression of the natural logarithm of wages on individual level characteristics and a set of fixed effects for each city-year combination.[19]

$$y_{icat} = \beta X_{icat} + \gamma_{cat} d_{icat} + \varepsilon_{icat}, \quad (1)$$

y_{icat} denotes the natural logarithm of wages for individual i in city a in country c at time t, X a vector of individual characteristics, d a vector of dummy variables that take

[18]See Combes et al. (2008) or Monastiriotis (2002) for earlier implementations of the empirical methodology.

[19]This model follows the seminal work by Mincer (1974) and the large body of empirical literature that followed it. The German data is right censored, which introduces a bias in OLS estimation. However, comparing the results from a Tobit model, which accounts for censoring, and the OLS model shows that the bias is negligible (see Ahrend and Lembcke, 2016).

the value 1 if the individual resides in city a at time t, and ε denotes an error term. The coefficient vector of interest, γ, captures the productivity differential across cities, net of (observable) skill differences.

Since the primary concern in this study is to create comparable estimates for all five countries (Germany, Mexico, Spain, United Kingdom, and United States), the specific controls that can be included are limited to the controls available in all five datasets. Not all variables are available in all countries and the different data sources include both panel data as well as repeated cross-sections. The common set of controls selected includes age (and its square), education (dummies for degree categories), occupation (dummies for occupational categories), gender (dummy), and an indicator for part-time work (dummy), in addition to the city-year fixed effects.[20]

The city-year fixed effects obtained in the first step capture city productivity differentials, net of the observable skill-relevant characteristics of the urban workforce for each of the five countries (c). The estimated productivity differentials ($\hat{\gamma}_{cat}$) are used as the dependent variable in the second step, in which they are regressed on indicators for structural and organizational determinants of city productivity—both time varying ($\boldsymbol{Q}_{cat}$) and nontime varying ($\boldsymbol{Z}_{ca}$). Additional country-year fixed effects d_{ct} control for time-fixed differences across countries, national business cycles and country specific inflation (the first-step estimates nominal productivity differentials).

$$\hat{\gamma}_{cat} = \delta \boldsymbol{Q}_{cat} + \mu \boldsymbol{Z}_{ca} + \theta d_{ct} + u_{cat}, \tag{2}$$

In addition to the main specification, which uses a balanced panel of all cities for the three years that are available for all five countries (2005–2007), estimates are reported on a subsample that focuses on metropolitan areas—cities with more than 500,000 inhabitants—only. This restriction is necessary as data on the presence of formal cooperation arrangement across municipal boundaries (in the form of metropolitan governance bodies) are only available for metropolitan areas. The standard errors in the OLS estimations are clustered at the city level to allow for heteroscedasticity and arbitrary autocorrelation over time (for each city) in the error term.[21]

The key indicators are administrative fragmentation and metropolitan governance structures. Fragmentation is captured by the natural logarithm of the number of municipalities (for Germany, Mexico, and Spain), local authority districts (United Kingdom) or counties (United States) within a city, based on data from the OECD Metropolitan Database.[22] Governance structures are based on the OECD Metropolitan Governance Survey (Ahrend et al., 2014) and enter the equation as a binary indicator for the presence of a governance body (which is also interacted with administrative fragmentation). Regressions also control for agglomeration benefits by including the (natural logarithms of) population density and the area covered by the city.

The two-step estimation accounts for selective sorting, but other aspects might influence both governance and productivity in cities, resulting in biased estimates. One

[20]Panel data are only available for three countries (Germany, Spain, and United Kingdom). The common specification can therefore not account for individual specific unobserved skill differences in the first step. Whether individual fixed effects would improve the estimation is not clear, as identification of productivity differentials would only rely on individuals who move between cities, a group that is likely highly selected (Combes et al., 2011).

[21]As the specifications include country-fixed effects, the standard errors should ideally be clustered at the country level. With five countries in the sample this is not feasible and spatial autocorrelation in the error could be a source of bias in the standard errors.

[22]For the OECD Metropolitan database see: http://dotstat.oecd.org/Index.aspx?Datasetcode=CITIES and http://www.oecd.org/gov/regional-policy/functionalurbanareasbycountry.htm.

concern is reverse causation, which could result in either upward or downward bias. On the one hand, productivity shocks can increase a city's commuting zone and lead to increased administrative fragmentation, which would result in a downward bias. On the other hand, more successful urban centers might be able to leverage their economic success and merge with surrounding administrations, which would lead to upward bias. To reduce the possibility of reverse causality, both the definition for FUAs and the measure of administrative fragmentation are based an earlier time period (2001) than the estimated city-year productivity differentials (2005–2007).

To further reduce the potential confounding factors additional controls are introduced to the specification. These include a capital city and port city dummies[23] and indicators that capture the industrial and skill structure of cities, calculated from the five estimation samples. These indicators are the share of employees working in one-digit industries, with manufacturing split into four categories based on technology intensity, and the Herfindahl Index of employment shares at the two-digit industry level are used to capture the industrial structure. The Herfindahl Index is defined for each city as the sum of the squared employment shares in each industry.[24] Finally, the share of university degree holders among the 25–64-year-old workforce in the city is used as a measure for human capital. Summary statistics for each of the indicators are presented in Table A1 of the appendix that also includes further descriptions of the datasets.[25]

As urban agglomerations expand beyond the boundaries of its central city, administrative fragmentation, but typically also the complexity of the urban form (the shape of the agglomeration) increases. Natural barriers (such as water bodies or mountains) or land use and building regulations and past investments (roads and public infrastructure) might favor development along paths that do not necessarily lead to the most compact or efficient urban form. To assure that it is indeed the impact of administrative boundaries and not the city's urban form that drives the results, four indicators that capture the shape of the city are constructed. The metrics follow Angel, Parent ,and Civco (2010) and capture the *remoteness* (average distance between the population-weighted centroid and all interior points), *spin* (average of the squared distances to the population-weighted centroid, giving more weight to extreme distance), *disconnection* (average distance between all interior points), and *range* (maximum distance between two points along the city's perimeter).[26] All four metrics are calculated using Euclidian distances for populated 1 km^2 cells inside the cities' boundaries (the "points") and are normalized using the radius of a circle with the same area as the (populated) area covered by the city.

Finally, the study considers two alternative indicators for administrative fragmentation, to assess the robustness of the results. The first is the concentration of population

[23]Port cities based on Lloyd's List "Ports" (http://directories.lloydslist.com/, accessed 1/7/2013).

[24]Spain and Germany are exceptions. For Spain, internal OECD estimates for city population are used. For Germany, only total employment can be observed; after the results from the last German census, municipality-level population data became unavailable. To estimate population in German FUAs the ratio of employment to population for 2000 (OECD estimates) is used to rescale the observed employment levels for all years.

[25]Despite the additional controls, the specification remains the estimation of a partial equilibrium. In a general equilibrium, residents might be willing to accept lower productivity (and therefore wages) if they are compensated by lower cost of living or higher amenities (e.g., in the Rosen-Roback model; Roback, 1982). This might create a bias if larger cities (or less fragmented ones) are associated with higher (dis)amenities, resulting in (upward) downward biased estimates.

[26]The authors would like to thank the anonymous referee that suggested these indicators. Labelling of the metrics follows Harari (2016). As additional controls, they increase the robustness of the analysis, although they might be capturing part of the fragmentation impact, since certain urban forms might sprawl into new municipalities.

TABLE 1: Regressions from Individual Country Regressions

	U.K.	Spain	Germany	U.S.	Mexico	U.K.	Spain	Germany	U.S.	Mexico
ln (population)	0.015	0.034***	0.037***	0.063***	0.042**					
	(0.009)	(0.012)	(0.010)	(0.008)	(0.020)					
ln (pop.density)						0.007	0.046***	0.068***	0.066***	0.022
						(0.010)	(0.011)	(0.010)	(0.009)	(0.019)
ln (area)						0.018*	0.032**	0.020**	0.058***	0.083***
						(0.010)	(0.013)	(0.009)	(0.010)	(0.021)
R-squared	0.607	0.294	0.191	0.914	0.483	0.617	0.314	0.328	0.915	0.569
Observations	707	532	981	345	825	707	532	981	345	825
FUAs	101	76	109	69	75	101	76	109	69	75

Notes: Table reports OLS regressions with estimated Functional Urban Area (FUA) productivity as dependent variable. FUA productivity is estimated by applying individual wage regressions to national microdata in order to control for workforce composition of cities. Log hourly wages/earnings are regressed on a gender (dummy), age, age squared, education (dummies), occupation (dummies), and city-year dummies; the coefficients of the latter are taken to denote productivity differentials. (see text for details). Variable definitions in section 4. Standard errors are clustered at the Functional Urban Area level, all specifications include time fixed effects.

Data sources: U.K.: ASHE/LFS; Spain: MCVL; Germany: IAB; U.S.: IPUMS; Mexico: ENE/ENOE.

***,**,* indicates a statistically significant coefficient at the 1 percent, 5 percent, and 10 percent level.

Sample years are: 2004–2010 (U.K.); 2005–2011 (Spain); 1999–2007 (Germany); 1990, 2000, 2005–2007 (U.S.); 2000–2010 (Mexico).

in the largest municipality and has been previously used in the literature (Cheshire and Magrini, 2009); the second uses the Herfindahl Index of population shares across municipalities. A second set of robustness checks aims at assessing whether individual countries in the study are driving the results. Since the number of metropolitan areas in each country is small, individual country regressions that evaluate the link between governance structures and productivity are infeasible. For administrative fragmentation, the main specifications are re-estimated interaction fragmentation with country dummies. For metropolitan governance, this strategy is infeasible, instead, a jackknife-style procedure is used, that is, the regressions are re-estimated using a sample that leaves out one of the countries at a time.

4. EMPIRICAL RESULTS

As a benchmark, it is useful to put numbers to the suggestive trends for agglomeration benefits in the descriptive graphs of section 2. Country-by-country regressions show productivity to be higher in larger cities across all five countries in this study (Table 1). When city productivity differentials are regressed on city population, the estimated elasticities range from 0.015 (United Kingdom) to 0.063 (United States). That is, a worker in an U.S. city with a population that is 10 percent larger than that of another comparable U.S. city is, on average, about 0.63 percent more productive.[27] The main results from the pooled regression, reported in Table 2, present equally strong evidence for sizeable agglomeration benefits. They indicate that, a city with 10 percent more residents is associated with 0.38 percent higher productivity (column I).

The source of agglomeration benefits can be further disentangled by a specification that uses both population density and surface area of the city. The coefficient of (the natural logarithm of) population density gives the elasticity of city productivity with respect to its population size, holding constant the surface area covered by the city. The coefficient

[27] Interpreting the elasticity multiplied by 100 as the percent increase in productivity associated with a “doubling in city size” is commonly used in the literature to give an idea of the size of the impact. The interpretation is not exact as the ln-approximation error is only negligible for small changes. The exact marginal effect for a doubling in city size is the product of the estimated coefficient with ln(2)≈0.693.

TABLE 2: Pooled Regressions: Common Years (2005–2007)

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
ln (population)	0.038***							
	(0.005)							
ln (density)		0.037***	0.048***	0.037***	0.034***	0.016**	0.022***	0.013*
		(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
ln (area)		0.038***	0.064***	0.062***	0.058***	0.036***	0.043***	0.031***
		(0.006)	(0.008)	(0.009)	(0.010)	(0.008)	(0.009)	(0.008)
ln (municipalit.)			−0.032***	−0.036***	−0.036***	−0.029***	−0.027***	−0.024***
			(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.005)
ln (pop. in catchment area)				0.018**	0.017**	0.012*	0.010	0.010
				(0.008)	(0.008)	(0.007)	(0.008)	(0.007)
University graduates (%)				0.283***	0.258***	0.275***	0.319***	0.303***
				(0.077)	(0.075)	(0.073)	(0.069)	(0.071)
Capital				−0.011	−0.000	0.028	0.039	0.035
				(0.037)	(0.038)	(0.030)	(0.029)	(0.025)
Port				0.027**	0.027**	0.039***	0.027**	0.035***
				(0.011)	(0.011)	(0.010)	(0.011)	(0.009)
Herfindahl Index					−0.698*	−0.704***	−0.615**	−0.616**
					(0.358)	(0.266)	(0.311)	(0.255)
Agriculture						0.0808		−0.117
						(0.257)		(0.255)
High-tech manufacturing						1.104***		0.669***
						(0.234)		(0.225)
Med. high-tech manufacturing						0.840***		0.531***
						(0.135)		(0.142)
Med. low-tech manufacturing						0.494***		0.249*
						(0.146)		(0.139)
Low-tech manufacturing						0.082		−0.102
						(0.149)		(0.150)
Electricity						−0.931**		−0.843*
						(0.463)		(0.456)
Trade						0.223		−0.142
						(0.171)		(0.182)
Catering						0.472**		0.176
						(0.230)		(0.231)
Transport and communication						−0.126		−0.162
						(0.200)		(0.191)
Finance						0.878***		0.286
						(0.181)		(0.177)
Real estate and business						0.410**		0.348**
						(0.176)		(0.167)
Public administration						0.057		−0.163
						(0.261)		(0.258)
Educ., health and social work						−0.120		−0.294**
						(0.154)		(0.148)
Other services						0.535*		0.404
						(0.275)		(0.277)
R-Squared	0.760	0.760	0.779	0.791	0.794	0.854	0.828	0.866
Observations	1,290	1,290	1,290	1,290	1,290	1,290	1290	1290

(Continued)

TABLE 2: Continued

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
FUAs	430	430	430	430	430	430	430	430
Controls		None			Core	+Ind		
East Germany dummy	No	No	No	No	No	No	Yes	Yes

Notes and data sources: see Table 1.
Includes an interaction control of country and year fixed effects (Country x Year FE).
***,**,* indicates a statistically significant coefficient at the 1 percent, 5 percent, and 10 percent level.

on (the natural logarithm of) city surface area captures the impact of an expansion of city limits while population density remains constant; that is, when population and area expand at the same rate. Finally, the difference between the area and the density coefficients gives the estimated impact of increasing the surface area covered by a city while holding the total population constant (i.e., decreasing density with the given population spreading out over a larger surface).

Interestingly, coefficients for population density and area are similar (Table 2, column II), indicating that both an increased population for a given surface area, and an increased spatial extent, while population density remains constant, have similar productivity effects. However, an increase in the surface area–for a given population–does not increase productivity, as suggested by the difference of the two coefficients that comes to zero. The introduction of additional city characteristics as controls leads to estimated agglomeration elasticities ranging from 0.02 to 0.05, with highly statistically significant coefficients in all specifications (Table 2, remaining columns).

The main focus in this study is on horizontal administrative fragmentation. An indicator for fragmentation is included in Table 2 from the third column onwards. It is measured as the natural logarithm of the number of municipalities within a city.[28] It is important to note that the specification controls for city size, since size is already captured by the population density and area indicators in the regression. The variable is also implicitly normalized for each country since the empirical specification includes a full set of country-year fixed effects. The result of the inclusion of this variable is a striking productivity penalty for more fragmented cities. The estimated coefficient (–0.032) is negative and highly statistically significant. The magnitude of this result remains largely unaffected when further controls are introduced to the estimation, resulting in a range of elasticities from –0.029 to –0.037. The estimates are also of a similar order of magnitude as the estimated agglomeration benefits. They indicate that between two cities of the same size, in the same country, if one contains 50 percent more municipalities within its functional boundaries it is on average about 1.5 percent less productive.[29]

Arguing that coordination is simplified if residents are heavily concentrated in a single administration, Cheshire and Magrini (2009) proxy for the degree of fragmentation in urban regions using the proportion of residents living in the largest municipality. Table 3 considers this alternative measure of fragmentation. The results in the first three columns show that concentration of a city's inhabitants in the largest municipality, which facilitates coordination and indicates lower fragmentation, is indeed associated with higher

[28]Local authority districts for the United Kingdom and counties for the United States.

[29]The sample covers the period 2005–2007, but even more than 15 years after Germany's reunification there might be a concern for persistent structural differences. The descriptive evidence points toward differences between eastern and western Germany and Table 2 therefore also reports two specifications (columns VII and VIII) that include a dummy for eastern Germany. The results are in line with our preferred specification, albeit slightly smaller than the corresponding estimates without the dummy.

TABLE 3: Robustness Checks with Alternative Fragmentation Indicators (2005–2007)

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)
ln (density)	0.043***	0.031***	0.015**	0.046***	0.032***	0.016**	0.047***	0.034***	0.017**
	(0.006)	(0.008)	(0.007)	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)
ln (area)	0.044***	0.036***	0.022***	0.064***	0.057***	0.036***	0.064***	0.057***	0.036***
	(0.007)	(0.009)	(0.007)	(0.008)	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)
ln (municipalit.)				−0.036***	−0.041***	−0.029***	−0.034***	−0.038***	−0.026***
				(0.007)	(0.007)	(0.006)	(0.008)	(0.007)	(0.006)
Percentage of pop.in largest municip.	0.054**	0.063**	0.072***	−0.037	−0.037	−0.001			
	(0.026)	(0.025)	(0.021)	(0.029)	(0.027)	(0.022)			
Herfindahl Index for municipal population concentration							−0.013	−0.010	0.017
							(0.027)	(0.026)	(0.021)
R-Squared	0.763	0.775	0.845	0.780	0.794	0.854	0.779	0.794	0.854
Observations	1,290	1,290	1,290	1,290	1,290	1,290	1,290	1,290	1,290
FUAs	430	430	430	430	430	430	430	430	430
Additional controls	None	Core	+Ind	None	Core	+Ind	None	Core	+Ind

Notes and data sources: see Table 1; Definition of additional controls: see Table 2. Full results are reported in the online appendix.
Includes an interaction control of country and year fixed effects (Country x Year FE).
***,**,* indicates a statistically significant coefficient at the 1 percent, 5 percent, and 10 percent level.

TABLE 4: Robustness Checks with Urban Form Indicators (2005–2007)

	(I)	(II)	(III)
ln(density)	0.047***	0.035***	0.016**
	(0.006)	(0.007)	(0.007)
ln(area)	0.050***	0.044***	0.024***
	(0.008)	(0.010)	(0.008)
ln(municipalit.)	−0.025***	−0.028***	−0.024***
	(0.005)	(0.005)	(0.005)
Remoteness	0.085	0.098	−0.017
	(0.085)	(0.095)	(0.079)
Spin	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
Disconnection	−0.119	−0.11	−0.046
	(0.109)	(0.093)	(0.069)
Range	−0.008	−0.007	−0.003
	(0.021)	(0.016)	(0.011)
R-Squared	0.791	0.807	0.863
Observations	1,290	1,290	1,290
FUAs	430	430	430
Additional controls	None	Core	+Ind

Notes and data sources: see Table 1; Definition of additional controls: see Table 2. Full results are reported in the online appendix.

Includes an interaction control of country and year fixed effects (Country x Year FE).

***,**,* indicates a statistically significant coefficient at the 1 percent, 5 percent, and 10 percent level.

city productivity. A 10-percentage point increase in the share of the population residing in the core municipality is estimated to increase productivity, on average, by 0.5–0.7 percent. However, when both indicators, concentration and administrative fragmentation, are combined in the same specification—columns (IV) through (VI)—horizontal fragmentation measured by the (natural logarithm) of the number of municipalities is very robust and in line with the main estimates, but concentration of residents becomes insignificant. The significant impact of administrative fragmentation also remains when concentration is measured by the Herfindahl Index of population shares across municipalities within the city (columns VII–IX), instead of the population concentration in the largest municipality. The elasticity for administrative fragmentation remains around –0.03 and the Herfindahl Index is not statistically significant.

The Herfindahl Index introduced in the last columns of Table 3 might proxy–to some extent–for urban form by capturing partly the population distribution within the city. To ensure that the estimated penalty from administrative fragmentation is not capturing some unfavorable effects of urban form, Table 4 introduces explicitly four metrics that capture the spatial extent of the urban agglomeration. The estimated fragmentation penalty is slightly lower, with estimates ranging from –0.024 to –0.028, but remain statistically significant.[30] While urban form can certainly have an impact on local conditions,

[30]Out of the four urban form metrics only "spin" is statistically different from zero, with a positive sign indicating that more complex urban forms are associated with higher productivity. The positive impact should be taken with a grain of salt as endogeneity in the urban form metrics is not addressed. It is also worth noting, that–under certain conditions—a more complex urban form might actually be beneficial, for example, high values in the "spin" metric can indicate "tendril-like" expansions of the urban agglomeration, which would be present if the agglomeration develops along public transport corridors, alleviating congestion.

TABLE 5: Pooled Regression with Heterogeneity in Administrative Fragmentation (2005–2007)

	(I)	(II)	(III)
ln(density)	0.052***	0.039***	0.020***
	(0.006)	(0.007)	(0.006)
ln(area)	0.058***	0.055***	0.036***
	(0.008)	(0.010)	(0.008)
ln(municipalit.) x DEU	−0.035***	−0.036***	−0.031***
	(0.006)	(0.006)	(0.005)
ln(municipalit.) x ESP	−0.008	−0.019*	−0.021**
	(0.010)	(0.010)	(0.009)
ln(municipalit.) x GBR	−0.029**	−0.037***	−0.030***
	(0.012)	(0.012)	(0.010)
ln(municipalit.) x MEX	−0.066***	−0.066***	−0.047***
	(0.013)	(0.013)	(0.011)
ln(municipalit.) x USA	0.007	0.005	0.006
	(0.011)	(0.009)	(0.008)
R-Squared	0.792	0.804	0.859
Observations	1,290	1,290	1,290
FUAs	430	430	430
Additional controls	None	Core	+Ind

Notes and data sources: see Table 1; Definition of additional controls: see Table 2. Full results are reported in the online appendix.

Includes an interaction control of country and year fixed effects (Country x Year FE).

***,**,* indicates a statistically significant coefficient at the 1 percent, 5 percent, and 10 percent level.

our results suggest that administrative fragmentation still plays a key role when it comes to urban productivity premia.

The degree of decentralization, municipalities' powers, capacities, responsibilities, and financing differ across (and within) countries, which suggests that fragmentation might also have a heterogeneous impact. Table 5 introduces interaction terms between fragmentation and country dummies that allow for a differential impact in each country. For the three European countries, the estimates are fairly close to the average. The estimated penalty in Mexico is stronger than in Europe and for the United States, the coefficients are statistically indistinguishable from zero. The focus to this point was administrative fragmentation. However, it is important to note that the estimated penalty is likely a lower bound. Co-operation and coordination across municipalities, for example, in the form of governance bodies, is common in OECD countries and can alleviate, to some extent, the problems associated with fragmentation. If this is the case, not explicitly controlling for coordination bodies will result in underestimates of the true extent of the fragmentation penalty (i.e., the estimated coefficient is too small in absolute value). This might also account for the insignificant impact found for the United States. Governance bodies are more likely to be sustained in large cities and the U.S. sample contains only metropolitan areas. Therefore, explicitly introducing governance arrangements into the estimation is likely to be even more relevant for the U.S. subsample than it is for the other four countries.

Ahrend et al. (2014) collect information on governance bodies for *OECD metropolitan areas*, that is, FUAs with at least 500,000 inhabitants, a subset of the cities considered in this study. Accounting explicitly for governance bodies therefore limits the analysis to 140 metropolitan areas. While this decrease in the size of the available sample reduces the available degrees of freedom and therefore the precision of the estimates, especially

TABLE 6: Pooled Regressions on Governance Indicators for the Metropolitan Area Subsample (2005–2007)

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
ln(density)	0.064***	0.065***	0.049***	0.047***	0.048***	0.035***	0.035***	0.033***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.007)	(0.011)	(0.011)	(0.006)
ln(area)	0.082***	0.085***	0.085***	0.087***	0.086***	0.069***	0.070***	0.064***
	(0.012)	(0.012)	(0.014)	(0.013)	(0.007)	(0.014)	(0.013)	(0.008)
ln(municipalit.)	−0.032***	−0.057***	−0.035***	−0.066***	−0.049***	−0.028***	−0.033***	−0.020***
	(0.010)	(0.016)	(0.008)	(0.017)	(0.010)	(0.007)	(0.013)	(0.007)
ln(municipalit.)		0.031**		0.036**	0.019**		0.006	−0.007
× govern. body		(0.014)		(0.015)	(0.009)		(0.011)	(0.006)
Governance		−0.079**		−0.092**	−0.075***		−0.024	−0.011
Body		(0.034)		(0.038)	(0.023)		(0.027)	0.033***
R-Squared	0.847	0.855	0.869	0.880	0.89	0.928	0.929	0.934
Observations	420	420	420	420	420	420	420	420
FUAs	140	140	140	140	140	140	140	140
Additional controls	None	None	Core	Core	Core	+Ind	+Ind	+Ind
East Germany dummy	No	No	No	No	Yes	No	No	Yes

Notes and data sources: see Table 1; Definition of additional controls: see Table 2. Full results are reported in the online appendix.

Estimates include only metropolitan areas, that is, FUAs with at least 500,000 inhabitants, since information on the presence of a governance body is not available for smaller FUAs.

Includes an interaction control of country and year fixed effects (Country x Year FE).

***,**,* indicates a statistically significant coefficient at the 1 percent, 5 percent, and 10 percent level.

when the full set of controls is considered, it can nonetheless shed some light on the true impact of fragmentation.

To ensure that estimates on the selected sample are comparable with estimates on the full sample of cities, Table 6 replicates the key results from Table 2 for metropolitan areas only. The estimates are similar compared to the specification that includes the full sample of cities. The impact of administrative fragmentation is the same, but point estimates for agglomeration benefits are slightly higher. This difference is however not statistically significant. Columns II, IV, and VII introduce the impact of horizontal fragmentation in metropolitan areas with and without the mediating presence of a metropolitan governance body. The estimated impact of horizontal fragmentation becomes even more severe when the presence of governance bodies is taken into account. Without a governance body the estimated elasticity is about –0.06, nearly twice the size of the impact in Table 2. The fragmentation penalty is (roughly) halved if the city has a governance body.[31]

Given the small number of metropolitan areas in each country, combined with the need for significant variation for the presence of governance bodies, it is not possible to consider the impact of fragmentation and governance bodies in each country separately.

[31]The coefficient on the interaction term indicates the difference in the impact of fragmentation for cities that do have a governance body compared to cities that do not have a governance body. For example, the marginal effect of an increase in (ln) fragmentation in column (II) of Table 6 is: -0.057 + 0.031 x *gov.body*. Again, we re-estimate the specification including a dummy for eastern Germany and find similar results, with slightly smaller coefficients. As eastern German cities tend to be more fragmented than western German cities of comparable size and among the four metropolitan areas in Germany that do not have a governance body, two are in eastern Germany, which only has three metro areas in total. While many factors contribute to the different performance of German cities, part of the challenge for eastern Germany cities also arises from their governance arrangements.

However, it is possible to use a jackknife approach and re-estimate the models excluding one country at a time, which can reveal whether the results are driven by a single country (full table in the online appendix). Without controlling for industry shares the results are qualitatively the same as the main results in Table 6. For four of the subsamples the estimates range from –0.5 to –0.8 with governance bodies alleviating 40–60 percent of the impact. Excluding Mexico results in the weakest impact of administrative fragmentation, but even in this specification the elasticity is –0.32 and governance bodies actually alleviate nearly 100 percent of the penalty.

Returning to Table 2 and the remaining controls, aggregate human capital, measured by the share of university graduates in the city, increases productivity. A 10-percentage point increase in the share of university graduates is associated with a 2.8 percent increase in productivity. It is important to note that this result does not indicate the direct impact of human capital on productivity, but only the externality associated with working in a city with a large share of university graduates in the workforce. And, while port cities exhibit higher productivity—on average port cities are 2.7–3.9 percent more productive than comparable cities without a port—there appears to be no evidence that capitals differ systematically from other cities.

Industrial specialization, measured by the normalized Herfindahl Index of employment shares at the two-digit industry level, has a negative and weakly significant impact. This suggests that a diversified industrial structure has a positive impact on productivity. However, variation in estimates across specifications suggests that this finding is not overly robust. Moreover, clear evidence can be found that cities with a large share of employees in specific industries exhibit higher productivity. The base category in the regressions is the share of employees in construction, such that when an increase in an industry share is considered, the share of employees in construction is reduced by the same amount. The results (column VI in Table 2) indicate that a 1-percentage point increase in the share of high-tech manufacturing workers (and a concomitant 1-percentage point decrease in the share of construction workers) is, on average, associated with 1.1 percent higher productivity in the city. This productivity premium gradually reduces with the technological intensity of the manufacturing industry: it is 0.8 percent and 0.5 percent for medium-high-tech and medium-low-tech manufacturing, respectively, while it becomes insignificant for low-tech manufacturing. The productivity premium for financial intermediation is estimated at 0.9 percent for a 1-percentage point increase in the employment share, while that of business services and real estate activity is 0.4 percent. Interestingly, it is not only the knowledge intensive services that yield a productivity premium, but also technology intensive manufacturing.

The final variable considered to determine productivity is the proximity of a FUA to other cities. The variable captures the idea that the exchange of people, ideas, and goods is greatly simplified by close connections between places. The indicator measures the number of people that residents of a given city can directly interact with, within a "reasonable" amount of time, the idea being that a meeting of several hours can take place going back and forth within a day. It is defined as (the natural logarithm) of all inhabitants in other FUAs within a 300-kilometer radius around a city, divided by the distance. For the sample of all cities, the estimates in Table 2 indicate that, *ceteris paribus*, a 10 percent increase in the (distance weighted) number of city residents within 300 kilometers is associated with 0.1–0.2 percent higher productivity. While this effect suggests that cities benefit from proximity to other urban agglomerations, it is unlikely to capture the full impact of the position of a city within its local network of cities and rural areas. For example, estimates by Partridge et al. (2009) for the United States show that the impact on earnings differs for counties with cities of different sizes and that it is the distance to large agglomerations that create the strongest benefits, rather than general market potential.

5. CONCLUDING REMARKS

This paper estimates productivity differentials of functionally defined cities—FUAs—across five OECD countries (Germany, Mexico, Spain, United Kingdom, and United States) and investigates the relationship of urban productivity with a city's size and its governance structure—the degree of horizontal administrative fragmentation and the presence of a governance body. As far as the authors are aware, this paper represents a first attempt in the literature to empirically examine the relationship between administrative fragmentation, metropolitan governance structures and city productivity across a large number of cities. The microdata-based two-step econometric approach adopted in this paper enables the analysis to capture the pure productivity advantages that arise at the city level, accounting for the potential sorting of more productive individuals into certain cities. The comparability of the analysis is supported through the use of an internationally harmonized definition of urban areas, according to functional economic linkages, rather than administrative boundaries.

The results suggest a significant role for horizontal administrative fragmentation of a city's governance structure in determining the magnitude of city productivity premiums. Specifically, for two cities of similar size and population composition in terms of observable characteristics, but with one city comprising of 10 percent more municipalities, the estimates indicate that productivity in the more fragmented city is 0.3–0.4 percent lower. The estimate is likely a lower bound, as formal or informal mechanisms that facilitate co-operation and coordination within the urban agglomeration are often present. This study finds that if the presence of a metropolitan governance body is taken into account, the fragmentation penalty lies around 0.6 percent, with governance bodies alleviating the penalty to about half its size. The estimated effects are sizeable and of a comparable order of magnitude as the estimated agglomeration benefits, that is, the increase in productivity with city size. Pooled across five OECD countries, estimates indicate that, *ceteris paribus*, a 10 percent increase in city size is associated with a 0.2–0.5 percent increase in productivity.

While the presence of a governance body mitigates the negative effect of fragmentation, little is known about the underlying transmission mechanisms from administrative fragmentation, via governance arrangements to stymied productivity. Important policy areas that are likely to create inefficient outcomes at the metropolitan level are land use and transport polices, which can greatly benefit from adequate metropolitan coordination. Descriptive evidence suggests that the presence of governance bodies is associated with less sprawling development, and that transport authorities at the metropolitan level are linked with better quality in public transport provision (Ahrend et al., 2014). However, the influence of administrative fragmentation may stem from a variety of associated factors and warrants further investigation. This paper constitutes a first attempt to establish a link between governance arrangements and economic outcomes; a full examination of the causes of lower productivity in more administratively fragmented urban areas will require more detailed information on urban governance structures.

APPENDIX: DATA DESCRIPTION

United Kingdom

The estimation of the first-stage is based on data from the U.K. Annual Survey of Hours and Earnings (ASHE) for 2004–2010. ASHE is the largest survey on labor market statistics with approximately 160,000 employees a year. It is a random sample of around 1 percent of the National Insurance pool, as it tracks employees whose national insurance ends with a specific pair of digits. The information is collected by questionnaires sent

to employers in April each year, with questions on wages, job and individual workers characteristics. It is an unbalanced panel as individuals can be followed over time, but would drop from the survey if they become unemployed or move to self-employment. The sample is restricted to main jobs only.

ASHE provides detailed information on individual earnings and hours worked and for our analysis we use gross hourly earnings as our wage measure. Additional information on individual characteristics includes occupation, industry, whether the job is in the private or public sector, the worker's age and gender. Information on education is not available via ASHE and thus we have to impute education using the U.K. Quarterly Labour Force Survey for 2004–2010. Specifically, an individual's years of schooling in ASHE are simulated using estimates of the coefficients of the Best Linear Predictor of education from the Labour Force survey over the same period.[32] Quarterly Labour Force Survey (QLFS) is also used to construct most of the city controls of the second stage, like population, the share of university graduates, Herfindahl Index (two-digit SIC2003) and the various industrial shares. A more detailed description of the data used is offered in Georgiadis and Kaplanis (2016).

Spain

For the empirical analysis, the Muestra Continua de Vidas Laborales, MCVL, (continuous sample of working histories), an administrative dataset provided by the Social Security Administration is used. The recently released MCVL contains information of individuals who had an active record with the Social Security system at any time during the years 2005–2011. Each year the sample is a 4 percent nonstratified random draw from a reference population that includes employed workers (wage earners and self-employed), unemployment benefits recipients and pension earners. It consists of nearly 1.1 million individuals per year. The MCVL tries to reconstruct the employment and contribution history of the selected individuals. The information available on labor histories dates back to 1967 while earnings records are tracked since 1980.

Individuals that are registered in the Social Security as wage earners between 2006 and 2011 are selected and their working histories are used to construct most of the individual variables of the first stage. Since 2006, the MCVL can be matched with the tax records, which contains the summary for each fiscal year of all the withholdings and prepayments of personal income tax on earned income, economic activities, prizes, and income imputations. Since, the aim is to investigate issues related to wages, this data is suitable as this category of income is well represented by the reliability and the general scope of the tax data for earned income. These tax records allow the construction of an annual panel covering the period 2005–2011, with very precise information about individual earnings. Therefore, all individual wages for all workers in the MCVL for that period are accounted for. In order to have the maximum number of observation the tax records are merged for all the available years, that is, 2005–2011. The analysis is restricted to wage earners, self-employed are left out of the sample. The OECD defines 76 FUAs in Spain, which represents about 62 percent of the Spanish population. In the MCVL, only municipalities with more than 40,000 inhabitants can be identified. For a detailed description of the necessary adjustments in order to construct FUAs well as

[32]In particular, education was simulated using coefficients' estimates of regressions of education on year of birth and year of birth squared separately by two-digit occupation in the Quarterly LFS (2004–2010) and information on year of birth and two-digit occupation code in ASHE. Other studies based in ASHE use occupation controls as proxies for education arguing that the former is a fairly good proxy for the latter (Gibbons et al., 2010; Kaplanis, 2011).

further information on the variables used in the regressions, the reader should refer to Diaz-Serrano and Kaplanis (2016).

Germany

For the German individual level regressions, the Employment Panel of the German Federal Employment Agency (BA) hosted by the Research Data Centre (FDZ) at the Institute for Employment Research (IAB) is used.[33] The data contains a 2 percent sample of all registered employees who are subject to social security contributions on the reference date. The sample is a panel dataset that covers the years from 1998 to 2007 and the onsite version of the dataset contains information on the municipality (*Gemeinde*) of residence.[34]

The data does not contain information on hours worked (other than part-time status). It is therefore necessary to estimate earnings rather than wage differentials across FUAs. As controls gender, age (and its square), educational attainment, occupational standing (apprentice, white or blue collar, master craftsmen, etc.; seven categories), and occupation (three-digit) are added.

United States

For the United States, the sample combines the U.S. censuses from 1990 and 2000 with the American Community Survey for the years 2005–2007. The data are provided as a scientific use-file by the IPUMS project.[35] The available information on county of residence is used to link the IPUMS data with the OECD (2012a) definition of FUAs. Since not all counties are identified in the scientific use-file, the metropolitan statistical area/s (MSAs) that coincide with a FUA is identified and observations from those MSAs are added. The resulting IPUMS-based estimates for FUA size are close to the corresponding OECD calculations.

To estimate the wage equations hourly wages are constructed as the sum of all earnings from wages in the last year divided by the product of the number of hours usually worked per week in the previous year and the number of weeks worked. The estimates include controls for part-time status (using the Bureau of Labor Statistics definition of usually working less than 35 hours per week), gender, educational attainment, age and its square, and occupation (three-digit codes). Sampling weights are used in all calculations.

Mexico

The data refer to 2000–2010 and come from the Labour Force Surveys (National Occupation and Employment Survey, ENOE and the National Employment Survey, ENE), carried out by the National Institute of Statistics and Geography of Mexico (INEGI). Data from 2000 to 2004 are derived from the National Employment Survey (ENE) and from 2005 to 2010 data refer to the National Occupation and Employment Survey (ENOE). Both are household surveys, whose selection units are dwellings selected by sample techniques.

The Mexican labor force surveys (ENE and ENOE) are representative of urban and rural areas, as well for each of the 32 Mexican states, include a quarterly rotating panel of survey respondents, and is a rotating panel (rotation scheme of 20 percent, i.e., workers are observed at most five times over a five-quarter period).

[33]See Schmucker and Seth (2009) for a detailed description of the data.

[34]The sample changes slightly in 1999. The study is therefore limited to the years 1999–2007.

[35]Ruggles et al. (2010)

The data provide information on both economically active (labor force) and noneconomically active population and is referred to persons aged 15 years onward. The surveys cover social and demographic information and provide details about job characteristics, incomes, work duration, demographics, and education. Schooling was aggregate in five categories: no schooling or incomplete primary; complete primary; lower secondary; upper secondary and higher or tertiary. The data contain a monthly earnings variable from which we calculate logarithmic hourly wages as the ratio of monthly earnings to 4.3 times the hours worked weekly. For individuals who report their wages as a multiple of the minimum wage, we assign as their wage the mean of the interval.

Additional city controls that are not from ENE or ENOE, have also been used. For city population, we use information from the census for the years 2000, 2005 and 2010 and interpolate the intermediate years. (Source: INEGI, General Census of Population and Housing, 2000, 2005, and 2010). For the land area, the data come from the Mexican Statistical Office, INEGI (Cartography of land use and vegetation 2002 and 2005). Finally, port data come from the Mexican Ministry of Transportation and Communications (STC), through the General Coordination of Seaports and Merchant Marine. A more detailed description of the data used for Mexico is offered in Kaplanis and Tello (2016).

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