Urban Fabric Designed for Diversity

How the Structure of Great European Cities Influences Attitudes and Behavior

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Abstract

Urban design influences how we go about our lives and even how we feel about our neighbors. Using data from the Copernicus Urban Atlas, I find that residents of cities across Europe that have more continuous urban fabric are more likely to think that migrants are good for their city. I argue that contact theory and the writing of Jane Jacobs can explain this relationship: compact design encourages neighborly interaction which, in turn, encourages inclusivity. To further test this framework, I compare 73 cities in Spain and find that those who live in cities with more continuous urban fabric are less likely to support the far right. Not only can social scientists use the Copernicus Urban Atlas to study attitudes, they can use it to predict behavior, too. In the final chapter, I demonstrate that models based on its data can improve on the classic gravity model of human mobility.

Resum

El disseny urbà influeix en les nostres vides i fins i tot en allò que sentim pels nostres veïns. Utilitzant dades de la Copernicus Urban Atlas, descobreixo que els residents de les ciutats europees amb un teixit urbà més continu són més propensos a pensar que els immigrants són bons per a la seva ciutat. Sostinc que la teoria del contacte i els escrits de Jane Jacobs poden explicar aquesta relació: un disseny compacte fomenta la interacció entre veïns, cosa que alhora afavoreix la inclusivitat. Per posar a prova aquesta idea, comparo 73 ciutats espanyoles i descobreixo que els que viuen a ciutats amb un teixit urbà més continu són menys propensos a recolzar l'extrema dreta. Els científics socials no només poden utilitzar la Copernicus Urban Atlas per estudiar actituds, sinó també per predir comportaments. A l'últim capítol, demostre que els models basats en les seves dades poden millorar el clàssic model gravitacional de la mobilitat humana.

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Chapter 1

INTRODUCTION

More than anything else, this thesis is about a dataset. It's about other things too, but data is what ties it together. The three papers that make up the thesis answer important questions, but they also shine light on new ways to answer those questions; their data is an overlooked piece that fits many social science puzzles.

I pursued a PhD because I knew that cities were important to me and wanted to figure out why. I grew up in a small, Vermont town but I've lived my adult life in Boston, Washington, D.C., New York City, Barcelona, and Zürich. The contrasts I've seen—village vs. metropolis, American city vs. European city—have made it clear that the design and structure of our cities impacts how we live, of course, but also how we relate to each other. I wanted my thesis to attempt to quantify what I, an untrained, non-academic city dweller, had felt.

Early on, I sought out quantitative data I could use to compare European cities and the attitudes and behaviors of their residents. I was particularly interested in attitudes toward diversity. While exploring city-level statistics in Eurostat's Urban Audit database, I came across some interesting but mostly unexplained variables among the environmental indicators: "Share of land (%): Continuous residential urban fabric" and "Share of land (%): Discontinuous residential urban fabric."

These figures come from the Copernicus Urban Atlas, which uses

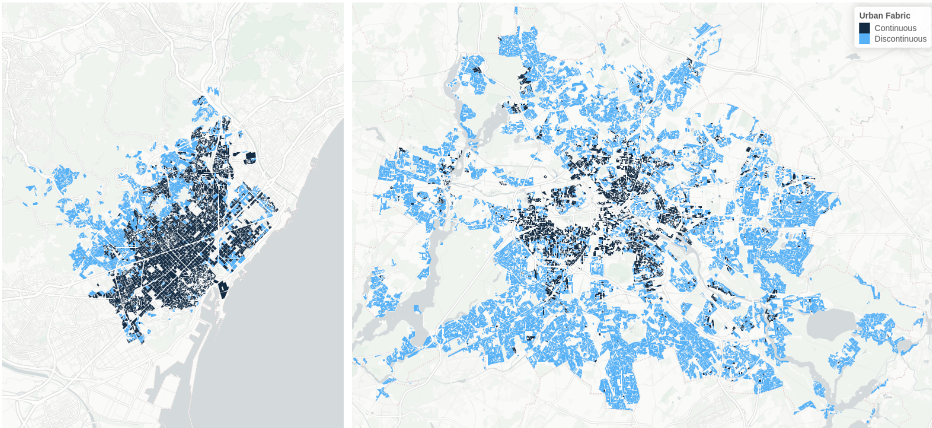

Figure 1.1: Urban fabric of Barcelona and Berlin. Dark blue polygons are designed as "continuous urban fabric" by the Copernicus Urban Atlas 2018, light blue polygons are "discontinuous urban fabric."

satellite data to map Europe's cities by land cover type. Any urban area with residential buildings is classified as "urban fabric," which is then disaggregated into it's "continuous" and "discontinuous" types. Continuous urban fabric is any zone in which at least 80 percent of the land is artificially covered—by buildings, sidewalks, or streets, for example. In discontinuous urban fabric, then, at least 20 percent of the land is vegetated (Copernicus, 2018). This environmental distinction also brings to mind the work of Jane Jacobs and the distinction she made between traditional, compact urban design and suburbanized, modernist designs. Most of the modern designs she railed against had one thing in common: they inserted grass into previously-continuous urban fabric.

Figure 1.1 maps the continuous and discontinuous urban fabric of Barcelona and Berlin. Aside from a few modern redevelopment projects to the east and hillside neighborhoods to the north and west, Barcelona is dominated by continuous urban fabric. Berlin, on the other hand, has a mix of continuous and discontinuous areas at its core, which is surrounded by a great deal of discontinuous urban fabric.

In Figure 1.2, we see what the difference between these classes looks

Figure 1.2: Google Earth images of continuous urban fabric (in Barcelona, left) and discontinuous urban fabric (in Berlin, right).

like at the neighborhood level. In the upper half of the Barcelona image we see part of the Sant Antoni neighborhood and its octagonal blocks which are typical of the city's Eixample neighborhoods designed by Ildefons Cerdà. The neighborhood in the bottom half of the Barcelona image is El Raval and its even more compact pattern of narrow, interwoven streets. Both neighborhoods are examples of continuous urban fabric, and though the design specifics differ, in both areas buildings come right up to the sidewalks, the distance between intersections is short, and there is very little vegetation within the urban fabric (parks of any substantial size are a separate land cover class, "green urban areas," and are not part of the distinction between continuous and discontinuous urban fabric).

The image at the right of Figure 1.2 is of discontinuous urban fabric in Marzahn, Berlin. Here, again, the top and bottom of the imagine demonstrate two styles of urban design. Indeed, the two areas typify two schools of modernist urban redevelopment ideals which Chapters 2 and 3 each describe in greater detail. In brief, philosophical and hygienic concerns over urban life in the early 20th Century gave rise to two broad urban design trends which both sought to replace urban fabric with grass. One trend preferred tall residential buildings set back from streets, much like the top of the Marzahn image. The other trend preferred to suburbanize cities and give priority to single-family homes with lawns, like the area we see at the bottom of the image.

Jacobs (1961) identified several significant social consequences of these modernist urban redesigns. She contrasted the vitality of cities and neighborhoods with traditional, continuous designs with the dullness of modern, discontinuous redevelopment. While traditional designs with short blocks and various uses would attract human activity throughout the day, few people would linger on the walkways joining discontinuous housing projects or the sidewalks of suburban-style residential neighborhoods. Without human activity, Jacobs found, crime would rise and neighbors would be less likely to interact and become acquainted. Quantitative studies of Jacobs’ theory have shown that the type of design she advocates for does indeed attract more activity, (Delclòs-Alió et al., 2019; Sung and Lee, 2015; Sung et al., 2015), while others have argued that thinning out compact neighborhoods thins out human activity (Gehl, 2011) and even that “continuous urban fabric,” specifically, produces more vital neighborhoods (2012).

Though Jacobs was well aware that racial inequity is deeply ingrained in society in the United States, she believed that urban design likely played a role in segregation and discrimination—for good or ill (Laurence, 2019). We now have a good idea why. Recent advances in contact theory and related fields have demonstrated that people who have been exposed to outgroups—migrants, racial or religious minorities, LGBTQ people, or even members of an opposing basketball team—are more likely to have positive attitudes toward that group (Pettigrew et al., 2011; Vezzali and Stathi, 2017a). If certain forms of urban design or structure promote activity, exposure, and interaction among their city’s diverse population, then people who live in those cities should have fewer discriminatory beliefs.

If Jacobs is right about the importance of urban design, and we have access to data that approximates the distinctions in her theory, there are many open questions in social science that could benefit. Among these are whether contact theory applies as well in real-life settings as it does in the wealth of experiments found in the literature, and whether geographic context can help clarify the still-blurry portrait of the typical far-right voter.

In Chapter 2, I lay out a theoretical framework grounded in urban theory and contact theory and test its implications. Using Eurostat's city-level summary statistics of the Copernicus Urban Atlas land cover data, which I merge with individual-level survey data, I compare 22 European cities. The key independent variable is the percentage of each city's urban fabric that is classified as "continuous." In models accounting for potential confounders, such as the city's region in Europe and its migrant population dynamics, I find that residents of cities with more continuous urban fabric are more likely to hold positive views toward the migrants in their city.

While this finding is important and exciting, it also raises several questions. I believe that the theoretical mechanism, which links urban theory and contact theory, is convincing, but it is surprising that the influence of urban design (which may be subtle) could be identified in a study of just 22 cities from a variety of national and regional contexts. Would the relationship hold in a study with a higher city-level n? Are there other implications of the theory which, when tested, could help clarify the mechanism at play? Do the broad classes of urban fabric in the Copernicus data truly influence human activity? In Chapters 3 and 4, I work to answer these questions and give further validity to the findings of this thesis.

Chapter 3 replicates Chapter 2, but in a different context and with a different dependent variable. Compared to the rich, complex data of the Copernicus Urban Atlas itself, the summary statistics found in Eurostat are limited. Nevertheless, they are useful for social scientists who may not have access to or training in GIS software and analysis. While Chapter 4 takes advantage of the full breadth of the Urban Atlas, in Chapter 3 I study a context in which Eurostat's data on continuous and discontinuous urban fabric is comprehensive: Spain.

In Chapter 3, I use data on land cover, city-level migrant population dynamics, and, crucially, residential segregation for 73 cities in Spain. I find that residents of cities with more continuous urban fabric are less

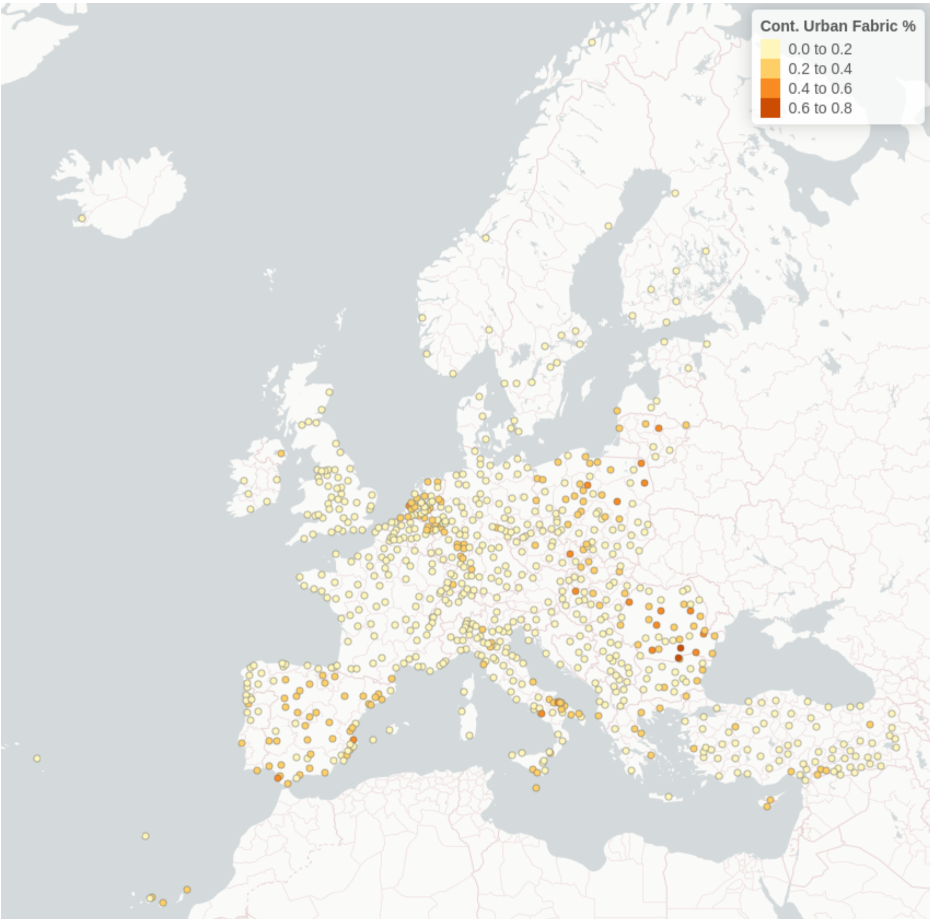

Figure 1.3: Functional urban areas of the Copernicus Urban Atlas 2018 with the percentage of urban fabric in each city that is designated as "continuous."

likely to report in national barometer surveys that they are considering voting for the far-right party, Vox. As with far-right parties elsewhere in Europe, Vox is staunchly anti-migrant and so I argue that the mechanism here is much the same as in Chapter 2. If it is true that continuous urban fabric encourages exposure to one's neighbors which leads to more inclusive attitudes, the relationship should be weaker in highly segregated cities. After all, if you and your neighbors are all alike, no amount of sidewalk activity will increase your exposure to diversity. The models in Chapter 3 show just that, that the positive influence of continuous urban fabric on attitudes is minimal in cities with the highest degree of residential segregation.

I believe that the findings of these two chapters are important on their own. But they also point to an untapped resource that can help social scientists make progress in longstanding debates. The latest edition of the Copernicus Urban Atlas includes data for 788 cities in and near Europe. Figure 1.3 maps those cities by their percentage of continuous urban fabric—the variable I use in Chapters 2 and 3—but the data set includes a great deal more. Table 1.1 gives the full list of land cover classes, including subclasses of discontinuous urban fabric. Figure 1.4 demonstrates the richness of the data by mapping the 23 classes found in the Brussels functional urban area.

In Chapter 4, I test whether land cover really influences human activity, as the previous chapters assume. Using data on mobility between urban districts, I construct machine learning models trained on the full set of Copernicus Urban Atlas land cover variables. I find that the land cover data is, indeed, predictive of human mobility in cities—and that continuous urban fabric contributes more to these predictions than any other form of land cover. The model I develop substantially improves on the classic gravity model of human mobility across a range of tests.

Code	**Class Name**
11100	Continuous urban fabric (>80% covered)
11210	Discontinuous dense urban fabric (50-80% covered)
11220	Discontinuous medium density urban fabric (30-50% covered)

11230	Discontinuous low density urban fabric (10-30% covered)
11240	Discontinuous very low density urban fabric ($<$10% covered)
11300	Isolated structures
12100	Industrial, commercial, public, military and private units
12210	Fast transit roads and associated land
12220	Other roads and associated land
12230	Railways and associated land
12300	Port areas
12400	Airports
13100	Mineral extraction and dump sites
13300	Construction sites
13400	Land without current use
14100	Green urban areas
14200	Sports and leisure facilities
21000	Arable land (annual crops)
22000	Permanent crops (vineyards, fruit trees, olive groves)
23000	Pastures
24000	Complex and mixed cultivation patterns
25000	Orchards at the fringe of urban classes
31000	Forests
32000	Herbaceous vegetation associations
33000	Open spaces with little or no vegetation
40000	Wetland
50000	Water bodies

Table 1.1: Land cover classes featured in the Copernicus Urban Atlas 2018.

In each chapter, I discuss the specific contributions I make to the persistent debate between contract theory and group threat theory, the messy portrait of who supports the far right and why, and the race to offer a model of human mobility that improves on the gravity model but retains its simplicity and ease of use. I hope that my arguments on each count are convincing, but I also hope that the following pages convince you of the outstanding potential that the Copernicus Urban Atlas holds for social

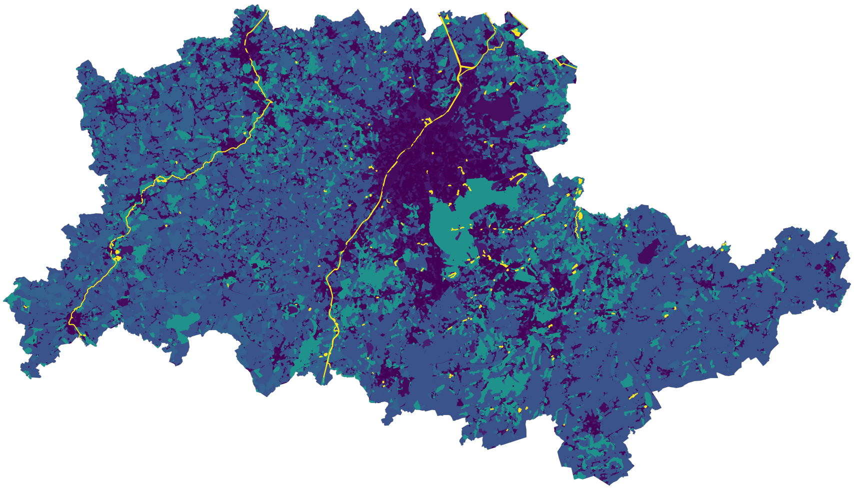

Figure 1.4: Copernicus Urban Atlas 2018 data for the Brussels functional urban area. Shown here with 23 classes of land cover mapped over 59,473 polygons.

scientists. I believe it can help answer questions that go far beyond those I cover in this thesis, whether through clean sets of summary statistics or vibrant and intricate geospatial data.

Chapter 2

CAN URBAN FABRIC ENCOURAGE TOLERANCE? EVIDENCE THAT THE STRUCTURE OF CITIES INFLUENCES ATTITUDES TOWARD MIGRANTS IN EUROPE

Does the structure of a city influence how its residents feel about migrants? Jane Jacobs railed against modernist planners who sought to replace the complex fabric of cities with suburbanized designs that prioritized sunshine and greenery. She theorized that this design trend had resulted in few opportunities for neighbours to interact with each other. In today's diverse cities, neighbourly interaction may be one key to enhancing social cohesion. Intergroup contact has been shown to reduce prejudice, and recent studies have found that even "mere-exposure" may have a positive effect. Taken together, the work of urban theorists and *contact theorists implies that residents of compact cities should be more likely to hold positive attitudes toward their neighbours—including migrants. Recent research, however, casts doubt on how well contact theory applies to the lived diversity of modern cities. This paper uses data from 22 European cities to identify a relationship between one's attitude toward migrants and the design of the city in which they live. It finds that, when controlling for individual- and city-level factors, residents of cities high in "continuous urban fabric" are more likely to agree that migrants are good for their city.*[1]

2.1 Introduction

Over the past half-century, European cities have been enriched by new dimensions of diversity due to migration. From the 1970s until the mid-1990s, European diversity policy was dominated by the paradigm of multiculturalism, which focused on establishing rights and cultural recognition for minorities. Since then, however, multiculturalism has faced a rhetorical backlash from both sides of the political spectrum. The right has argued that multiculturalism eroded national unity, while the left has contended that it failed to achieve meaningful equality (Kymlicka, 2010). Many cities in Europe have now embraced an alternative paradigm, interculturalism, which claims to address the concerns of both right and left through cross-cultural interaction. Parallel to the rise of interculturalism, a debate has been simmering over the so-called "progressive's dilemma." This theoretical dilemma holds that diversity and generous welfare states may be politically incompatible. Strong welfare states require high levels of taxation and, therefore, citizens who are willing to pay more in taxes for the benefit of their fellow nationals. If citizens do not feel solidarity toward minorities and migrants, they turn to welfare chauvinism policies which restrict migrants' access to benefits and allow inequality

[1]This paper was published on October 11, 2021, as: Kent, J., 2022. Can urban fabric encourage tolerance? Evidence that the structure of cities influences attitudes toward migrants in Europe. *Cities, 121*, p.103494.

to grow (Kymlicka, 2020). It is clear that European policymakers face a complex challenge to ensure that communities remain cohesive as they diversify and that migrants are met with solidarity and not exclusion. Interculturalists have proposed a wide range of public policy reforms, often highlighting the importance of public spaces as venues of contact and relationship-building between neighbours. These proposals are grounded in Allport's intergroup contact hypothesis, but they also bring to mind the work of Jacobs and Gehl, urban theorists who sought to design city neighbourhoods rich in neighbourly interaction.

Although a large body of research has found that intergroup contact does reduce prejudice, the efficacy of contact at the scale of a city, or even a neighbourhood, is contested. Wessel (2009) argues that we can better understand the value of contact by taking an interdisciplinary approach to the study of diversity in cities, with greater engagement from geographers and urban theorists. He distinguishes between two divergent perspectives in the literature: the contact theory perspective that diversity promotes tolerance and the growing perspective among geographers that diversity promotes conflict. He argues that, while researchers from the contact perspective have made strides in advancing beyond overly prescriptive initial theories, empirical research retains its "narrow focus on contact incidents" (p. 12). Instead, Wessel urges a focus on "casual contact." These forms of contact are too minute to be easily classified as explicit incidents and have elsewhere been referred to as exposures. Such small interactions are key to a geographical perspective on urban diversity: cities are home to millions of such exposures every day, and urban structure plays a vital role in determining how frequently residents cross paths. This temporal perspective is key to Wessel's argument about the uniqueness of cities: encounters in cities may be brief, but for residents they occur regularly, frequently, and repeatedly.

As Wessel notes, however, other scholars cast doubt on the efficacy of contact in promoting tolerance in urban neighbourhoods. Valentine (2008) argues that casual contact has been naively romanticized by researchers, and that we must instead focus on identifying and creating opportunities for "meaningful contact." Matejskova & Leitner (2011), in an ethnographic study, find "chance contact" across groups to be superficial and ineffective, and others have found that such encounters can be limited by segregation in public spaces Liu et al. (2020); Orum et al. (2009); Legeby and Marcus (2011). Using survey data, Piekut & Valentine (2017) suggest that the benefits of contact may be stronger in quasi-public spaces, like workplaces, social clubs, and restaurants, than in public spaces like sidewalks and parks.

Despite bountiful evidence of the efficacy of contact theory in a wide variety of settings, evidence that contact-promoting infrastructure, like public space, leads to a reduction in prejudice is mixed, at best. This paradox may be due, in part, to the difficultly in measuring the casual contact that Wessel emphasizes. Surveys and even ethnographies can miss the small, subtle contact that is frequent in large cities, creating a perception that only deeper contact is effective. This paper contributes to the debate by conducting a zoomed-out comparison of 22 European cities. Instead of seeking to identify specific sites or instances of contact, this paper shows that a broad type of urban fabric known to promote contact is associated with more tolerant attitudes. The findings suggest that—although they are difficult to quantify directly—momentary but frequent encounters between city residents do have the positive influence predicted by contact theory.

2.2 Literature review

In comparing cities, this paper is concerned with geographic variation in attitudes toward migrants, and I use Robinson's (2010) framework in order to situate the mechanism of interest—casual contact provoked by urban design—among other important individual and geographic factors. Robinson asserts that place matters in the formation of attitudes toward migrants, alongside individual-level factors. He proposes three dimensions as a framework for the effect of place. *Population characteristics* are the first dimension, including the socioeconomic makeup of both the native and migrant populations, the size of the newly-arrived migrant population, and other characteristics of the migrant population such as legal status. The *social and physical environment* is Robinson's second dimension. Among many examples of environmental factors, such as resource availability and patterns of mobility, he notes "opportunities for interaction" as a factor (p. 2461). The final dimension is the *sociocultural and historical background* of the place, including how diversity has been treated in the past and how political officials and the media frame immigration. Having sketched out this framework, Robinson calls for further research to identify the pathways by which these factors have an impact on attitude formation. Urban design which promotes contact falls within the social and physical environment dimension, but this paper's analysis also accounts for key characteristics of Robinson's other dimensions that may confound the relationship between urban design and attitudes. The inclusion of factors that represent each dimension is validated by a recent qualitative study of a neighbourhood in Glasgow, which found that the dimensions Robinson identified can be deeply intertwined (Bynner, 2019). The next subsection reviews theoretical and empirical research on the forms of urban design that promote contact, as well as recent research on how contact influences the complex dynamics of diversity in modern European cities. The second subsection briefly recapitulates research on the influence of population characteristics, which informs the inclusion of additional data in this paper's analysis.

2.2.1 Social and physical environment: opportunities for interaction

In her landmark book, *The Death and Life of Great American Cities* (1961), Jacobs advocates for the restoration of urban vitality, which has been threatened by design choices that lead to *dullness*. Jacobs uses the word vital to refer to neighbourhoods that are full of activity due and an *economic and social diversity* of people. While this paper uses the term diversity to refer to ethnic diversity, and more specifically diversity of national origins, Jacobs' use of the term encompasses a wider spectrum that includes people's backgrounds as well as the reason that they have come to a neighbourhood or block at a particular time. In *Great American Cities*, she is especially concerned with this physical and economic diversity which influences the variety of ways in which a city is used, as this diversity of uses and continuous flow of users is what gives a neighbourhood vitality. At all times of day, vital neighbourhoods are full of human activity, foot traffic, and eyes on the street. Alternatively, dull neighbourhoods may have periods of activity but, due to their lack of diverse uses, are otherwise quiet and empty. Neighbourhoods with a variety of uses are more likely to attract *strangers*, people whom a resident does not know. To Jacobs, strangers are what make cities distinct—and not simply large towns—because in cities, strangers vastly outnumber one's acquaintances. Therefore, the way in which city residents interact with strangers must be a key consideration of urban design.

These interactions take place at the sidewalk level, to which Jacobs gives a great deal of attention. There, vitality brings two key benefits: safety and contact between neighbours. On a bustling street, there is a steady flow of potential witnesses which discourages crime and makes residents and strangers feel safe. There are also many opportunities for neighbours to encounter each other and, potentially, turn strangers into acquaintances. Jacobs writes of the importance of the relationships which can form on the sidewalks of a city neighbourhood. "It is possible to be on excellent sidewalk terms with people who are very different from oneself, and even, as time passes, on familiar public terms with them. Such relationships can, and do, endure for many years, for decades," she writes (p. 62).

Jacobs devotes much of the book to developing four specific features of vital cities and the mechanisms by which they function. To achieve vitality, a neighbourhood must have mixed uses to draw foot traffic at all times of the day, short blocks to prevent isolation, some older buildings with lower rents, and a high concentration of dwellings and residents to fuel human activity. The specific conditions Jacobs develops have drawn the attention of recent research. Delclòs-Alió and Miralles-Guasch (2018) assessed, block-by-block, the extent to which Barcelona's urban structure fits with Jacobs' ideals using their JANE Index. The index comprises measures of population, housing, and building density; the mix of building uses; the length of blocks and width of streets; the age of buildings; the availability of public transportation; and the distance to border vacuums that discourage pedestrian activity, such as highways. The index score is the sum of the z-scores of these measures, with higher scores representing greater compliance with Jacobs' ideals. In a subsequent paper, the index was used to show that neighbourhoods with higher scores attract more pedestrian activity (Delclòs-Alió et al., 2019). This validation of Jacobs' theory echoes similar findings in Seoul (Sung and Lee, 2015; Sung et al., 2015). Despite the specificity of the 11-variable JANE Index, however, Delclòs-Alió and Miralles-Guasch allude to a simpler dichotomy between the "traditionally inherent vital nature" of Mediterranean cities and the "paradigm of modernity" which has made certain inroads in Barcelona (Delclòs-Alió & Miralles-Guasch, 2018, p. 506). This conflict can be seen in their results, which find that areas with low JANE Index scores are primarily those which were redeveloped with modernist, high-rise residences.

On the very first page of *Great American Cities*, Jacobs acknowledges that despite the specificity to come, her book is an attack on an entire philosophy—modern orthodox city planning—and not "quibbles" or "hair-splitting" about design trends. She traces the history of this orthodoxy to two key figures: Ebenezer Howard, whose Garden City ideal inspired a legion of anti-density followers that Jacobs calls "the Decentralists" and Le Corbusier, who envisioned high-density residential skyscrapers within vast parkland. Though the two schools differed on ideal densities, Jacobs writes that they agreed on one thing: "grass, grass, grass" (p. 22). Of his aspirations for New York, Le Corbusier wrote, "The whole city is a park. The terraces stretch out over lawns and into groves... Here is the city with its crowds living in peace and pure air, where the noise is smothered under the foliage of green trees" (Corbusier, 1987, p. 177).

To Jacobs, lawns are an indicator of the open designs that reduce human activity and contact between neighbours. She takes aim at both the lawns that frequently surround high-rise housing projects and suburban-style, single-family housing where space for lawns thins out crucial concentrations of people. She is not alone in this observation. Gehl (2011) focuses on the importance of quality spaces in drawing people out of their homes, but also makes distinctions between broad design philosophies. He writes that replacing compact urban fabric with high-rise buildings offset by grassy areas has the effect of discouraging foot traffic and reducing the amount of contact between neighbours. In cities that favour open designs or single-family housing, "communal outdoor activities have been reduced to a bare minimum,' he writes (p. 46–47).

Jacobs, writing during the Jim Crow era, was well aware of the depth of racism in the United States, referring even to the country's "master-race psychology" (1961, p. 284). She was under no illusions that urban design alone could eliminate discrimination, but, as Laurence (2019) writes in characterising her views on racism, she did believe urban design could help. If cities have a role in promoting tolerance, it is through public spaces and sidewalks where strangers—from different neighbourhoods or different backgrounds—encounter each other. She writes that such "room for great differences" is only possible in "intensely urban life" which she contrasts with the modernist "pseudosuburbs" (Jacobs, 1961, p. 72; Laurence, 2019).

The context of ethnic diversity in contemporary Europe is substantially different from the context in which Jacobs developed her theory. Perhaps most importantly, academics now understand that identities, which are often presented in simple dichotomies based on race or migration status, are actually shifting social constructs which intersect with other identities at individual and group levels. Vertovec (2021) argues that diversity in modern societies is better understood as a *social organization of difference*, his model of which includes three domains: configurations, representations, and encounters. Configurations are the economic, cultural, and even physical strata formed by political, social, legal, and other structures or institutions. Representation refers to the natural inclination of humans to place each other into categories and the social processes through which these groupings can flatten identities, ignore intersections, and encourage stigmatization. Encounters are causal or fleeting contacts made by members of different groups, groups which are, of course, products of the configurations and representations of that society.

Wilson (2017), in considering how the concept of encounter has been employed in research on post-colonial geography and animal geography, as well the study of urban diversity, argues that encounters are not simply contacts but contacts in which difference is noteworthy. She writes that “encounters make (a) difference” (p. 14). That is, our awareness of difference is formed by encounters, but encounters can also alter our perceptions of and attitudes toward difference. Given these dualling roles, the outcome of any given encounter is uncertain, and change may only come through an accumulation of contact. Wilson emphasizes the importance of the sensory effects of encounter, arguing for research that looks beyond face-to-face contact. Her work helps contextualize recent research that has questioned the capacity of casual contact to change attitudes toward diversity in cities.

The promise of encounter lies in intergroup contact theory, which originated with Allport’s (1954) hypothesis that contact across groups would reduce prejudice. His contact hypothesis has grown into the heavily researched intergroup contact theory, and recent work has shown that the benefits of contact extend beyond reducing prejudice and can also include enhancing empathy and altering political views. For example, studies of black and white college roommates, rich and poor friends, and neighbours of varied incomes have found that intergroup contact may also increase support for egalitarian public policies (Duncan et al., 2003; Kearns et al., 2014; Newman, 2014). Allport contended that contact would be most effective if four conditions were met: equal status of the participants, common goals among participants, a cooperative environment for contact, and societal or legal support for the interaction. A meta-analysis of 515 empirical studies of the theory found, however, that each of Allport’s four conditions is beneficial but not essential (Pettigrew & Tropp, 2006). Evidence for the effect of intergroup contact is so strong that research has begun to focus instead on the extended contact hypothesis, which holds that that the positive effect of contact extends to the friends of participants, even if those friends did not experience intergroup contact themselves. Zhou et al. (2019) conducted a meta-analysis of 115 studies and found significant effect sizes for both extended contact and direct friendship and found that there was not a significant difference between the two forms of contact.

Even "mere exposure," which falls short of contact, can have positive effects (Pettigrew et al., 2011). Research on the effect of exposure on attitudes has primarily been conducted in the laboratories of social psychologists. Zajonc (1968), who was an early pioneer in the field, focused on exposure between humans and objects. Two decades after Zajonc's key monograph, Bornstein (1989) conducted a meta-analysis which found extensive support for Zajonc's thesis that repeated exposure increased positive attitudes, and he noted that advertisers had already begun to leverage the power of repeated exposure. Bornstein suggested that researchers should shift their focus to exposure's effect on social interactions. More recent research has heeded this advice and found positive human-to-human effects, often by exposing subjects to photographs of faces in laboratory experiments (Rhodes et al., 2001; Harmon-Jones and Allen, 2001).

Matejskova and Leitner (2011), however, seek to remedy what they view as an uncritical acceptance of contact theory literature by scholars and policymakers by conducting an ethnography of relations between Russian Aussiedler and local German residents of Berlin's Marzahn locality. They express three chief concerns with the contemporary literature: insufficient attention to the forms of contact that actually worsen prejudice, the potential for reverse-causality in some research designs, and the reliance on clinical experiments that do not capture the "mundane contact" of "everyday settings" (p. 721). They conclude that these casual forms of contact have "little potential to spur transformation of anti-immigrant attitudes and prejudice" (p. 735) and focus much of their paper, instead on sustained contact that may take place in, for example, workplace environments. Despite acknowledging that the underlying mechanism of contact is likely affective, and not cognitive, they rely on the testimony of focus group participants to dismiss the value of casual contact. Furthermore, Marzahn suffers from a discontinuous, modernist design with few mixed-use areas, affording few opportunities for street-level contact to accumulate and overcome Wilson's first stage of encounter in which it "makes difference." Matejskova & Leitner find evidence of the duality Wilson describes, noting cases in which contact reinforces prejudice and that some prejudices may remain even after positive contact experiences.

Piekut & Valentine (2017) hypothesize that public spaces, like streets, have limited potential to improve attitudes due to divergent power relations and lack of opportunity for "meaningful contact." They compare these spaces to four other contact settings, consumption spaces, like cafes; institutional spaces, like workplaces or schools; socialisation spaces, like clubs; and private spaces. Using survey data from Leeds and Warsaw, in which respondents were asked to recall frequencies of intergroup contact in each type of space, they find institutional and socialisation spaces to have the most potential in Leeds but that public and consumption spaces fare best in Warsaw. These mixed results are further complicated by the question of reverse causality, which they only address by asking respondents whether they avoid contact with minorities. Liu et al. (2020) also contrast types of spaces, in this case "open spaces," like public courtyards or parks, and commercial spaces, by asking survey respondents in Beijing to recall how frequently they use the spaces and separately assessing the diversity of those spaces. They find that the presence of diverse public spaces in one's neighbourhood does not correlate with inclusive attitudes, but that self-reported usage of open spaces—regardless of the diversity of usership—does. Importantly, the researchers find, during field visits to several of the locations, that locals and migrants use the open spaces in very different ways, echoing other findings of segregation in public spaces (Legeby and Marcus, 2011; Orum et al., 2009).

2.2.2 Population characteristics

The relative size of a place's migrant population is a key factor of Robinson's population characteristics dimension and a factor that has been frequently studied. Often, the influence of migrant population size is attributed to perceptions by native residents that they face economic or cultural competition from migrants. Where migrant populations are large or rapidly growing, the perception of this threat is said to increase and worsen attitudes. This theory—variously referred to as group threat or perceived threat, among other terms—is often traced back to Blumer (1958), who proposed that such attitudes are a product of the relative position of groups within a society. Dominant groups, he theorizes, will develop prejudicial attitudes when an out-group is perceived to threaten their dominance. In the European context this has been applied at both the individual and group levels. At the individual level, studies have found negative correlations between individuals' economic means and their attitudes toward migrants (Heath and Richards, 2020). In this case, theory suggests that individuals who are more economically vulnerable are more likely to feel threatened by immigrants. At the group level, the competition explanation predicts that larger migrant populations will be seen as more threatening either economically, culturally, or generally (Dancygier and Laitin, 2014). Recent studies have noted, however, that the perceived size of the migrant population has more predictive power than the actual size (Gorodzeisky and Semyonov, 2020; Rustenbach, 2010; Schlueter and Scheepers, 2010).

The effect of migrant population size on attitudes has been often studied, but rarely at the city level. A recent meta-analysis of 55 studies identifies only 6 that conduct city-to-city comparisons, none of which consider variables related to urban fabric or structure and all of which compare cities in a single country (Pottie-Sherman and Wilkes, 2017). Hjerm (2009) compares municipalities in Sweden and finds that migrant population size did not have an effect on attitudes but calls for additional research comparing cities across national borders. Green et al. (2010) and Sarrasin et al. (2012) both compare Swiss municipalities and consider intergroup contact, but both operationalize it as friendships with migrants thereby disregarding the exposure or casual contact effect. Schlueter and Scheepers (2010) conduct a similar study in the Netherlands and additionally consider migrant work colleagues in measuring intergroup contact. Tolsma et al. (2008) also compare Dutch municipalities, though they focus on opposition to ethnic intermarriage. Finally, Taylor (1998) examines white attitudes toward African Americans based on municipal populations in the United States.

2.3 Hypotheses

The primary objective of this paper is to consider the effect of urban structure on residents’ attitudes toward migrants. Within Robinson’s second dimension, the pathway of interest is as follows. Residents of cities with more continuous urban fabric have more opportunities to interact with their neighbours, according to urban theory. Those who interact with members of other groups will be less likely to hold prejudices toward those groups, according to contact theory. This implies that residents of diverse cities with continuous designs will be more likely to hold positive attitudes toward out-groups. For this study, the out-group of interest is migrants.

> **Hypothesis 1:** The more continuous urban fabric in a city, the more likely individual residents will agree that migrants are good for the city.

An additional hypothesis considers the interaction of factors across two of Robinson’s dimensions. If continuous urban fabric provides opportunities for interaction with migrants, a large migrant population should further increase such opportunities thus strengthening the relationship between urban structure and attitudes.

> **Hypothesis 2:** The larger the migrant population in a city, the stronger the positive correlation between urban fabric continuity and attitudes toward migrants.

2.4 Research design and data

To test these hypotheses, I have constructed a multilevel dataset (see: Table 1) combining individual-level data from the Flash Eurobarometer 419

Quality of Life in European Cities 2015 survey and city-level data from the Eurostat Urban Audit. Eurobarometer 419 surveyed residents of 79 European cities in May and June of 2015. Each city’s sample of approximately 500 respondents was drawn from the population of EU citizens living in that city. The sample is suitable for this paper, which conducts cross-city comparisons with a primary focus on the attitudes of native residents. The survey includes several demographic questions which are used as individual-level controls, and the following question, which is used as the dependent variable, quoted here from the English-language version of the questionnaire:

”I will read you a few statements. Please tell me whether you strongly agree, somewhat agree, somewhat disagree or strongly disagree with each of these statements … The presence of foreigners is good for [CITY NAME]”

This question serves as the “attitude toward migrants” variable and was recoded to be dichotomous (agree/disagree). It should be noted that the phrasing of the question does not distinguish between migrants specifically and foreigners who may be present in the city for other reasons.

	Level	**Question/format**
Dependent Var.		
Attitude toward migrants	Individual	“The presence of foreigners is good for [city name],” recoded as dichotomous: agree, disagree
Independent Vars.		
Continuous urban fabric	City	Proportion of 2012$*$ residential urban fabric designated as continuous
Change in migrant population	City	Difference between 2001$**$ and 2015$***$ migrant populations as proportions of overall population
Migrant population	City	2015$***$ migrant population as a proportion of overall population
City population	City	2015 population of city aged 15 or older

City density	City	2015 population of city per square kilometre
Age	Individual	Continuous
Gender	Individual	Dichotomous
Age at end of education	Individual	Categorical based on age at completion of education: 15 or less, 16–19, 20 and older, still studying
Occupation	Individual	Categorical variable: employed, self-employed, manual worker, not working
Bill trouble	Individual	Categorical variable: "Difficulties paying bills in the last 12 months": most of the time, from time to time, never/almost never
Nationality	Individual	Dichotomous variable: reported nationality matches country of residence or not
Region in Europe	Region	Dummy variable

Individual-level data and city populations from Flash Eurobarometer 419 (Quality of Life in European Cities 2015). Other city-level data from the Eurostat Urban Audit. ∗ Except Barcelona, Madrid, Malaga, and Oviedo (2014), ∗∗ Except Geneva (2000) and Liege (2004), ∗∗∗ Except Amsterdam (2014)

Table 2.1: Data source details.

City-level variables come from Eurostat's Urban Audit database of city statistics and include variables on land cover and population. Eurostat's land cover data, based on the Copernicus Urban Atlas, provides the share of a city's land dedicated to particular uses including "continuous residential urban fabric" and "discontinuous residential urban fabric" (Eurostat, 2016). Continuous urban fabric is defined as areas of a city in which some buildings contain residences and at least 80 percent of the surface area is covered by buildings, streets, or other artificial surfaces. Discontinuous urban fabric, therefore, is the area in which some buildings contain residences but less than 80 percent of the area is artificially covered (Kosztra et al., 2017). The distinction between these two types of urban fabric mirrors the distinction Jacobs makes between dense urban designs that promote human activity and so-called "modern orthodox city planning" that emphasizes greenery and openness but reduces interaction between neighbours. The variable I will use to test Hypothesis 1, Hypothesis 2 is the proportion of total residential urban fabric in each city that is designated as continuous. The migrant population growth variable I will use to account for the relationship, found in the empirical literature, between population changes and attitudes toward migrants comes from Eurostat's population data, which is provided by national or local authorities and is available at somewhat irregular intervals. To maximize data availability, I have chosen the years 2001 and 2015 to identify the change in migrant population, which is calculated as the difference in the population proportion of migrants over that time period.

As controls, at the city level I include the static 2015 migrant population proportion, the overall population of the city, and the population density of the city, as well as a dummy variable of the city's region in Europe. Based on the literature reviewed above, leaving these variables out would have some potential to confound the relationship of interest in Hypothesis 1, due to their known association with a city's urban fabric (population and density) or attitudes toward migrants (migrant population variables). Region of Europe is especially important, as it is potentially associated with both the independent and dependent variables. The regions used in this analysis are geographical but closely reflect the country groupings developed by Bail (2008) and Heath and Richards (2020) based on social and political acceptance of migration. One additional city-level control variable, homicide rate, was tested but not included in the final models due to lack of significance, no impact on findings, and unclear theoretical grounding. At the individual level, age, gender, education, nationality, occupation, and economic wellbeing are also used as controls. More information on all of the variables, including some exceptions made to increase the city-level sample size, can be found in Table 1.

The analysis was conducted using multilevel logistic regression models. After accounting for city-level data availability and individual-level missing data, the dataset includes 10,003 individual-level observations within 22 cities, nested in three regions (see: Table 2 for city list and Table 3 for descriptive statistics). To enhance interpretability and model specification, the city-level variables are rescaled as one-standard-deviation z-scores. To best account for the small level-3 sample size of just three regions, I have followed the prescription of McNeish and Wentzel (2017) whose simulations found that, in models with incidental third levels at which there are no explicit research questions, a two-level model with a fixed-effect dummy variable for the third level is optimal. As such, I model random intercepts at the city level and utilize a dummy variable to distinguish regions.

Southern Europe	**Western Europe**	**Eastern Europe**
Barcelona, ES (469)	Amsterdam, NL (467)	Bratislava, SK (440)
Madrid, ES (451)	Antwerpen, BE (489)	Kosice, SK (429)
Malaga, ES (484)	Berlin, DE (462)	Sofia, BG (449)
Oviedo, ES (470)	Brussel, BE (463)	
Roma, IT (458)	Dortmund, DE (434)	
Torino, IT (463)	Essen, DE (431)	
Verona, IT (452)	Geneva, CH (455)	
	Hamburg, DE (461)	
	Leipzig, DE (436)	
	Liege, BE (464)	
	Munchen, DE (444)	
	Rostock, DE (432)	

Table 2.2: Cities in model by region with n in parentheses.

This research design has certain limitations. First, it uses city-level data, although much of the literature, including Jacobs (1961) and Robinson (2010), is especially interested in neighbourhood-level effects. While this is a limitation of the survey data utilized, which is only disaggregated by city of residence, using city-level data does have some advantages. City residents are much less likely to move between cities than between neighbourhoods, which substantially reduces the concerns over reserve causality that plague other studies. While a resident's attitudes toward immigrants could influence their choice of neighbourhood, choosing to relocate to another major city for this reason is less likely. Additionally, this paper is chiefly concerned with the casual contact that takes place anytime a city resident goes out in public. As such, it is not only important to know where a respondent lives, but where they work, shop, and socialize. The extended contact hypothesis also suggests that where a person's friends spend their time is important. While neighbourhood-level research is also important, focusing on the city-level reduces concerns regarding these spill-over effects.

The second important limitation is that this analysis uses a blunt measure of urban design, the ratio of continuous urban fabric to discontinuous urban fabric. I argue that this data broadly captures the dichotomy at the heart of Jacobs' writing, but it cannot capture any of the specific design features she identifies. Much of the current literature, especially that on exposure, pays a great deal of attention to specific public spaces, the features of those spaces, and the instances of contact that take place within. While this literature has provided many important insights, it also risks missing the forest for the trees. Wessel (2009) argues that greater attention to the temporal, and therefore cumulative, effect of casual contact may provide insight into the paradoxical discrepancies between contact theory literature and a growing body of on-the-ground research. This research design exploits the implications of urban theory to determine whether cities that should have more casual contact also have more tolerant residents.

Third, diversity in cities is more than a set of dichotomies, such as native-migrant. Quantitative research often strips individuals of their intersectional identities and sorts them into categories. Gawlewicz (2016) argues that, by treating migrants as a homogenous group, researchers "overlook migrant populations and what they bring to encounters" (p. 257). Unfortunately, due to the data employed, this paper cannot distinguish between groups of migrants in the independent variables nor in the construction of the dependent variable. As such, I am unable to assess how attitudes toward migrants vary based on the background, class, or gender of the migrants nor the inequalities they face. Furthermore, the dependent variable refers to foreigners, therefore attitudes toward domestic migrants is not captured. The exploratory model, described below, takes a small step toward adding complexity to the native-migrant dichotomy by assessing how the influence of urban fabric on attitudes varies by the occupation and economic means of the respondents.

	Min	**Max**	**Mean**	**SD**
Continuous urban fabric	8.96	84.84	33.45	16.59
Change in migrant population	-1.80	11.40	3.45	4.21
Migrant population	1.60	48.40	14.22	10.68
City population	162,896	3,035,226	894,690	840,730
City density	494.2	13,418.2	2955.6	3066.6
Age	15	98	52.3	17.9
	Count	**Pct.**	**w/o Miss.**	**Cum.**
Attitude to migrants: Positive	7618	69.1	73.6	73.6
Negative	2735	24.8	26.4	100.0
Missing	679	6.2		
Gender: Male	4466	40.5	40.5	40.5
Female	6566	59.5	59.5	100.0
Age at education end: 15 or less	1288	11.7	11.9	11.9
16–19	3633	32.9	33.5	45.4
20 or older	5374	48.7	49.6	95.0
Still studying	540	4.9	5.0	100.0
Missing	197	1.8		
Nationality: Native	10,643	96.5	96.5	96.5
Migrant	389	3.5	3.5	100.0
Bill trouble: Never or almost	7725	70.0	71.5	71.5
Time to time	2056	18.6	19.0	90.5
Most of the time	1027	9.3	9.5	100.0
Missing	224	2.0		
Occupation: Employed	3989	36.3	36.5	36.5
Self-employed	988	9.0	9.0	45.5
Manual worker	527	4.8	4.8	50.4
Not working	5425	49.4	49.6	100.0
Missing	58	0.5		
Region: Western Europe	6026	54.6	54.6	54.6
Eastern	1503	13.6	13.6	68.2

Southern	3503	31.8	31.8	100.0

Table 2.3: Descriptive statistics.

2.5 Findings

2.5.1 Hypothesis tests

The data was analysed by fitting a series of multilevel logistic regression models. The empty model found an inter-class correlation coefficient (ICC) of 0.12, justifying the use of multilevel analysis and indicating that, in this data, a relevant portion of the variance between individual attitudes toward migrants is related to individuals' city of residence. Table 4 reports the four models used to test the hypotheses and further explore the data and its implications.

Model 1 includes the individual-level control variables, the level-3 region dummy variable, and five city-level variables: migrant population proportion in 2015, change in migrant population between 2001 and 2015, urban fabric continuity, total city population, and city population density. To simplify interpretation, city-level variables are reported as z-scores, wherein one unit represents one standard deviation. In this model, and all subsequent models, I find support for Hypothesis 1.

	Model 1	**Model 2**	**Model 3**	**Model 4**
Continuous urban fabric	0.452**	0.496***	0.454**	0.363*
	(0.180)	(0.172)	(0.184)	(0.195)
Change in migrant pop.	-0.796***	-0.975***	-0.791***	-0.979***
	(0.126)	(0.156)	(0.122)	(0.160)
Migrant pop.	0.113	0.305	0.100	0.231*
	(0.107)	(0.188)	(0.127)	(0.135)
City population	0.003	0.028	-0.000	0.029
	(0.096)	(0.103)	(0.092)	(0.103)
City density	0.027	-0.117	0.052	-0.117
	(0.143)	(0.127)	(0.211)	(0.126)

Urban fabric x Migrant pop.		0.419		0.413
		(0.297)		(0.298)
Urban fabric x Change in mig. pop.			-0.025	
			(0.147)	
Age	-0.006**	-0.006**	-0.006**	-0.006**
	(0.003)	(0.003)	(0.003)	(0.003)
Gender (Ref: Male)				
Female	0.017	0.017	0.017	0.015
	(0.052)	(0.052)	(0.052)	(0.053)
Age at education end (Ref: 20 or older)				
15 or less	-0.760***	-0.759***	-0.760***	-0.742***
	(0.090)	(0.090)	(0.090)	(0.090)
16–19	-0.473***	-0.472***	-0.473***	-0.461***
	(0.056)	(0.056)	(0.056)	(0.050)
Still studying	0.423**	0.424**	0.423**	0.433**
	(0.172)	(0.172)	(0.172)	(0.170)
Nationality (Ref. Native)				
Migrant	0.699***	0.698***	0.700***	0.704***
	(0.146)	(0.146)	(0.146)	(0.138)
Bill trouble (Ref: Never or almost never) Most of the time	-0.488***	-0.488***	-0.490***	-0.484***
	(0.083)	(0.082)	(0.083)	(0.077)
Time to time	-0.292***	-0.292***	-0.292***	-0.284***
	(0.068)	(0.068)	(0.068)	(0.060)
Occupation (Ref: Employed)				
Self-employed	-0.024	-0.024	-0.024	-0.001
	(0.073)	(0.073)	(0.073)	(0.068)
Manual worker	-0.465***	-0.464***	-0.465***	-0.403***
	(0.143)	(0.124)	(0.143)	(0.127)
Not working	-0.165***	-0.165***	-0.165***	-0.165***

	(0.060)	(0.060)	(0.060)	(0.059)
Region (Ref: Western Europe)				
Eastern Europe	-1.080∗∗∗	-0.930∗∗∗	-1.102∗∗∗	-0.928∗∗∗
	(0.233)	(0.248)	(0.251)	(0.247)
Southern Europe	0.489∗	0.783∗∗∗	0.471	0.793∗∗∗
	(0.276)	(0.282)	(0.308)	(0.283)
Age at education end x Urban fabric				
15 or less				0.087
				(0.070)
16-19				0.093
				(0.069)
Still studying				0.149
				(0.220)
Occupation x Urban fabric				
Self-employed				0.188∗∗
				(0.077)
Manual worker				0.534∗∗∗
				(0.144)
Not working				0.023
				(0.055)
Bill trouble x Urban fabric				
Most of the time				-0.142
				(0.089)
Time to time				0.164∗∗∗
				(0.050)
Constant	2.337∗∗∗	2.171∗∗∗	2.360∗∗∗	2.153∗∗∗
	(0.245)	(0.291)	(0.261)	(0.287)
Observations	10,003	10,003	10,003	10,003
AIC	10,401.70	10,401.97	10,403.68	10,377.27

∗ p<0.1, ∗∗ p<0.05, ∗∗∗ p<0.01

Table 2.4: Regression coefficients with robust standard errors in parenthesis.

Hypothesis 1 proposes that those who live in cities with compact urban designs will be more likely to have positive attitudes toward migrants due to increased opportunities for contact and exposure. In Model 1, I find support for this theory based on the significant positive relationship between city-level urban fabric continuity and individual attitudes with a regression coefficient of 0.452 (odds ratio: 1.57). Therefore, in this model, a person living in a more compact city (one unit is 16.6 percentage points of urban fabric continuity) is 57 percent more likely to have a positive attitude toward migrants. As a point of comparison, migrants themselves are 201 percent more likely to have positive attitudes toward fellow migrants in this model.

Hypothesis 2 proposes that the effect of urban design that promotes interaction should be even stronger in cities with large migrant populations and, thus, more migrants with whom natives may interact. To test this hypothesis, Model 2 includes the interaction term of the urban fabric continuity and migrant population variables, however, I do not find significant support. This may be due to the unobserved effect of residential or activity space segregation. The exploratory Model 4, discussed below, does find a significant positive relationship between migrant population and attitudes, indicating that when controlling for recent changes in migration, a greater presence of migrants—and therefore more opportunities for interaction—may improve attitudes. Nevertheless, Hypothesis 2 is not confirmed in this analysis.

In each of the models, I find a significant negative relationship between attitudes toward migrants and change in migrant population with a regression coefficient of -0.796 (odds ratio: 0.45) in Model 1. This indicates that, holding all else equal, a resident of a city in which the migrant population increased by one-standard-deviation (4.2 percentage points, in the cities modelled) is less than half as likely to agree that migrants are good for the city. This result concurs with findings in the empirical literature that recent increases in migrant populations have a negative effect on attitudes. Given the strength of this relationship and the importance of cities with rapidly changing populations in any analysis of attitudes toward migrants, in Model 3 I include the interaction between continuous urban fabric and change in migrant population. However, the coefficient of the interaction term is close to zero with a p-value of 0.87. The model indicates that the key finding of this paper, tested in Hypothesis 1, is not dependent on city population trends.

Among the individual control variables, the results are consistent with previous findings in the literature. Younger, more educated, and more financially stable respondents are more likely to report positive attitudes toward migrants, as are migrants themselves. This model uses region of Europe as a proxy for cultural and historical immigration trends across the continent. As expected, region also has a strong and significant impact. Those living in the Eastern European cities are less likely to have positive attitudes toward migrants, compared to those living in Western European cities, while those living in the Southern European cities are more likely.

Each of the models includes overall population and population density as city-level control variables. Density and urban fabric continuity are distinct concepts. Density, defined here as population per square kilometre, captures only the concentration of residents and not whether the design of their city facilitates interaction. For example, a discontinuous development of residential high-rises may be high in density but low in Jacobian vitality. Indeed, it is exactly this form of urban redevelopment that Jacobs argued against. As such, the theoretical framework of this paper does not predict any effect of overall population nor density. As seen in Table 4, neither variable has significance in any of the models.

2.5.2 Exploratory model

These findings indicate that there is a relationship between urban structure and attitudes toward migrants. As I have proposed, this relationship may be due to a mechanism based on contact theory. I have argued that a key sociological difference between continuous and discontinuous urban fabric is the extent to which such designs encourage contact between neighbours. To better understand how urban structure may be acting at an individual level in this model, I have fit an additional exploratory model. Model 4 includes interactions between the urban fabric variable and each of the three available socioeconomic status variables. In comparison to the reference categories, the models find that those who are employed as manual workers and those who have trouble paying bills "from time to time" are more likely to be positively influenced by compact urban designs. This despite the persistent finding that both of these groups are less likely to hold positive views toward migrants overall.

Allport (1954) originally hypothesized that intergroup contact would be effective if the participants are of equal status. If a significant number of migrants in a city are manual workers, Allport's condition may explain why contact seems to have a stronger effect on natives who are manual workers. Pettigrew and Tropp (2006), who confirm the efficacy of Allport's conditions, argue that the effects of intergroup contact are not limited to certain categories of people, based on their meta-analysis of 515 studies. Unfortunately, they do not analyse variation by socioeconomic factors, only age, gender, and nationality. The results of the exploratory model may also be due to the particular type of light-touch contact that continuous urban design encourages. Those employed in non-manual work may be more likely to have been exposed to foreigners, through leisure or business travel, for example. As such, for these individuals contact experienced on city streets may have less marginal impact. For those with fewer economic means, however, interacting with migrant neighbours may be their primary source of cross-group exposure. Furthermore, those with fewer economic means may be more likely to live in neighbourhoods with large migrant populations, which could also increase opportunities for intergroup contact for those who also live within continuous urban fabric.

2.6 Discussion

2.6.1 Policy implications

Much more research is needed to confirm a linkage between compact urban designs and positive attitudes toward migrants. However, Jacobs and others have argued extensively against the modernist turn in city planning for a host of reasons—any effect on the integration of migrants would only add to that list. Interested policymakers should consider this issue from both wide and narrow perspectives. While the structure of many cities dates back centuries, the philosophical approach of councilmembers and planners can still have a powerful impact as projects are approved and city life evolves. They should reject viewpoints that romanticize what Jacobs called the "suburbanized anti-city" and instead seek to understand the value and function of complex, chaotic urban fabric and the communities that form within it.

While a broad philosophical shift is crucial, block-level policy prescriptions have also been proposed. Jacobs devotes a full chapter to how ill-conceived housing projects and civic centres can be reintegrated into streetscapes, with an emphasis on promoting foot traffic and mixed uses at the ground level. Constructing and improving public spaces may also encourage residents to spend time outdoors and interact with their neighbours, and Gehl emphasizes that the quality of these spaces can be decisive. Interculturalism, which has emerged as the favoured diversity management approach of many European policymakers, is said to have been "founded on interaction promotion in public spaces" (Zapata-Barrero, 2015, 3). Some of its key theorists, however, are careful to avoid describing public spaces as a silver bullet. Cantle (2012) recommends fostering interaction in public spaces among key policy initiatives but notes that there is little evidence of the effectiveness of these policies. Wood (2015) believes that close friendships across groups are unlikely to form through passing interactions in public spaces, but he argues that such interactions are still meaningful and offers a series of recommendations regarding public spaces for interculturalist policymakers.

Policymakers who are sceptical that urban design can actively encourage tolerance should heed Jacobs' advice. While she, too, did not believe that design alone could eliminate racism, she wrote that streets that discourage contact "can make it much harder for American cities to overcome discrimination no matter how much effort is expended" (1961, p. 72). Policymakers in European cities with ethnically diverse populations should be aware that modernist designs may hinder efforts to enhance social cohesion and solidarity.

2.6.2 Future research

Future research should try to better understand the sociological implications of data on the continuity and discontinuity of urban fabric and how that data can be exploited. One step is to determine how closely the continuity distinction correlates with the design conditions that Jacobs proposes. The JANE Index developed by Delclòs-Alió and Miralles-Guasch (2018) may provide a means to achieve this. The data used in this paper was gathered by the Copernicus Land Monitoring Service and its stated purpose is for environmental, not sociological, research. This paper relies on the fortunate occurrence that the presence of grass is key to how Copernicus identifies types of urban fabric and to the distinction Jacobs makes between cityscapes ideal for neighbourly interaction and those that discourage it. Nevertheless, this uncommon use of Copernicus' data increases the likelihood of some unconsidered confounding factor. Comparing cities within a single context or country may be one way to better isolate the influence of urban design on attitudes. Furthermore, Jacobs' work extends far beyond the dichotomy that this paper exploits using Copernicus' data. As such, there are a number of specific mechanisms, described in Jacobs' work, that may allow us to better understand how urban design may promote tolerance through interaction between neighbours.

Jacobs wrote that, "Cities are an immense laboratory of trial and error, failure and success, in city building and city design" (1961: 6). The embrace of modernist city planning over the past century seems to have weakened the ability of Europe's great cities to positively integrate migrants into their communities. Meanwhile, the rise of the far right in many countries indicates that this challenge is only intensifying. Addressing this challenge will require more research alongside trial on the ground level to repair our cities and make them more welcoming to migrants and all others.

Chapter 3

DOES URBAN DESIGN DRIVE SYMPATHY FOR THE FAR RIGHT?

The far right has now entered into the mainstream politics of nearly every European country, yet we have confirmed little about the social context in which far-right parties thrive. While most of the literature assumes that far-right sympathies are driven by economic or cultural grievance, this paper looks to cities and contact theory. Recent advances suggest that even indirect or vicarious intergroup contact can reduce prejudice toward out-groups such as migrants. Urban theorists, as well, have long argued that urban design can influence social outcomes by promoting or discouraging interaction between residents. This paper applies this literature to the rise of the far right, which often scapegoats out-groups in its rhetoric. Using data from 73 cities in Spain, we find that residents of cities rich in continuous urban fabric—which promotes contact—are less likely to consider voting for the far right but that this relationship is weaker in highly segregated cities.[1]

[1]This paper is currently under review at *City, Culture and Society*.

3.1 Introduction

Far-right political parties in Europe are in the midst of their fourth wave (Mudde, 2019). No longer marginalized, even in countries that had once resisted them, these parties have become mainstream, expanded their agenda-setting influence, and shaped social norms. Despite a large literature on individual-level explanations for the rise of the far right, evidence on the social context of far-right electoral success remains mixed. Much of this literature focuses on hypotheses that economic or cultural grievance drives far-right voters, which are tested using national- or regional-level data on unemployment rates and migration population data to operationalize these concepts. Mixed findings suggest that the effect of high unemployment or migration influxes may be conditional on other factors of the social or political context. In reviewing the inconsistent literature, Golder (2016) suggests that progress can be made by focusing on geography to better understand sub-national variation. This paper uses a theoretical framework based on urban theory and intergroup contact theory to insert a new factor—urban design—into this debate.

Given that xenophobia and opposition to immigration are of “tremendous importance” to far-right parties (Mudde, 2007, 19), intergroup contact theory is highly relevant to the study of far-right voters. The theory posits that contact between in-groups and out-groups (natives and migrants, for example) decreases prejudicial attitudes. The effect can even be detected following “mere exposure” to out-group members or when a friend makes contact with an out-group member (Pettigrew et al., 2011). At the city level, Jacobs (1961), Gehl (2011), and others have shown that certain urban design archetypes are more conducive to street-level interaction between neighbors than others. This implies that urban design, through a contact theory mechanism, influences the level of prejudice in a city.

For centuries, academics and philosophers have argued over how urban design influences social outcomes. The rapid urbanization that accompanied the Industrial Revolution quickly drew criticism, like that from Thomas Jefferson who wrote, in 1784, that cities were eroding the spirit of their residents (Conn, 2014). By the beginning of the 20th century, philosophical objections to city life had been joined by legitimate hygienic concerns. City planners began to inject openness and light into cities, either by razing compact, low-rise neighborhoods and replacing them with set-back, high-rise housing or by expanding outward—what we now know as sprawl. Jacobs famously identified unintended consequences of this de-urbanization and brought them to the public's attention though her writing and advocacy. She found that neighborhoods opened up by redesign had less human activity, fewer interactions between neighbors, and more crime. Although urban design has important societal implications, data on urban design is not incorporated into most political science or sociological research.

This paper takes a step toward rectifying this gap by applying the urban design literature to a pressing social concern. To test if design influences support for far-right parties, it conducts a multilevel study of 73 cities in Spain. City-level data comes from Eurostat's Urban Audit, which includes data from the Copernicus Urban Atlas on urban land cover type. The ratio of continuous urban fabric to discontinuous urban fabric is used to distinguish between urban design archetypes. Unemployment rate, migrant population size and change, density, overall population, and level of segregation are also considered as factors of the social context. Variation in the political context within Spain is accounted for using regional and temporal variables. At the individual level, data is pooled from 12 barometer surveys conducted by the *Centro de Investigaciones Sociológicas* between January 2019 and March 2020, which is used to account for demographic variation and for the outcome variable, self-reported likelihood to vote for Spain's far-right party, Vox. Bayesian multilevel models find a clear, negative relationship between individuals' sympathy for Vox and the proportion of continuous urban fabric in their cities of residence.

3.2 Background

Von Beyme (von Beyme, 1988) first organized the history of the far right in post-war Europe into three waves, the third of which began in the 1980s and has been characterized by the rise of far-right political parties. Mudde (2019), however, argues that we are now in a distinct fourth wave in which the far right is part of mainstream politics in Europe and across much of the world. The first wave began immediately after the Second World War and consisted mostly of social organizations led by still-loyal fascists in Germany and Italy, as well as groups inspired by the regimes in Spain and Portugal. The second wave, beginning in 1955, saw the emergence of rural, right-wing populism in several European countries, including the first election of Jean-Marie Le Pen to parliament in France. These mostly short-lived movements of the second wave gave way, beginning in 1980, to far-right political parties, whose rise accelerated in the 1990s. During the two decades of this third wave, modest electoral success of far-right parties in countries like the Netherlands and Austria was met with shock, protest, and international condemnation. Following the turn of the century, however, the far-right of the fourth wave has exploited terrorism, economic crises, and immigration to consolidate its electoral success and establish a place in the mainstream. Across Europe, the far right has influenced the formation of governments, altered the discourse, and affected policy change, especially on immigration. Its rise has certainly not been limited to Europe. Three of the world’s largest democracies, India, the United States, and Brazil, have each elected far-right leaders in recent years.

The fourth wave features two types of far-right parties, *extreme right* parties which are anti-democracy but remain at the fringes of European politics, and *radical right* parties which are authoritarian but not outwardly opposed to democracy (Mudde, 2007). Mudde (2019) argues that although modern far-right parties are fundamentally nativist, they are not single-issue, anti-immigration parties. Mudde channels Bobbio (1996) in describing the far-right’s core ideology as a belief “that inequalities are natural and outside of the purview of the state.” In addition to virulent views on immigration and integration, far-right parties also attract support by promoting racist narratives around crime and security, anti-Semitic theories of corruption, and a zero-sum perspective on foreign policy. In each case, these stances take a nativist, "us versus them" perspective.

Theoretical explanations for the rise of the far right are often organized using a supply-and-demand metaphor. Mudde (2007), for example, groups explanations in three categories: demand-side, external supply-side, and internal supply-side. Though this typology is very common throughout the literature, it is not ideal for study of the social, urban context. This is because, in this framework, the demand side typically includes both individual-level explanations (what Mudde refers to as demand-side, micro-level explanations) as well as explanations related to social context (Mudde's demand-side, macro-level and demand-side, meso-level explanations). For clarity and conciseness, this paper will instead use the terms *individual level*, *social context*, and *political context*, as described below.

At the individual level, demographic variables such as age, gender, occupation, and education, have been studied often, as have individual attitudes toward immigration and migrants. Despite this extensive literature, the baseline profile of the far-right voter remains unsettled. A meta-analysis of 46 quantitative studies of individual-level predictors of far-right voting found that empirical support for even simple demographic characterizations of far-right voters is often overstated (Stockemer et al., 2018). For example, much of the literature suggests that "the typical far right voter is a young male, with a low level of education, who is either unemployed, self-employed, or a manual worker" (Golder, 2016, 483). However, the meta-analysis, which covered two decades of research on European voters, mostly during the fourth wave, found that age only predicted far-right voting successfully 29 percent of the time. The success rate for gender was 55 percent, for education it was 33 percent, and none of the tested employment statuses exceeded a 36 percent success rate.

The fundamentally nativist and anti-immigration stances of the far-right suggest that their voters are likely to hold anti-immigration views themselves. Though Stockemer et al. (2018) find only a narrow majority of studies support this hypotheses, recent literature has proceeded to examine the driving factors behind far-right voters' opposition to immigration. The most common theoretical approach traces back to Blumer (1958) who proposed that prejudice is a product of "group position." Similar to Bobbio's (1996) definition of right-wing ideology, Blumer theorizes that the racially prejudiced believe they are members of group that is superior to other groups and therefore entitled to certain advantages. Crucially, they also fear that other groups are intent on overtaking them and stripping them of their privileges. In the context of modern research on the far right, these fears are said to manifest as economic or cultural grievance. That is, far-right voters may have hostile attitudes toward immigrants because they are concerned that immigrants have or will threaten their economic dominance or their cultural hegemony. Halikiopoulou and Vlandas (2020) find that these voters are influenced by both economic and cultural concerns about immigration, but that, contrary to the literature's prevailing view, economic fears may be a more important predictor.

Numerous studies have applied economic and cultural grievance hypotheses to the level of social context, as well. Usually, attempts to identify economic grievance as an element of the social context of far-right success use unemployment rates as the key variable. At the national level, evidence that higher unemployment is correlated with support for the far right predates the fourth wave (Jackman and Volpert, 1996) while more recent evidence either casts doubt on the relationship or inverts it (Lubbers et al., 2002; Arzheimer and Carter, 2006). At the regional level, however, Georgiadou et al. (2018) do find a strong, positive relationship across Europe. The relative size of migrant populations, as well as recent change in those populations, has also been used in social context studies. While Blumer-descendent theories of conflict suggest that larger migrant populations would prompt voters to support the far right, intergroup contact theory suggests that increased opportunities for interaction between natives and migrants would increase tolerance and suppress far-right support. Perhaps unsurprisingly, the empirical evidence is mixed (Golder, 2016). Although much of the literature focuses on the economic grievance versus cultural grievance debate, Bolet (2021) instead applies local socio-cultural degradation theory to show that the disappearance of socio-cultural spaces—pubs, in this case—triggers social isolation and, in turn, support for the far right.

Finally, the political context includes many understudied factors that may condition the influence of individual-level and social context factors. Important elements of the political context include the structure of elections and parties; the organization, actions, and rhetoric of far-right parties; the manner in which the media and other parties react to the far right; and the current stage of success of the party in question (Golder, 2016). This paper is chiefly concerned with urban social context, however, and any variation in political context is isolated by studying a single country and accounting for regional and temporal variation.

3.3 Theoretical framework

3.3.1 Contact theory and recent advances

Though Allport and his contact hypothesis (1954) are widely credited for the inception of intergroup contact theory, Allport was hardly alone in believing that contact between groups could improve social tolerance. Empirical evidence of the phenomenon predates Allport's famous work by at least two decades (Zeligs and Hendrickson, 1933), and theorists had already begun to formulate the conditions under which contact would be most effective (Vezzali and Stathi, 2017b). Based on a growing body of evidence, Allport identified four conditions, which he believed were necessary for contact to reduce prejudice: participants should be of equal status, have common goals, act in cooperation, and have the support of authorities or norms. Without these conditions, Allport believed that contact could actually worsen tensions. Over a half-century of empirical study has since confirmed Allport's central hypothesis, that intergroup contact reduces prejudice, but found that his four conditions may enhance the effect of contact but are not necessary (Pettigrew et al., 2011). A comprehensive meta-analysis of 515 studies, totaling over 250,000 participants across 696 samples, found a significant negative relationship between contact and prejudice in 94 percent of the samples (Pettigrew and Tropp, 2006), and it found that these findings are were not the result of selection bias, publication bias, nor variation in methodological rigor (Pettigrew et al., 2011). Importantly, the effect generalizes beyond individual participants, as contact reduces prejudice of in-group members toward the out-group as a whole, and may even reduce prejudice toward other out-groups (Pettigrew, 2009).

While contact theory is certainly relevant, on it own, to urban intergroup relations, three recent advances provide important insight into how contact may function at the scale of a city.

The *extended contact hypothesis* posits that the effect of intergroup contact on an in-group member extends to that person’s friends. For example, Dhont et al. (2011) found lower levels of racism among Belgian adults who did not have contact with immigrants themselves but did “know many native Belgian people within their circle of acquaintances who get along well with immigrants.” Similar effects have been found regarding attitudes between genders in Australia (Paolini et al., 2007) and towards gay men in Italy (Vezzali et al., 2016). Several studies have shown that those affected by extended contact are more likely to make out-group friends in the future and thus extend the effect further (Vezzali et al., 2015; Mallett and Wilson, 2010; Schofield et al., 2010). Zhou et al. (2018) conducted a meta-analysis of 115 studies and found significant effect sizes for both extended contact and direct friendship and that there was not a significant difference between the two forms of contact. The analysis found that the effect may be stronger in Europe than North America, based on studies from a wide range of European contexts including relationships between natives and immigrants in Finland, France, Germany, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, and the UK, as well as relationships between Northern Irish Catholics and Protestants, Estonians and Russians, Kosovar Albanians and Serbians, and many other in-group/out-group combinations. The effect is also not limited to relationships between ethnic groups, as noted in the examples above. Zhou et al. (2018) identified studies of attitudes based on gender, sexual orientation, age, body weight, and disability. Taken together, extended contact seems to reduce prejudice toward any group that the far right may consider "naturally unequal." In the context of the large, interconnected population of a city, this research implies that a modest number of intergroup friendships could have substantial, rippling effects.

A growing branch of the extended contact literature, *vicarious contact*, may be even more promising in urban settings, however. This branch is theoretically grounded by Bandura's (1986) social cognitive theory (Vezzali and Stathi, 2017a). Social modelling is central to the theory, which holds that "people pattern their styles of thinking and behaving after the functional ones exemplified by others" (Bandura, 2005, 11). Applied to contact theory, this implies that merely observing intergroup contact may reduce any prejudicial attitudes of the observer. Unlike empirical study of extended contact, which is mostly correlational, vicarious contact has mostly been studied experimentally (Vezzali and Stathi, 2017a). Evidence has been found in a variety of contexts. Gómez and Huici (2008) found that supporters of a basketball team in Madrid were more likely to have sympathy for the rival team if they watched a video of the two teams training together. Mazziotta et al. (2011) found that German university students expressed warmer feelings toward Chinese students and more willingness to interact with them after watching a video in which German and Chinese students spent time together. Preuß and Steffens showed straight men a video of a gay couple interacting with a conservative man in two separate experiments. The first experiment did not find an effect among its German participants, but the second, using participants from the United States, did show a reduction of negative attitudes.

In cities with ample sidewalk activity, residents may frequently observe intergroup contact, such as mixed-gender friend groups and interracial couples. However, even if in-group city dwellers only observe out-group members, without an element of intergroup contact, the *mere exposure effect* suggests that their attitudes toward that group may still improve. Zajonc (1968) found that people's attitudes toward objects improved following repeated exposure to them. In recent decades, this research has been extended to include exposure to people, such as the finding of Zebrowitz et al. (2008) that white participants had more positive attitudes toward Asian faces after being exposed to pictures of other Asian faces. The same effect was found in a second experiment in which they subliminally exposed white participants to pictures of Black faces.

3.3.2 Urban design that promotes contact

Contact theory and the noted recent advancements provide a mechanical link between individual attitudes associated with the far right and urban design. That is, if contact reduces prejudice and associated attitudes, then in urban designs that encourage contact, we should expect less prejudice, nativism, and sympathy for far-right parties. The following section briefly summarizes the literature on forms of urban design that promote human activity and the modernist trend that famously suppressed it.

The urbanization following the Industrial Revolution gave rise to philosophical and hygienic concerns about crowding in cities. In the early 20th century, two theories of urban design offered conflicting solutions, each of which sought to break up urban fabric with green space and openness. Howard's (1902) "Garden City" ideal would marry town and country by decentralizing cities and segregating their functions. Though Howard advocated for public land ownership, his philosophy, fairly or not, is blamed for the arrival of modern, sprawling cities dotted with private gardens (Richert and Lapping, 1998). Most post-war urban designers, however, came to favor an alternate, modernist approach (Barnett, 2016). Instead of making room for open space by expanding the city horizontally, as Howard proposed, Le Corbusier's (1987) modernism would expand it vertically. He envisioned high-rise apartment buildings, each setback from the street and surrounded by openness, and his model was quickly adopted by European and American planners (Marmot, 1981). Throughout the remainder of the century, scores of cities replaced swaths of continuous urban fabric or expanded, using architecture descendant from Howard and Le Corbusier.

Jacobs' scholarship and advocacy established her as the most prominent opponent of these 20th century trends. In *The Death and Life of*

Great American Cities (1961), she argues that by replacing chaotic “slums” with neatly organized, modernist designs, city planners failed to understand what makes city neighborhoods vibrant and safe. To Jacobs, the role of *strangers* is key to what makes big cities distinct and why modernism failed. In a city, the vast majority of people one encounters are strangers—people they do not know. This means that cites are not merely larger than other municipalities, but functionally different. Cities must be *vital*—full of activity—in order to be safe and livable, she writes, in large part because activity discourages crime. Jacobs develops four key reasons why modernism has made cities less vital. First, neighborhoods must have a mix of uses, in order to attract people who come to the area for different purposes and at different times. Second, walking patterns mean that the long blocks favored by modernists isolate certain areas, unlike traditional short blocks. Third, neighborhoods should have a mix of old and new buildings, in order to encourage economic diversity. And, finally, a dense concentration of people, not only residents, is key. By segregating functions of the city and reducing crowding through openness, modernism destroyed the vitality city neighborhoods.

In vital neighborhoods, residents are more likely to encounter their neighbors, and street-level acquaintances form. Greater vitality, therefore, implies more intergroup contact in cities with diverse populations. Jacobs, writing during the Jim-Crow-Era United States, recognized that racial inequity was the nation’s most serious problem and that, of course, retreating from modernism would not solve the problem by itself. Nevertheless, she did believe that thoughtful urban design could help reduce segregation and discrimination (Laurence, 2019). Though she does not directly engage with contact theory, she does argue that vitality encourages interaction, and even friendship, among people from different economic and ethnic backgrounds.

Gehl (2011) also finds that the trends of building either high-rise residences or single-family homes, in pursuit of openness, has reduced the vitality of cities. “The spreading and thinning out of dwellings assured light and air but also caused an excessive thinning of people and events,” he writes (46). He identifies many of the same consequences as Jacobs, from a European context, arguing that medieval design encouraged what he calls *life between buildings*, while post-war design has done the opposite. The emergent field of space syntax provides tools for considering these social implications of urban design. Grönlund (2007) called for more research into the spectrum of *urbanity* among spaces we call "urban," noting that anti-urban modernist design has effectively made some cities more urban than others. He proposes that urbanity is closely related to *co-presence*, the amount of human activity and interaction in an urban setting over a given time period. Hillier et al. (1986) found that the integration of an urban layout, or how far any space is from other spaces, is a key predictor of human activity, and Rokem and Vaughan (2018) use space syntax analysis to study the impact of urban fabric on social integration in Stockholm, with a focus on immobility and its exacerbating effect on residential segregation and social exclusion.

Though space syntax provides several granular measurements of the characteristics of a city's urban fabric, the CORINE Land Cover designations from the European Environment Agency permit a straightforward distinction between compact and open urban designs. CORINE distinguishes between *continuous urban fabric* in which at least 80 percent of the land is covered by buildings or other artificial surfaces and *discontinuous urban fabric* in which much of the land is vegetated or bare (Kosztra and Büttner, 2019). By using the presence of vegetation to distinguish land cover types, the CORINE data mirrors the debate between the modernist penchant to insert grass and trees into urban fabric and Jacobs who mocked such grassy areas as underused and detrimental to vitality. Though the CORINE distinction between continuous and discontinuous urban fabric has rarely been applied to social outcomes, Ceccato (2012) quotes Grönlund regarding its importance: "The urban fabric affects the distribution of functions and social networks. A continuous urban fabric normally is a more integrated and vital urban system which often produces safer environments" (6).

3.3.3 Hypotheses

The preceding theoretical framework implies two hypotheses. If continuous urban fabric promotes contact between residents of diverse cities, and intergroup contact reduces the prejudiced attitudes underlying nativism and far-right ideologies, then:

> **Hypothesis 1:** Residents of cities with more continuous urban fabric will be less likely to have sympathy for far-right parties.

If Hypothesis 1 is confirmed but segregation reduces the likelihood that street-level contact takes place between in-groups and out-groups, then:

> **Hypothesis 2:** The negative relationship between continuous urban fabric and far-right sympathy will be weaker in cities with high levels of residential segregation.

3.4 Methods

3.4.1 Case selection and context

Kent (2022) uses CORINE data from cities in several European countries to identify a significant negative relationship between urban fabric continuity and attitudes toward migrants. The study is limited, however, by a small city-level *n* of only 22 and limited consideration of the variation in social and political culture across the continent. By studying a single nation, the present study is able to address these concerns. There were two key criteria for country case selection. First, the country must have a far-right party that has achieved a substantial level of success, and, second, high quality data must be available at both the city and individual levels. Eurostat provides CORINE Land Cover data for many European cities, but its data is most complete and most recent for Spain, and Spain is among the eight European countries included in the Data Challenge on Integration of Migrants in Cities (D4I) data with which segregation indices can be calculated. At the individual level, Spain's *Centro de Investigaciones Sociológicas* (CIS) conducts monthly barometer surveys on political and social topics and, crucially, this data includes the respondent's city of residence. Spain's prominent far-right party, Vox, has found electoral success recently and has done particularly well in cities, which adds relevance to the Spanish case.

Though Spain was under fascist dictatorship for much of the 20th century, the present-day electoral success of the far right in Spain occurred later than in many European countries. As recently as June 2016, the far-right party Vox received only 0.2 percent of the vote in a national election, consistent with its historical results to that point. However, in December, 2018, in regional elections in Andalusia, the party secured 11 percent of the vote, shaking up a parliament that had been led by the left-wing *Partido Socialista Obrero Español* for over three decades. Vox supported the regional parliament investiture of two other right parties, *Partido Popular* and *Ciutadanos*, in exchange for several concessions (Barquero, 2019). Since then, it has consolidated its support nationally, receiving 15 percent of the vote in the 2019 national elections. It has also found support in regions where it had previously struggled, such as in February, 2021, when it won 11 seats in the Parliament of Catalonia, the far right's first seats in the body.

Turnbull-Dugarte et al. (2020) found that Vox voters nationally were more likely to live in urban areas and to be men, practicing Catholics, and from bourgeois occupations. Gould (2019) compared Vox and Germany's far-right party, *Alternative für Deutschland*, and found the two parties to be remarkably similar, both in ideology and strategy. Both believe their nation's identity is in crisis due to migration, supranational organizations, and globalization. They view Spain and Germany, respectfully, as culturally homogeneous and anchored by Christian values, including traditional gender roles. On immigration, Arcila Calderón et al. (2020) found that the discourse regarding Vox on Twitter included hate speech toward immigrants, such as incitement to violence or the dissemination of false information. Bernardez-Rodal et al. (2020) analyzed Vox's anti-feminist discourse on Instagram and found strains of anti-Muslim gender nationalism, as well as rhetoric delegitimizing feminism and gender as a concept. They also note that Vox's anti-feminism is closely intertwined with its anti-immigration and anti-Catalan stances. Vox also opposes autonomous governance in Catalonia, and Turnbull-Dugarte (2019) found that this position is key to its electoral success.

3.4.2 Data and modelling

The analysis uses five city-level variables from the Eurostat Urban Audit: *continuous urban fabric*, *migrant population*, *migrant population change*, *overall population*, and *density*, as well as a *segregation* index calculated using the D4I dataset. Continuous urban fabric is coded as the percentage of total urban fabric in a city that is designated as continuous, using the CORINE Land Cover designations described above and data from 2014. Migrant population is coded as a percentage of the total population in 2019 and migrant population change is the difference in migrant population since 2010. Overall population size, which is also used to calculate density, is from 2019, as well. The D4I segregation data includes a 100 x 100 meter grid of Spain with 2011 population by continent of birth for each cell (Alessandrini et al., 2017). Using this data and the `segregation` R package, I calculate the mutual information index for each city which serves as the segregation variable (Elbers, 2021).

Individual-level data is pooled from 12 CIS monthly barometer surveys[2] conducted between January 2, 2019, and March 13, 2020. The outcome variable is constructed using a question that asks respondents to give the probability that they will vote for each major party on a scale of 0 (never) to 10 (always). For the primary analysis this question is recoded dichotomously so that *no sympathy for Vox* includes only those who originally answered 0 and *sympathy for Vox* includes all other responses (1-10). Coded this way, 25.6 percent of respondents are sympathetic to Vox. However, all other possible dichotomous codings are also tested. The findings section discusses these tests, as well as models that treat the

[2]Barometers 3238, 3240, 3242, 3247, 3252, 3257, 3261, 3263, 3267, 3271, 3273, and 3277

original 0-10 variable as continuous.

The CIS surveys also provide five demographic variables that are included in the models: age, gender, religion, education level, and occupation. The analysis uses coding for religion based on ten of the surveys, in which Catholic respondents are asked to self-identify as practicing or non-practicing. The other two surveys only ask respondents how frequently they attend church, and in these cases those who identify as Catholic but attend church "almost never" are coded as *non-practicing Catholics*. The additional categories are *Catholic*, *another religion*, and *not religious/other*. Education levels are collapsed to five categories: *no education*, *primary*, *secondary*, *university*, and *vocational*. Given that prior research has found that far-right sympathy is not always related linearly to economic status, the occupation variable is coded to retain as much detail as possible. For those who are currently employed, occupation is coded as one-digit CNO-11 occupation, the same level of detail as in most of the CIS surveys. Those who are not employed are categorized as either: *retired*, *student*, or *not working*. CIS data only reports binary sex, either *male* or *female*.

Of the 77 cities of residence identified in the CIS data, Eurostat provides data for all but 4. Residents of these cities, as well as all respondents who do not live in cities, are removed. Only residents of the 73 remaining cities, 40.7 percent of the total sample, are included in the analysis. The appendix provides descriptive statistics for the data, which totals 23,917 complete observations.

Bayesian multilevel logistic regression models are fit in R using `brms` and `rstanarm`. The models include city-level variables scaled as one-standard-deviation z-scores. In Bayesian modelling, including categoricals as indicator variables with reference categories would imply that certain categories have less prior uncertainty, therefore using index variables and modelling separate intercepts is preferable (McElreath, 2020, 157–162). All individual-level categorical variables are treated in this manner, as are *cities*, which are nested within *autonomous communities* in order to account for variation in the political and social environments at this level. Finally, the models include *survey date* as a continuous variable coded as years since January 2, 2019, to account for any change in sympathy for Vox over time.

3.5 Findings

All of the models find a negative relationship between continuous urban fabric and sympathy for Vox, with at least 97.4 percent confidence. In Model 1, which includes city-level unemployment, migrant population, and overall population, and Model 2, which replaces migrant population with change in migrant population, greater than 99.9 percent of draws find a negative relationship. As a test, Model 3 also includes city-level population density, which only slightly reduces confidence in the relationship between urban fabric and Vox sympathy. The three models provide very strong evidence in support of Hypothesis 1, that those living in cities with more continuous urban fabric are less likely to have sympathy for the far right, as shown in Figure 3.1.

Model 4 tests Hypothesis 2 by including an interaction term for the *continuous urban fabric* and *segregation* variables. Here, the hypothesis expects to find a positive coefficient for this term, indicating a weaker effect of urban fabric in more segregated cities. This hypothesis is confirmed, with 96.8 percent confidence. These conditional effects are shown in Figure 3.2.

Regarding other aspects of the social context, in these models it is very likely that sympathy for Vox is greater in cities with higher unemployment. Neither current migrant population level, nor change in migrant population, shows a strong and confident relationship with support for the far-right, however. Consistent with previous findings that Vox's support is strong in large cities, overall population positively correlates with sympathy for Vox, for the cities in this data, though the range of coefficient estimates is wide in each model.

Though the main interest of this paper is in the social context of far-right sympathy, as represented by the city-level variables, the literature on individual-level causes remains unsettled. Figure 3.3 shows estimated

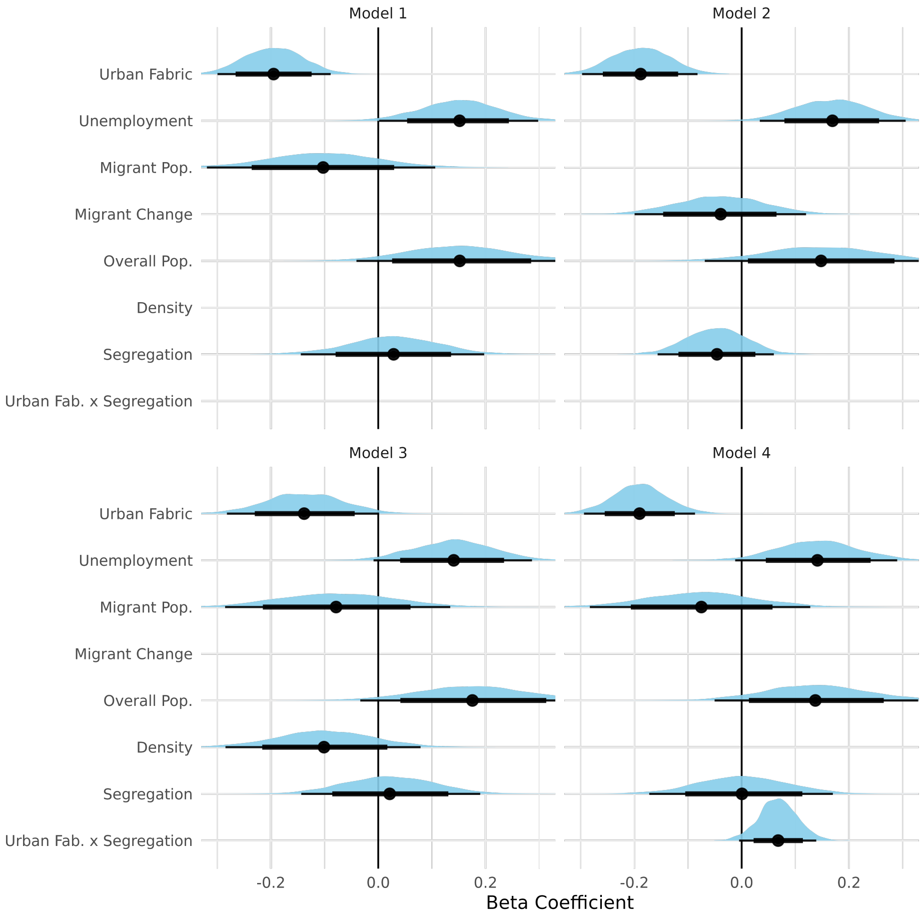

Figure 3.1: City-level variable coefficient estimates for Models 1-4 with 80 and 95 percent confidence intervals.

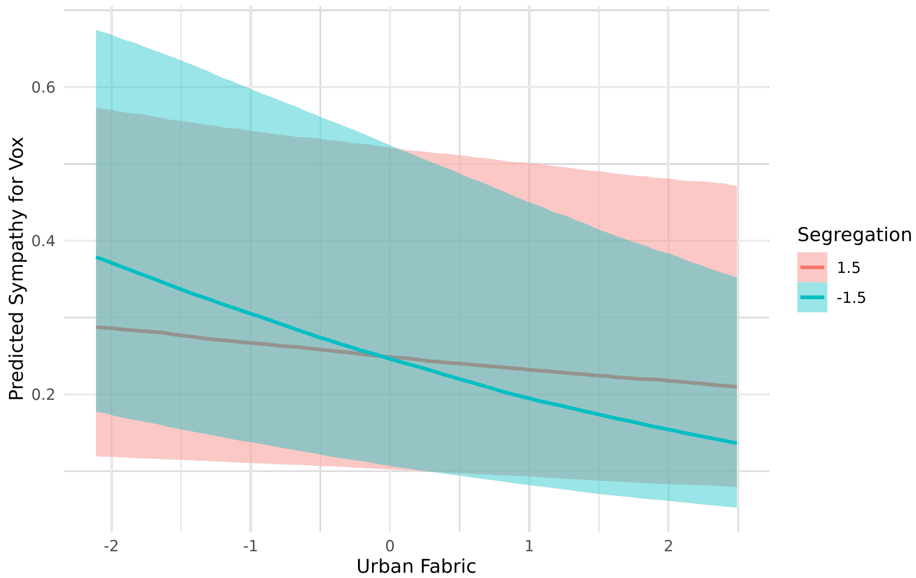

Figure 3.2: Effect of continuous urban fabric on predicted sympathy toward the far right conditional on segregation with 80 percent confidence intervals, per Model 3.

intercepts by occupation, education level, and religion. The clearest predictive power is for the military and police, who are much more likely to have sympathy for Vox. Managers are more likely to support Vox, as well, while craft and related trades workers and those with elementary occupations may be less likely. This is consistent with previous findings that Vox voters are more likely to hold bourgeois occupations. Model 1 shows that respondents with no education or only primary schooling are less likely to support Vox, and those with only secondary education are more likely, although the effect size for each is small. The model also finds that practicing Catholics may be more likely to have sympathy for the far right, while non-religious people are less likely.

As noted previously, the outcome variable was recoded dichotomously. The variable is based on a survey question asking respondents how likely they are to vote for Vox on a 0-10 scale. For the preceding models, all those who did not answer 0 (that they would never vote for Vox) were considered to have some degree of sympathy for Vox. To test whether this coding influenced the findings, and in particular the confirmation of Hypothesis 1, Model 1 was sequentially re-fit using all possible dichotomous codings of the outcome variable. These tests found that Hypothesis 1 would be confirmed in all cases. As an additional test, linear, Poisson, and negative binomial models were run, treating the original 0-10 variable as continuous. In each case, the key relationship persisted, however none of the models fit the data well due to the large number of 0 responses.

3.6 Discussion

This paper finds that residents of cities with high levels of continuous urban fabric are less likely to consider voting for far-right Vox. The finding suggests that far-right support is not driven, at the level of social context, solely by economic grievance or cultural grievance. The literature, which generally organizes explanations using a supply-and-demand metaphor, has given much focus to competition-oriented theories that treat voters as a kind of consumer in an ideological marketplace. Though grievance explanations are rooted in social theory, other perspectives on how societies react to inequality—such as urban theory and contact theory—can reveal new explanations.

This paper argues that intergroup contact is the mostly likely mechanism driving the relationship between urban design and sympathy for the far right, especially given the confirmation of Hypothesis 2. The second hypothesis speculated that, if contact is indeed the key mechanism, the effect of urban design on far-right sympathies would be weaker in highly segregated cities where any contact is less likely to be "intergroup." Other mechanisms may also contribute, as well. For example, Jacobs argued that compact urban design prevents crime. Residents of low-crime cities may see less appeal in the fear-based rhetoric often used by the far right, and future research should seek to measure and disentangle these rela-

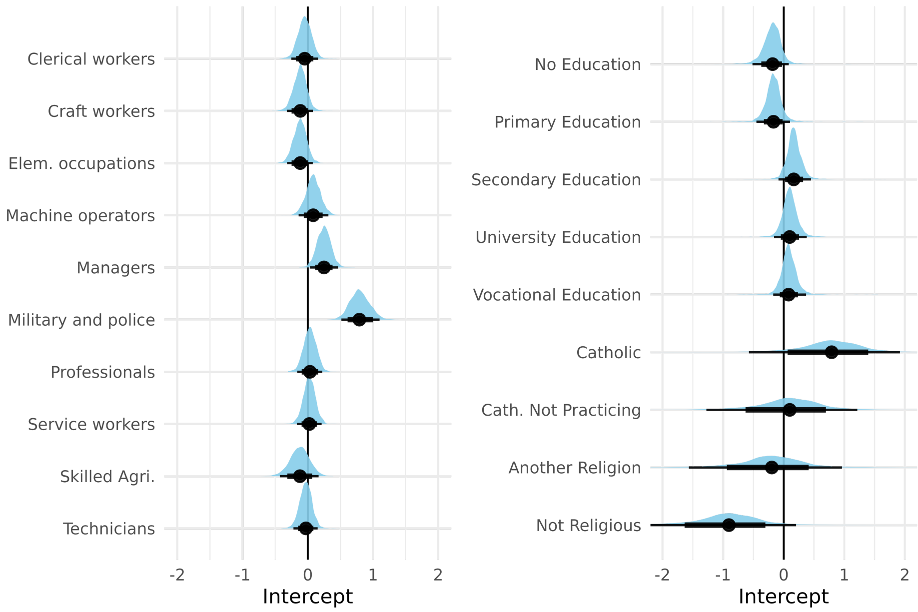

Figure 3.3: Intercept estimates of Model 1 for selected demographic variables with 80 and 95 percent confidence intervals.

tionships.

Data on urban fabric is readily available and may be beneficial to social scientists investigating a wide range of social phenomena. This paper's findings suggest that the built environment may have other unknown and unexpected influences on urban society. This point is particularly salient for policy makers and urban planners. The modernist tread in urban design arose at a moment when countless cities, desperate to reduce overcrowding, were open to radical changes. Within decades, whole neighborhoods had been razed and replaced, in many cases, with high-rise apartments and segregated uses. Not until *The Death and Life of Great American Cities* did we begin to understand the consequences.

Cities across Europe are now facing another crisis—climate change—that is forcing governments to make changes to the built environment. The need for such changes will only intensify in the future. The leaders who take these decisions will undoubtedly consider the environmental and economic impacts, but this paper urges them to carefully assess the social impacts, as well.

3.7 Appendix: Descriptive statistics

Variable	**Min.**	**Q1**	$\tilde{x}$	$\bar{x}$	**Q3**	**Max.**
Individual-level						
Age	18.0	38.0	51.0	51.5	65.0	98.0
City-level (z-scores)						
Continuous Urban Fabric	-2.1	-0.7	-0.2	0	0.5	2.5
Migrant Pop.	-1.6	-1.1	0.1	0	0.6	2.7
Migrant Pop. Change	-2.6	-0.5	0.1	0	0.6	2.2
Segregation	-1.9	-0.8	0.1	0	0.5	3.0
Population	-0.7	-0.6	-0.5	0	0	2.6
Unemployment	-1.5	-0.7	-0.3	0	0.3	2.6
Density	-0.9	-0.7	-0.4	0	0.3	3.4

Table 3.1: Descriptive statistics for continuous variables.

Variable	**Levels**	**Count**	**Pct.**	**Cum.**
Occupation	Clerical support workers	1506	6.3	6.3
	Craft and related trades workers	1821	7.6	13.9
	Elementary occupations	1855	7.7	21.7
	Managers	1082	4.5	26.2
	Military and police	306	1.3	27.5
	Not working	1496	6.3	33.8
	Other occupations	1140	4.8	38.6
	Plant and machine operators	822	3.4	42.0
	Professionals	2733	11.4	53.4
	Retired	3145	13.1	66.5
	Service and sales workers	3439	14.4	80.9
	Skilled agri., forestry, fishery	251	1.0	81.9
	Student	573	2.4	84.3
	Technicians, assoc. professionals	3748	15.7	100.0
Education	No education	833	3.5	3.5
	Primary	3127	13.1	16.6
	Secondary	8087	33.8	50.4
	University	7468	31.2	81.6
	Vocational	4402	18.4	100.0
Religion	Another Religion	688	2.9	2.9
	Catholic	4846	20.3	23.2
	Catholic, non-practicing	11132	46.5	79.7
	Not religious or other	7251	30.3	100.0
Sex	Female	12603	52.7	52.7
	Male	11314	47.3	100.0

Table 3.2: Descriptive statistics for individual-level categorical variables.

Chapter 4

IMPROVING THE GRAVITY MODEL OF HUMAN MOBILITY WITH LAND USE DATA

Models of human mobility are crucial to understanding transit needs, demographic trends, and disease outbreaks, among much else. Recently, new datasets have arrived from public and private sources, and the literature has advanced with new modelling techniques using deep learning and machine learning. Inspired by these breakthroughs, this paper seeks to develop a model of human mobility that competes with the traditional gravity model in both accuracy and ease of use—and that is based on data which is widely and consistently available. To do so, I employ Copernicus Urban Atlas land cover data and XGBoost models, tested using recent data collected from over 40 million mobile phones in Spain. The land use model improves on the gravity model in both prediction of future flows and generation of flows for unknown locations.

4.1 Introduction

Understanding how people move about their cities, regions, and countries—and even internationally—has long been important to researchers and practitioners in fields ranging from transit planning to public health to demography. Recent study of human mobility has often relied on employment data or trace data, such as public transit transactions (Xia et al., 2018) or geolocated social media posts (Jurdak et al., 2015; Pourebrahim et al., 2018; Osorio-Arjona and García-Palomares, 2019; Huang et al., 2020), therefore access to comprehensive or near-comprehensive data presents exciting new opportunities to model mobility in innovative ways and test these models against ground truth. Since Zipf (1946) introduced his elegant gravity model, academics and officials have needed only population data and the distance between locations in order to approximate mobility flows using simple models.

Recently, researchers have taken advantage of deep learning and machine learning techniques and a wide range of data sources to improve on the traditional gravity model (Luca et al., 2021; Xie et al., 2020; Shi et al., 2019). However, these breakthroughs often use complex geographic data with inconsistent availability, such as points of interest, making it difficult for researchers to apply the techniques in other contexts and limiting the benefit for policymakers and the public. In Europe, an underused but rich and widely available dataset holds great promise to solve this problem. The Copernicus Urban Atlas provides detailed land use data for 788 urban areas in identical format. Initiatives are underway to increase usage of this data, however the focus is on environmental applications such as monitoring landscape changes and managing natural disasters (Apicella et al., 2022), and the data has been applied to social questions only rarely (Chênes et al., 2021; Kent, 2022).

The objective of this paper, then, is to test whether data from the Copernicus Urban Atlas can be used to improve on the flow prediction and generation accuracy of the gravity model—a finding that would be useful for researchers across the whole of Europe. To develop and test the model, I use data collected in multiple stages starting in 2019 by Spain's

National Institute of Statistics. The data comes from over 40 million Spanish mobile phones and includes daily mobility flows between over 3,000 districts, which serve as the dependant variable and ground truth for testing.

The data is modelled using extreme gradient boosting (XGBoost), a machine learning technique that is easily and efficiently implemented in R and other languages. Using this process, I am able to accurately predict future mobility flows using historical data and also generate realistic flows for unknown urban areas using data from even a small number of other cities. This later task, flow generation, is more challenging and much less common in the literature (Luca et al., 2021). In addition to flow prediction and generation, I also gain some additional understanding of how land cover—and particularly *continuous urban fabric*—influences mobility through importance measures.

4.2 Background

Luca et al. (2021) develop a taxonomy of human mobility modelling tasks under active investigation in the literature. The tasks related to aggregated flows—as opposed to individual trajectories, which are outside of the scope of this paper and its data—are of two types: prediction and generation. The former uses historic data to predict future flows between the same points or areas, whereas the latter attempts to generate realistic flow matrices without access to historic data for the location pairs in question.

Traditionally, both prediction and generation tasks utilize the gravity model first proposed by Zipf (1946). The model is so named because it takes inspiration from Newton's law of gravity, assuming that mobility (of people, goods, capital, etc.) decreases with greater distance between two bodies but increases with the size of those bodies. In the context of commuter flows, the model suggests that an area with a large population has a sort of "gravitational pull" that attracts people to it. More complex approaches have since emerged, such as the intervening opportunities or radiation model which considers the potential destinations that lie between two given locations, however variations of the gravity model remain very popular, especially among planners and economists (Barbosa et al., 2018).

Recently, new geographic data sources and the rise of computationally intensive algorithms have sparked renewed interest in improving on gravity models. While there is now an extensive literature using deep learning, machine learning, and hybrid approaches to predict flows of commuters, much less attention has been given to flow generation (Luca et al., 2021; Xie et al., 2020; Shi et al., 2019).

Three recent attempts to improve on the gravity model are especially relevant here. Spadon et al. (2019) test nearly two dozen machine learning models before deciding to use XGBoost to model mobility between cities in Brazil. Their models go beyond traditional gravity model variables, incorporating additional population, economic, and crime data. As with the present paper, Morton et al. (2018) focus on mobility within urban areas, and they find that XGBoost machine learning models generate significantly more accurate commuter flows, without using additional data, for Knoxville, Tennessee. Finally, Simini et al. (2021) use commuting data from all of England, Italy, and New York State to develop what they term a "deep gravity" model for flow generation. Their approach uses deep neural networks and an array of data, including area of five land-use types, road network features, and counts of a wide range of points of interest. They find that deep gravity outperforms the traditional gravity model and a progression of intermediate models. Notably, in the two European contexts, the performance of deep gravity declines substantially as population increases. The authors speculate that this deficiency is due to the large number of points of interest in densely populated areas.

The present paper builds on the approach of Simini et al. (2021) in particular. However, given that I are exclusively focused on mobility in urban areas I forgo points-of-interest data and instead employ land-use data at a greater level of specificity (26 types), as discussed in the following section. I choose to employ XGBoost machine learning, instead of deep learning, in line with most of the literature to date (Luca et al., 2021).

4.3 Data

In 2019, Spain's National Institute of Statistics (INE) initiated a pilot study of human mobility within the territory using data from three mobile phone operators—Movistar, Orange, and Vodafone—which total over 42 million users or approximately 79 percent of Spanish mobile phones. INE determined that the usership of these operators was distributed evenly across Spain and that the data gathered would be representative of the mobility of Spain's population at large. The data is aggregated into 3,214 "mobility areas" of at least 5,000 residents. Municipalities with between 5,000 and 50,000 residents constitute their own mobility area, while larger municipalities are divided into districts or sub-districts. Municipalities with populations below 5,000 are grouped with one or more other municipality to reach to the threshold. On average, the mobility areas have a population of approximately 15,000 and approximately 12,000 mobile phone users for which INE received data. In the initial phase of the study, INE aggregated this data into three products: the seasonal population matrix, the day and night population matrix, and the daily mobility matrix (INE, 2020).

The third of these datasets, INE's daily mobility matrix, which is used in this paper, provides mobility flow counts between each pair of mobility areas in Spain for the workweek of November 18-21, 2019. Each mobile phone's origin area is the one in which the phone was most frequently located between the hours of 1:00 and 6:00. For any phone that left the origin area for at least four hours between 10:00 and 18:00 on two of the four study days, the most frequent location was assigned as the destination area. INE argues that the selected week in November is representative of normal daily mobility, as no holidays take place during that week. Following the onset of the COVID-19 pandemic, however, the institute resumed collecting mobility data for the benefit of public health officials and researchers. From March 2020 through the end of 2021, INE published data with varying frequency, including data for Wednesday, November 17, 2021, the same calendar week as the original 2019 data. In these additional data collection phases, INE used the same methodology as in the initial study, and therefore the data is ideal for testing against the original 2019 data (INE, 2021).

INE's mobility data has two key limitations. First, locations are estimated not from GPS but from telephone antenna connections which limits precision, especially along area borders. Second, the mobile phone operators only provided data for area pairs with flows of greater than 15 users. Both limitations suggest that this data is most valuable for tracking mobility within urban areas, where traffic is high and antennas are numerous (INE, 2020).

This paper merges INE's data with data on the land cover of the underlying mobility areas. The land cover data comes from the Urban Atlas of the Copernicus land monitoring service, a project of the European Commission and the European Environment Agency. A chief goal of the Urban Atlas is to provide detailed geographic data on land use and land cover in a harmonized and comparable format across the continent. While most cities, regions, or countries produce their own land use maps, the 2018 Urban Atlas uses a common scale and nomenclature for 788 functional urban areas in 38 countries in the EU, EFTA, Western Balkans, and Turkey. Each functional urban area comprises a high-density city along with any lower-density surrounding municipalities in which at least 15 percent of workers commute to the city (Copernicus, 2018).

Using satellite imagery with a very high resolution of 2.5 meters, the Urban Atlas employs statistical image classification and visual interpretation, along with some ancillary data, to divide each urban area into polygons by land cover type. The land cover types include 17 urban classes, 9 agricultural or semi-natural ones, and bodies of water. Among the urban classes, there are five classes of "urban fabric" in which same of the structures are residential, ranging from "continuous urban fabric" to "discontinuous very low density urban fabric." For these classes, the degree of density or continuity is determined by the percentage of the land that is artificially covered (Copernicus, 2018).

This paper uses the Copernicus Urban Atlas 2018 to determine the types of land cover contained within each of INE's mobility areas. Using the R package `sf`, the INE and Urban Atlas shapefiles are joined in order to find the total area of each land cover type for each mobility area. In several cases, functional urban areas overlap, and therefore the smaller of the overlapping areas is omitted from the data in order to avoid duplicated mobility area pairs or incomplete urban areas.

The final version of the primary dataset, from November 2019, includes flows between 52,565 unique pairs of mobility areas, representing the mobility of 5,443,148 residents of Spain in sum. The pairs of mobility areas come from 39 functional urban areas in Spain and only include mobility within each area. Mobility between urban areas is outside of the scope of interest of this paper. Each observation includes the population of the origin and destination, the area of each land cover type for the origin and destination, and the distance between the centroids of the two areas.

4.4 Methods

This paper primarily compares two models: the traditional gravity model and the land use model developed here. Unidirectional flow total between mobility area pairs is the outcome variable. The gravity model is a linear regression in which the outcome variable is in the log scale, as are the three predictor variables: the distance between origin and destination, the population of the origin district, and the population of the destination district.

Given the uncertain relationships and interactions between the land use variables and the outcome variable, a simple linear regression is unlikely to significantly improve on the gravity model. Fortunately, there are many machine learning models that do an excellent job identifying complex relationships and sorting important information from unimportant information. As noted above, previous research has found XGBoost to be especially effective when modelling human mobility—among many other tasks.

Like random forests, XGBoost is a decision-tree-based algorithm. Random forests (Breiman, 2001; Ho, 1995) comprise a series of randomly generated decision trees. Each tree uses a random subset of data and a random selection of variables. At the start of each tree, a split point is randomly assigned within the range of a randomly selected variable. Each observation is then placed into one of two nodes, depending on which side of the split point it falls. Each of these nodes is then split again, based on another random variable and split point. For regression trees, this process is repeated until each node contains a set number of observations or until a set number of nodes has been generated. These final nodes are known as terminal nodes, and the predicted value for each path through the tree is the average value of the outcome variable for the observations in that path's terminal node. As the name suggests, random forests contain many of these random trees, and therefore the final predicted values are averages across all of the trees. This approach allows for a complex web of interactions between variables and is unharmed by any irrelevant predictor variables. A technique called boosting improves random forests by increasing the influence of models within a random forest structure that perform well. XGBoost combines this and other insights and offers a highly scalable, efficient, and accurate algorithm that has proven itself in the scientific literature, machine learning competitions, and other challenges (Chen and Guestrin, 2016).

This paper uses the `xgboost` R package (Chen et al., 2015). The land use model, implemented with XGBoost, includes the following predictor variables: distance between origin and destination mobility areas, population of origin, population of destination, and area of each of the 26 land cover types found in this data for origin and destination (for a complete list of land cover types, see Table 1.1 in the Introduction chapter). There are 57 predictor variables in total. Variable importance measures allow for a glimpse into the black box of machine learning models. While this paper is primarily interested in flow prediction and generation accuracy, access to variable importance gives us some understanding of which geographical features have the greatest influence on human mobility patterns in urban areas.

To test whether differences between the gravity model and the land use model are due only to the large number of additional variables included in the latter, I also run a linear land use model. This linear model includes the three traditional gravity predictors as well as the 52 land cover variables, without interaction terms. The results of this test are discussed below.

We use two metrics to assess performance of the models. Common Part of Commuters (CPC) is the metric most often used in the mobility literature for this purpose. CPC is computed as follows, where $flow^{obs}$ is the observed flow and $flow^{gen}$ is the flow generated by the model for all pairs $area_i$ and $area_j$.

$$CPC = \frac{2\sum_{i,j} min(flow^{gen}(area_i, area_j), flow^{obs}(area_i, area_j))}{\sum_{i,j} flow^{gen}(area_i, area_j) + \sum_{i,j} flow^{obs}(area_i, area_j)}$$

The resulting metric can range from 0 to 1 and approximates[1] the percentage of trips correctly predicted by the given model. I also use root mean squared errors (RMSE) as an additional comparison metric.

4.5 Findings

I conduct several initial tests to establish a baseline land use model, using XGBoost. In order to tune the `nrounds` parameter, I ran the model 1000 times, setting the parameter randomly between 2 and 300, drawing a random 80 percent of the data as the training set, and making predictions for the remaining 20 percent. As seen in Figure 4.1, the model gains accuracy rapidly as rounds are added initially but levels off. This pattern is evident for both metrics, RMSE and CPC. Running the model with over 180 rounds produces very little additional accuracy, and so this value was

[1]The sum of the model-generated flows in this paper do not always equal the sum of observed flows, therefore the CPC is not exactly equal to the percentage of correct predictions.

selected as a starting point. As described below, however, I conducted additional tuning in later tests in which there was a greater risk of overfitting due to out-of-sample test data.

Using 180 rounds as a baseline, I also trained a model on the entire 2019 dataset to assess variable importance. This test confirmed my expectation that continuous urban fabric would be a key driver of human mobility. Based on the gain metric, which measures the relative contribution made by each variable to the accuracy of predictions, the amount of continuous urban fabric in the destination districts is even more important to the model than the population of the destination, with gain scores of 0.102 and 0.074, respectively. The only variables with greater gain scores were the other two traditional gravity model variables, distance between districts (0.270) and origin district population (0.125). The the amount of continuous urban fabric in the origin district was fifth, with a gain score of 0.0468, followed by the industrial and commercial land use of the destination at 0.0396. No other variable scored higher than 0.03 in this relative measure. The order of variable importance was confirmed when conducting the same test using random forests via the `ranger` R package (Wright and Ziegler, 2015), which implements the bias-corrected measure of variable importance, actual impurity reduction or AIR (Nembrini et al., 2018).

The demonstrated importance of continuous urban fabric validates both of this paper's key contentions: that continuous urban fabric influences the behavior of city residents (though, of course, the direction and complexity of that relationship are not clear when using these methods) and that even relatively broad land use data can add value to models of human mobility.

4.5.1 Random flow generation

The next tests assess the degree to which the land use data can improve on the traditional gravity model. Here, I again divide the data into randomly sampled training and test sets and compare the predictive accuracy of the gravity model to both versions of the land use model—one estimated

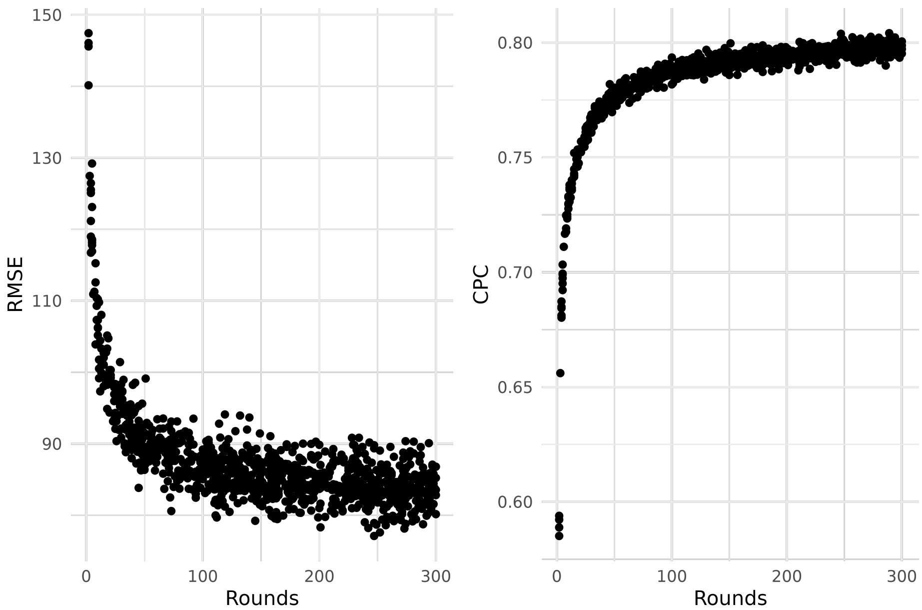

Figure 4.1: RMSE and CPC values of generated flows for test data by number of XGBoost rounds using 80:20 random train-to-test ratio.

using XGBoost and the other a simple linear model estimated using `lm` in R. In these tests I also check the sensitivity of the models to the train:test ratio by randomly setting the size of the test set to between 60 percent and 80 percent of the full data. Here, again, I use the data from 2019. Figure 4.2 shows the results. As expected, the linear version of the land use model is clearly inferior to the XGBoost model, and provides only a minimal improvement over the gravity model, if any. For the remaining tests described in this paper, that model is not reported.

These tests demonstrate that, in the context of generating flows for random pairs of mobility areas, the land use model is far superior to the commonly used gravity model. The land use model produces an average CPC score of 0.791 for the test data, indicating that it predicts nearly 80 percent of movements accurately, compared to 0.579 for the gravity model. I do find, however that the gravity model did not significantly improve as the size of the training data increased, while the land use model did improve it's CPC score by an average of 0.005 when comparing the 80:20 train:test ratio to the 60:40 ratio. This indicates that the gravity model may be useful in circumstances where relatively little data is available. In the following subsections, I test some real world examples to evaluate the practical value of the land use model.

4.5.2 Real world flow prediction

The comprehensive nature of INE's data means that modelling is not strictly necessary to understand urban mobility in Spain from 2019-2021. The data is already effectively complete. Most times, however, researchers and policymakers do not have access to such bountiful mobility data. To test the real world value of the land use model, I conduct three tests that simulate the needs of data-strapped researchers. First, we imagine a researcher several years in the future who is interested in using the data INE gathered to predict current mobility patterns in Spanish cities. Second, we imagine a policymaker in another European city, who has access to Copernicus Urban Atlas data but does not have mobility data and would like to generate it. And third, we imagine a research who can only afford

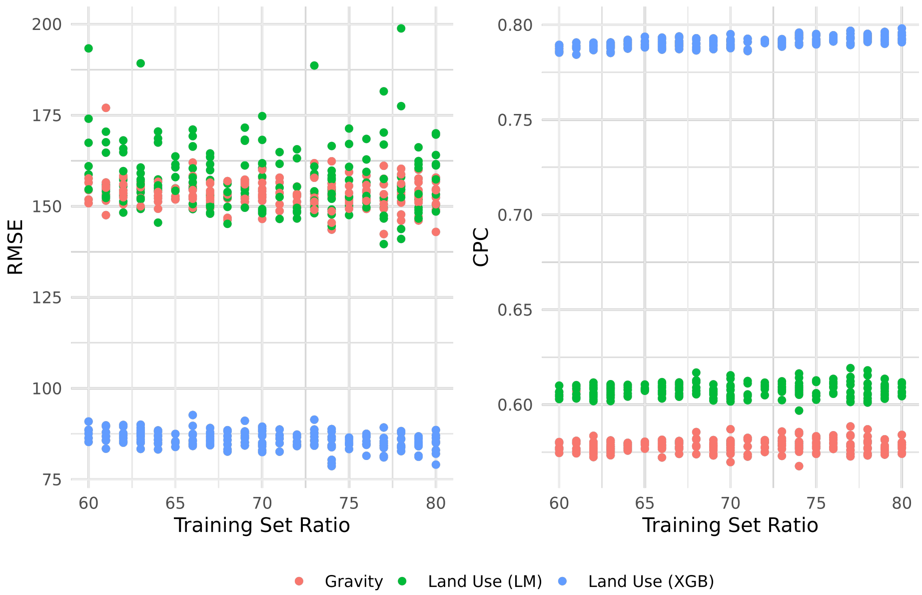

Figure 4.2: RMSE and CPC values of generated flows for test data by model type and training set ratio, ranging from 60:40 to 80:20.

to purchase data for a subset of cities and would like to use that data to generate flows for other cities of interest.

The INE data makes it easy to test whether models based on past mobility data can accurately predict mobility in the future. By using the complete set of 2019 data as the training set and the 2021 data as the test set, I find a 0.815 CPC for the 180-round land use model, which is substantially better than the gravity model (0.568). Importantly, these models are unaware of the city that each observation comes from or the identity of the origin and destination areas, only the underlying land cover and population characteristics of those areas. In this sense, the task is a hybrid between prediction and generation. Figure 4.3 visualizes how the model-generated "future" flows compare to the observed flows in 2021 for the Barcelona, Valencia, and Zaragoza functional urban areas. Given the lingering effects of the pandemic, it may be unsurprising that the land use model overestimates the degree of mobility in each city, however it impressively identifies patterns that elude the gravity model. In each case, the gravity model assumes that population centers (especially those also in the geographic center) drive mobility. While this captures the broad strokes of mobility patterns, to some extent, the visualization of observed data reveals additional complexities. Given the variable importance findings, it is possible that the presence of continuous urban fabric drives mobility to and/or from non-central districts with relatively low populations, and that the land use model picks up on this pattern.

Given that the testing data in this simulation is not drawn from the same dataset as the training data, overfitting may be a risk. Figure 4.4, however, shows that prediction accuracy continues to increase up to the 180 rounds used for the analysis and visualizations described above. Notably, even when the land use model is only run for 2 rounds, it still outperforms the gravity model in this test.

4.5.3 Real world flow generation

To test whether this modelling procedure could be used to accurately generate mobility flows for a city outside of the dataset, I sequentially assign

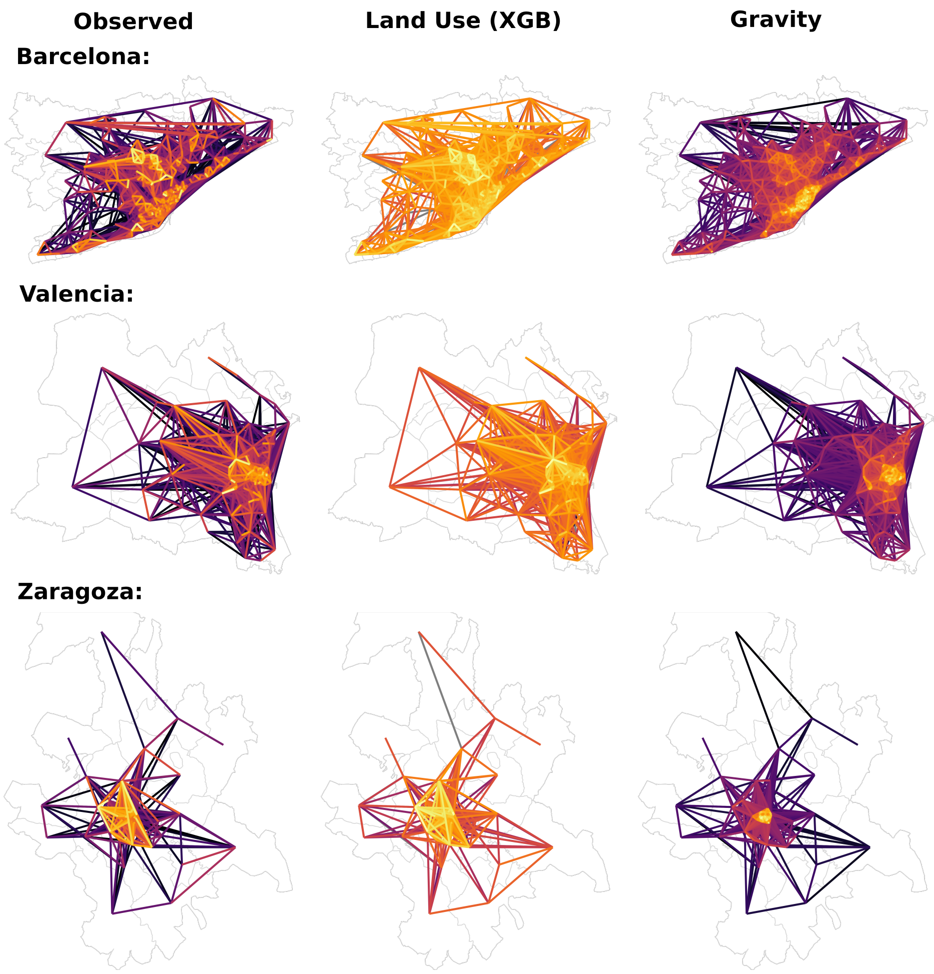

Figure 4.3: Log of observed bidirectional flows for Barcelona, Valencia, and Zaragoza on November 17, 2021, and predicted flows using land use model and gravity model based on data from November 18-21, 2019.

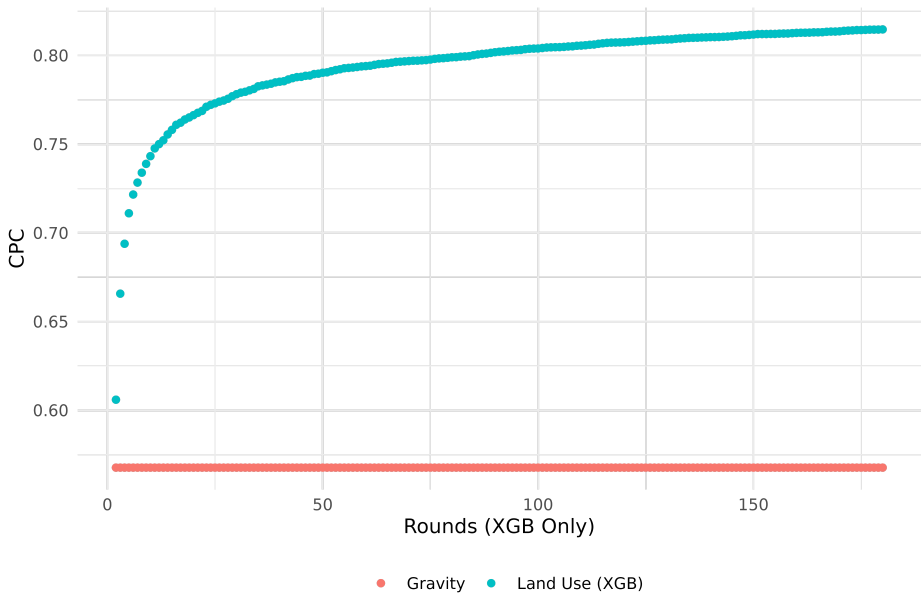

Figure 4.4: CPC values of predicted flows for November 17, 2021, based on models trained on data from November 18-21, 2019, depending on number of XGBoost rounds. Gravity model baseline shown for comparison.

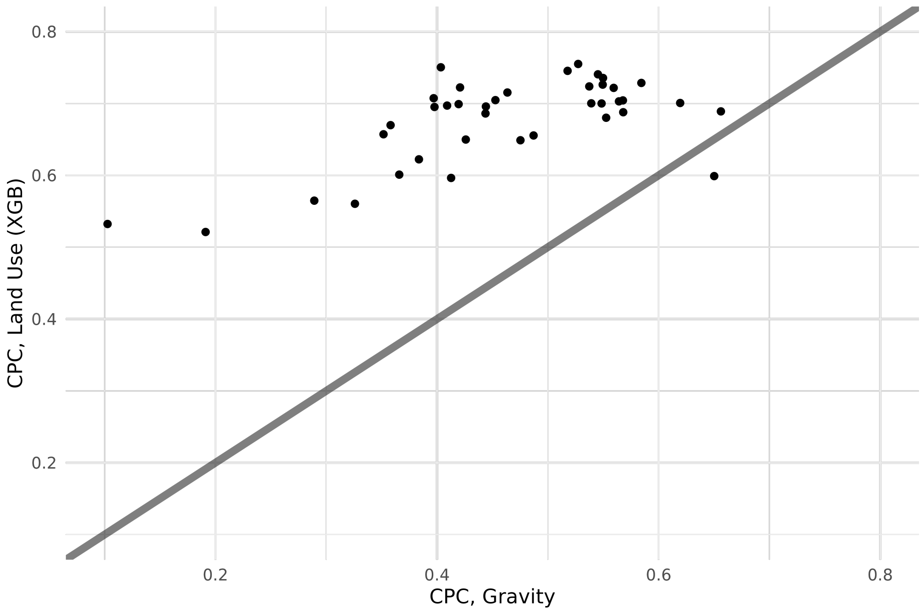

Figure 4.5: CPC values for generated flows using the land use and gravity models for each test city. Models are run 39 times each, using one city as test data and the other 38 cities as training data.

one city as the test set and generate flows for it using all data from the remaining 38 cities as the training set for each model. I conduct this test using only the 2019 data. Figure 4.5 plots the CPC scores for the land use and gravity models for each test city.

Here, I see that the land use model performs better, with only one unsurprising exception. The Madrid functional urban area is much larger than any other in Spain and XGBoost can struggle to make predictions for test data that is meaningfully distinct from the training data. Despite this exception, the flows generated by the land use model were quite realistic overall, with a mean CPC of 0.677 compared to just 0.463 for the gravity model. Figure 4.6 maps the observed and generated flows for Oviedo, Alicante, and Córdoba. Unlike the previous test, in which the land use model frequently overestimated pandemic-era mobility after being trained

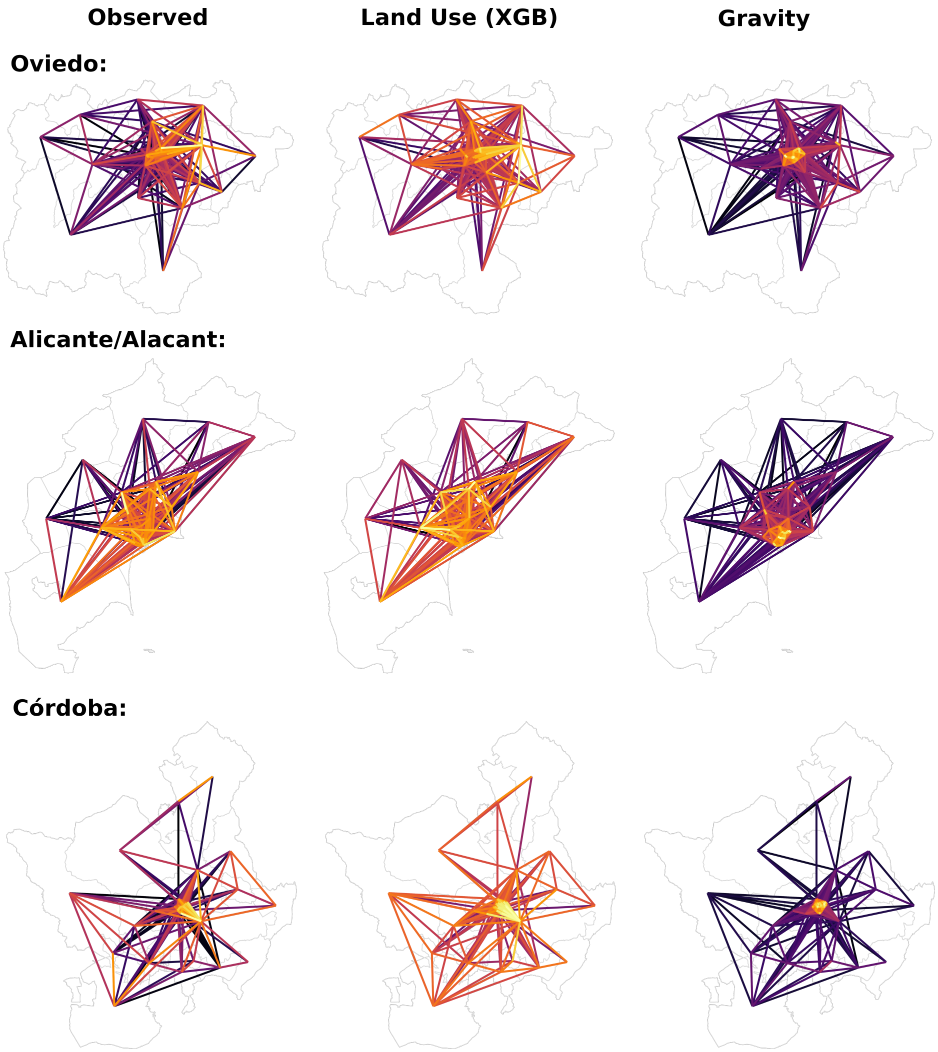

Figure 4.6: Log of observed bidirectional flows for Oviedo, Alicante, and Córdoba on November 18-21, 2019, and predicted flows using land use model and gravity model based on data from the same dates from the other 38 cities, respectively.

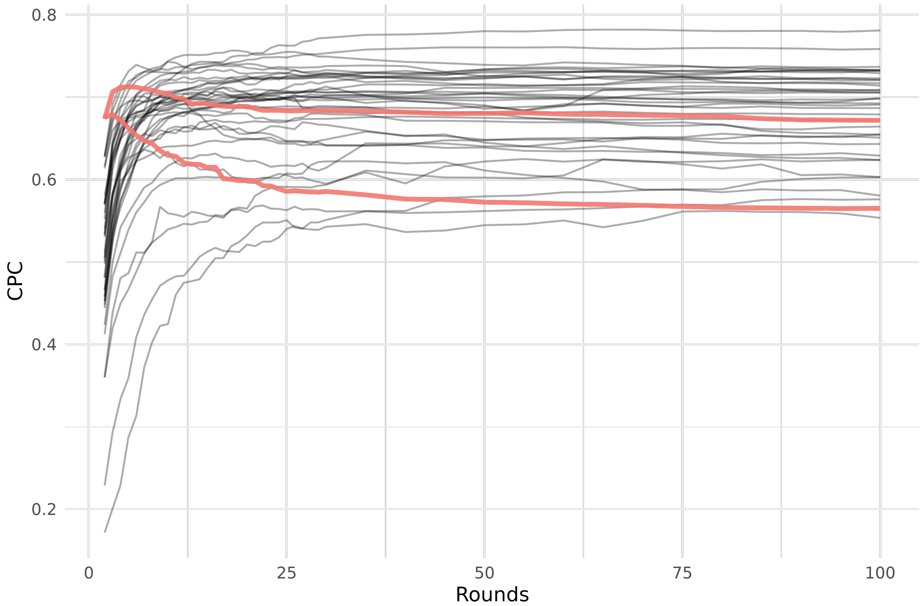

Figure 4.7: CPC values for generated flows for each city using the land use model by number of XGBoost rounds. Highlighted cities (Barcelona above, Madrid below) demostrate risk of overfitting.

on pre-pandemic data, there is no obvious, systematic overestimation in this case.

Given the substantial overfitting risk for this fully out-of-sample test data, these results are based on land use models run on just 20 rounds. Figure 4.7 shows the land use model's performance by number of rounds for each city. In nearly every case, the accuracy of the predictions stops rising after relatively few rounds and even begins to decline in some cases. Barcelona and Madrid, which are larger and more complex than other cities in the data, are particularly difficult test cases for the model. For Madrid, the models performance begins to drop almost immediately as rounds are added, and in both cases the model made more accurate predictions when trained with 5 rounds than with 10.

Finally, I simulate which model would best serve a researcher who can only afford to purchase mobility data for several cities and wants to generate flows for the missing ones. To do so, I run each model over 2,000 times with full data from a random number (between 5 and 20) of randomly selected cities serving as the training data and the remaining cities serving as the test data. To account for the oversampling issue identified in the previous test, I run the land use model three times, once with 10 rounds, once with 20 rounds, and once with 30 rounds. As with the previous test, I use the 2019 data here. Figure 4.8 shows the smoothed CPC scores for flows generated in each simulation.

The traditional gravity model performs nearly as well as the land use model in scenarios where very few cities are "purchased," but the land use model continues to improve as more cities are added to the training data while the gravity model plateaus. As in the test shown in Figure 4.2, I again see that the gravity model does not need much data to estimate its small number of parameters and that adding additional data does little to improve its predictions.

4.6 Discussion

In nearly every scenario tested here, modelling human mobility in urban areas using the XGBoost model of Copernicus Urban Atlas land cover data produces more accurate predictions of future mobility and generates more realistic flows for new cities than the traditional gravity model. This approach fails in only one instance, when generating flows for Madrid using data from 38 other urban areas in Spain, however this deficiency is unsurprising given the model's known disadvantage when making predictions for data that is far outside the training sample.

Unlike many attempts in the literature to improve upon the gravity model, our model can be easily and rapidly implemented on a personal computer and relies on predictor variables that are available for hundreds of cities in a consistent format. Future research, however, should consider how effective our approach is for contexts outside of Spain.

The Copernicus land cover data that I employ is underutilized, es-

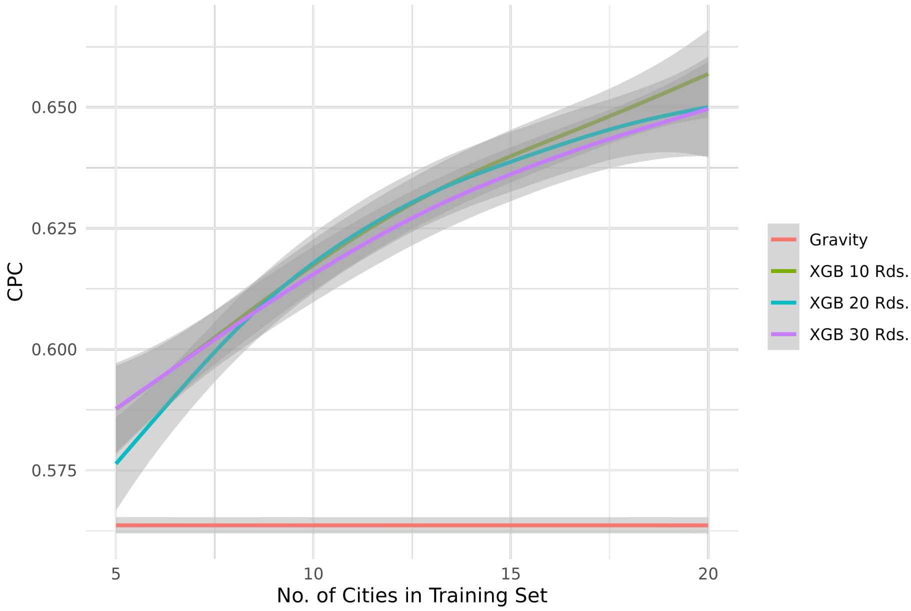

Figure 4.8: CPC values by model, presented using generalized additive mode smoothing, for simulatoins in which data for a random number (5-20) of randomly selected cities are 'purchased' and flows are generated for the remaining cities. Data from November 18-21, 2019.

pecially in the social sciences. Beyond mobility, this data allows for apples-to-apples comparisons between cities that can help grow our understanding of how urban design influences political behavior, inclusion, childhood development, population change, and many other social and demographic outcomes.

Chapter 5

CONCLUSION

This thesis finds that data from the Copernicus Urban Atlas can help piece together social sciences puzzles in cities. The questions that each of the three papers ask are important ones: why do the residents of some cities have more positive views towards migrants than others, what influences the rise of far-right sympathies in certain geographic areas, and can we better predict human mobility in urban areas using widely available data and easy-to-implement tools? In each case, land cover data helps find answers. The latest version of the data used in these papers is available—in a harmonized format—for 788 cities across Europe and beyond. This outstanding resource deserves greater attention among political scientists and sociologists.

The specific findings of the three papers in this thesis are just a few examples of the great potential of this data. In Chapter 2, I compare 22 cities from eastern, western, and southern Europe. Using multilevel models, I find that those who live in cities with more continuous urban fabric are more likely to agree that migrants are good for their city. The models control for city-level migrant population dynamics including the relative size of the migrant population in the city and the recent change. I also show that the distinction between continuous and discontinuous urban fabric is not simply a reflection of population density, though the two concepts are correlated to an extent. Here, the relationship of interest is clearly driven by urban design not just density. The models also include individual-level demographic data, which shows that the positive influence of urban design is even stronger among manual workers.

I further hypothesize, in Chapter 2, that the relationship between urban design and attitudes toward migrants will be moderated by the size of the migrant population. That is, if continuous urban fabric encourages interaction between neighbors and interaction with migrants improves attitudes, I expected that the positive influence of continuous urban fabric would be even stronger in cities with large migrant populations. This hypothesis was not confirmed, however. The failure of this test may simply be due to the limited power of the research design which only includes, due to data availability, 22 cities. Even more importantly, however, it may be that segregation disrupts the logic of the hypothesis: the relative size of the migrant population only influences the likelihood of intergroup contact if the city is not highly segregated.

Chapter 3 takes on many of the lingering doubts left by Chapter 2, and also extends the theoretical framework to a new dependent variable: sympathy for far-right political parties. The leap, here, is not that great. The far right has prominently deployed anti-immigration rhetoric and policy proposals throughout it recent rise. By using different individual-level data and focusing on a single country, Spain, Chapter 3 is able to improve on the prior chapter's approach in a few ways. Spain's *Centro de Investigaciones Sociológicas* conducts monthly barometer surveys which ask respondents how likely they are to vote for each major political party and—crucially—reports the respondent's city of residence. Eurostat's data set for land cover is especially comprehensive for Spain, and the country is also included in the Data Challenge on Integration of Migrants in Cities (D4I) dataset which allows for the calculation of segregation indices at the city level. All told, these advantages made it possible to compare 73 cities, all from the same national context, with additional data that could offer a new perspective on the mechanisms involved.

Chapter 3 finds that, just as in Chapter 2, residents of cities high in continuous urban fabric are more likely to hold progressive views. This this case, that means that are less likely to consider voting for Spain's far-right party, Vox. This finding, which uses entirely different survey data than the original study and includes 69 additional cities (Barcelona, Madrid, Malaga, and Oviedo are included in the data in both papers), provides important validation that the relationship identified in Chapter 2 was not just a data anomaly. Even more important, however, the segregation data provides an opportunity to test whether the theoretical mechanism I argue for has merit. Whereas the failed additional hypothesis in Chapter 2 simply considered if the size of the migrant population moderated the relationship between urban fabric and attitudes, in Chapter 3 I control for migrant population and instead look to segregation as a moderator. By holding migrant population equal, segregation therefore indicates how likely natives are to encounter migrants should they spend time on the sidewalks of their neighborhood. As expected, the interaction term of segregation and continuous urban fabric confirms this hypothesis.

Both Chapter 2 and Chapter 3 argue that continuous urban fabric promotes human activity in cities. This argument is based on theoretical and empirical work by Jacobs, Gehl, and many others, but Chapter 4 shines some light on the outstanding question of whether the land cover reported by the Copernicus Urban Atlas really drives the behavior of city dwellers. The main purpose of Chapter 4 is to use land cover data to improve on the elegant-but-approximate gravity model of human mobility. The greatest virtue of the Copernicus Urban Atlas is that it provides uniform, harmonized geographic data for such a large number of cities. Whereas other attempts to improve the gravity model use, for example, points-of-interest data which can be hard to precisely reconstruct in different contexts, the Urban Atlas data is ready to use for cities from Spain to Turkey to Iceland. A model of human mobility based on this data would be useful to researchers and policymakers across a whole continent.

Given the wide range of land cover types included in the data, and the uncertain relationships between each type and human mobility, the model I propose uses XGBoost machine learning which seamlessly creates an intricate web of interactions between variables and is not bothered by the inclusion of unimportant data. Using data gathered in Spain based on the movements of 40 million mobile phones, I find that the model I propose does indeed improve on the traditional gravity model in all randomized testing and nearly every real-world simulation I imagine. I also find that continuous urban fabric, in particular, is a key driver of mobility in cities.

What does the future hold for Europe's urban fabric and research about it? We can already take a glimpse at the future of urban fabric, or at least recent trends, which also suggest a few directions for research. The 2018 edition of the Copernicus Urban Atlas was first published in April of 2020. I suspected that city-wide percentages of continuous urban fabric, or any other type of land cover, would not change drastically over short periods of time, and so I was content to leave the data in Chapters 2 and 3 alone although it comes from a previous edition.

Between 2012 and 2018, just 92 of 784 functional urban areas, or 11.7 percent, saw an increase in continuous urban fabric relative to their total urban fabric. Among these cities, the change was minimal, with a mean increase of just one-tenth of a percentage point. Among the cities that gained discontinuous urban fabric, the mean change was greater though still small. In 2012, the population-weighted mean of the continuous urban fabric percentage—the key variable in Chapters 2 and 3, here applied to full functional urban areas—was 20.8 percent. By 2018, the figure had fallen to 20.3 percent. Future research should consider whether the decline in continuous urban fabric is a long-term tread and, if so, identify the causes. On the whole, however, the ratio of continuous to discontinuous urban fabric appears stable over time.

While this may raise some normative concerns, it does assuage my concern over an assumption that runs through Chapters 2 and 3. That is, if the percentage of continuous urban fabric is quite stable over time, it is unlikely that reverse causality is taking place, whereby those who have progressive views toward migrants and the far right also hold progressive views toward architecture and push their cities to become more continuous. Given the small degree of the changes between 2012 and 2018, especially in central cities, and the wide range of the continuous urban fabric variable city-to-city, any such uprising by followers of Jane Jacobs would have little affect on my findings.

One example of recent urban fabric trends is the Bucharest functional

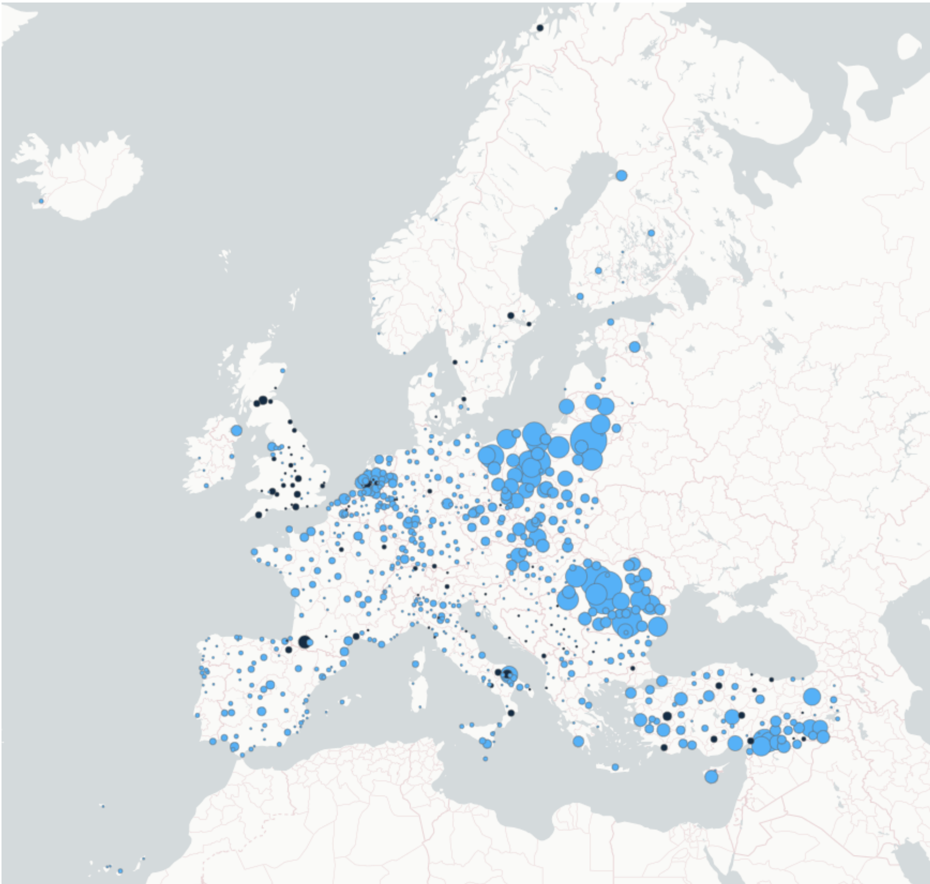

Figure 5.1: Change in percentage of continuous urban fabric between 2012 and 2018 editions of the Copernicus Urban Atlas for all functional urban areas. Dark blue cities gained continuous urban fabric, light blue cities gained discontinuous urban fabric, relative to total urban fabric. Size indicates degree of change.

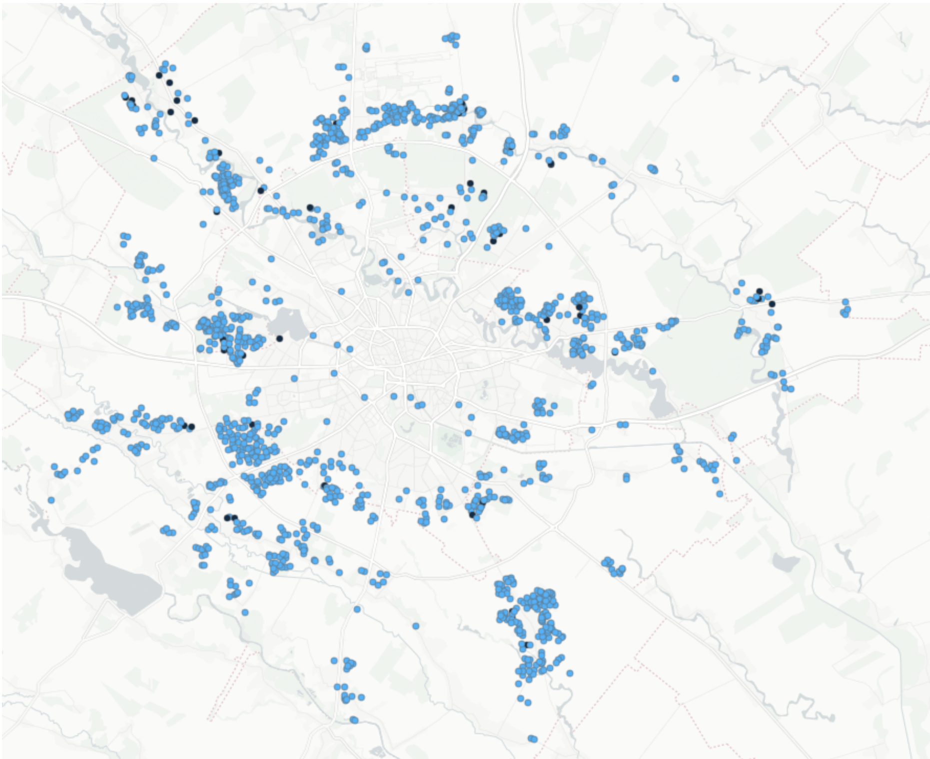

Figure 5.2: Locations of new continuous urban fabric polygons (dark blue) and new discontinuous urban fabric polygons (light blue) in Bucharest based on the change between 2012 and 2018 editions of the Copernicus Urban Atlas.

urban area, which boasted a very high 76.7 percent continuous urban fabric in 2012. The vast majority of changes in Bucharest since then have favored discontinuous urban fabric. Figure 5.2 maps the locations of these changes. Unsurprisingly, nearly all new plots of discontinuous urban fabric—nearly all new urban fabric of any kind, in fact—are found outside of the central city. Future research could consider how sprawl, and the discontinuous urban fabric that often accompanies it, contributes to the relationships identified in the thesis. It is worth noting here, however, that Jacobs is very clear that the theory she lays out in *The Death and Life of Great American Cities* only applies to cities themselves, not suburbs.

To take full advantage, in the social sciences, of the wealth of data provided by the Copernicus Urban Atlas we need theoretical work that ties classes of land cover to concepts in sociology, political science, and urban studies. The relevance of the distinction between continuous and discontinuous urban fabric to Jacobs work is, to my knowledge, a happy coincidence. Theory could help bridge the gap between spatial data and social phenomenon. For example, the Urban Atlas documentation suggests that the data can be used for public transportation development and to assess flood risk—two issues that can, among other consequences, exacerbate inequalities. Providing social scientists with the theoretical and technical tools to incorporate this data into their research agendas could produce breakthroughs and stave off the unintended consequences of well-intentioned urban development.

It is urgent that we get to work immediately. As temperatures and sea levels continue to rise, it is becoming even more vital to identify the subtle ways that cities influence our lives. The Industrial Revolution began a chain of events that, nearly two centuries after its start, saw urban communities destroyed and continuous urban fabric replaced. It appears that the next wave of urban redesign will happen more suddenly. If we are going to make our cities resilient to the physical affects of climate change, we will have to act quickly. And so social scientists must prepare, right now, to identify the social affects of changes to our urban landscapes.

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