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Research Paper

Does urban sprawl hold down upward mobility?

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HIGHLIGHTS

- Upward mobility is significantly higher in compact areas than sprawling areas.
- The direct effect of compactness is attributed to better job accessibility in more compact areas.
- As compactness doubles, the likelihood of upward mobility increases by about 41%.
- Among indirect effects of compactness, only poverty segregation is significant and negative.

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ABSTRACT

Contrary to the general perception, the United States has a much more class-bound society than other wealthy countries. The chance of upward mobility for Americans is just half that of the citizens of the Denmark and many other European countries. In addition to other influences, the built environment may contribute to the low rate of upward mobility in the U.S. This study tests the relationship between urban sprawl and upward mobility for commuting zones in the U.S. We examine potential pathways through which sprawl may have an effect on mobility. We use structural equation modeling to account for both direct and indirect effects of sprawl on upward mobility. We find that upward mobility is significantly higher in compact areas than sprawling areas. The direct effect, which we attribute to better job accessibility in more compact commuting zones, is stronger than the indirect effects. Of the indirect effects, only one, through the mediating variable income segregation, is significant.

1. Introduction

Rising income inequality, and associated lack of upward mobility, have emerged among the most important issues of our time, prompting concern and commentary from top world leaders, including President Obama and Pope Francis, and world class scholars, such as Nobel Laureate Stiglitz (2012), New York columnist and Nobel Laureate Paul Krugman, and Thomas Piketty (2014), and many others. While inequality often makes headlines, upward mobility or intergenerational mobility, concerned with the relationship between the socio-economic status of parents and the socio-economic outcomes of their children as adults (Blanden, 2013), is barely on the radar of the urban planning profession.

Upward mobility and intergenerational mobility are linked and overlap in the literature; however, upward mobility is a broader term that refers to one's ability to move to a higher income bracket and social status and is often tied to one's opportunities (Corak, 2013; Torche, 2013). Areas with high levels of upward mobility tend to have the following characteristics: "(1) less residential segregation, (2) less income inequality, (3) better primary schools, (4) greater social capital, and (5) greater family stability" (Chetty, Hendren, Kline, & Saez, 2014a; Chetty, Hendren, Kline, Saez, & Turner, 2014b). Intergenerational mobility refers to changes in income and social status among different generations but within the same family (Chetty, Hendren, Kline, & Saez, 2014a; Chetty, Hendren, Kline, Saez, & Turner, 2014b; Corak, 2013). Although intergenerational can be an up, down, or lateral move, in the research presented in this paper it is a measure of a child's likelihood of moving to a higher income bracket than his or her parents.

The ideal of upward mobility is rooted in the U.S. Declaration of Independence: hard work is enough to create upward mobility, with greater opportunities than previous generations, personal

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security, and affluence. But is the American idea equally achievable for all societal groups? Recent studies show that the U.S. has one of the lowest rates of upward mobility in the developed world, and only a small proportion of citizens move from the class into which they are born into a higher one (e.g., DeParle, 2012).

Americans experience less economic mobility than counterparts in Europe and Canada due in part to the extent of poverty in the U.S. (DeParle, 2012). A study from the Brookings Institution claims that one's family is a large determinant of individual success, more so in the U.S. than in other countries. Thirty-nine percent of children born to parents in the top fifth of the income distribution will remain in the top fifth for life, while 42% of children born to parents in the bottom fifth income distribution will stay in that bottom fifth (Isaacs, Sawhill, & Haskins, 2008). Furthermore, there is evidence that intergenerational mobility is lower in the U.S. than in many other countries, such as France, Portugal, Canada, and Norway (Isaacs et al., 2008). Additionally, others argue that higher levels of income inequality limit the economic mobility seen in future generations, a situation known as "The Great Gatsby Curve" (Corak, 2013).

Upward mobility and widening economic inequality are particularly pronounced in the United States, but it is a problem faced elsewhere as well. A study by Jäntii et al. (2006) examines the mobility outcomes and intergenerational mobility for six countries: Denmark, Finland, Norway, Sweden, the United Kingdom, and the United States. Looking at mobility for men who were born to fathers in the bottom fifth income bracket, the findings show that these men have a 14% chance of climbing to the top fifth income bracket in Finland, a 12% chance in Denmark and the U.K., and an 11% chance in Norway and Sweden. Only 8% climbed to the top fifth income bracket in the United States (Jäntii et al., 2006). At least one quarter of these men remained in the lowest income bracket in all six countries. Additional studies have found variation in inequality, both in terms of access to opportunities and advantages that one is born with, across countries, ranging from relatively low levels of inequality in Denmark, Norway, Sweden, and South Africa to much higher levels of inequality in Guatemala and Brazil (Brunori, Ferreira, & Peragine, 2013).

Correlates of social mobility are an often-researched topic with scholarly articles on the subject dating back to the 1950s and 1960s. Much of the research has focused on race (Hardaway & McLoyd, 2008), family background (Black & Devereux, 2010; Jäntii et al., 2006), income (Corak, 2006), and family structure (particularly divorce – DeLeire & Lopoo, 2010) as determinants of social mobility. Poorly staffed and funded schools in poor and working-class neighborhoods, inadequate prenatal nutrition and health care, environmental hazards, and pollution are some other factors that affect social mobility (Delgado, 2007).

Countries with less intergenerational persistence tend to have more state programs that ensure all children receive the same education and try to minimize unequal investments in some children (Altzinger, Cuaresma, Rumplmaier, Sauer, & Schneebaum, 2015). "Socioeconomic status influences a child's health and aptitudes in the early years – indeed even in utero – which in turn influences early cognitive and social development, and readiness to learn. These outcomes and the family circumstances of children, as well as the quality of neighborhoods and schools, influence success in primary school, which feeds into success in high school and college" (Corak, 2013). Numerous studies have shown Scandinavian countries, such as Sweden and Norway, having a "uniquely egalitarian mobility regime" (Esping-Andersen & Wagner, 2012) due in large part to state redistribution and removal of financial constraint (Esping-Andersen, 2004; Jaeger & Holm, 2007). Regardless of socioeconomic status all children receive the same education, and standards of education and teaching are consistent across the country. Removing any barriers to a quality education, therefore, contributes to the relatively high levels of social mobility seen in Scandinavian countries.

In addition to these factors and conditions, in this paper we ask whether metropolitan sprawl contributes to the low rate of upward mobility for lower-income residents. The most important indicator of sprawl is poor accessibility (Ewing, 1997). Poor accessibility may be a particular problem for certain socioeconomic groups, since low income and low automobile ownership make the distances inherent in sprawl harder to overcome. The spatial mismatch of low-income (and often minority) residents in inner cities, and low-skill jobs in the suburbs, is particularly a serious case of inaccessibility. Evidence demonstrates that low-income residents have limited transportation mobility and inaccessibility to job opportunities can affect their social mobility (Chapple, 2001; Grengs, 2010; Ong & Miller, 2005). Still, there is no evidence in the literature on how sprawl itself may affect the upward mobility of youth in disadvantaged families.

In this context, we test hypotheses about the connections between urban sprawl and upward mobility for metropolitan areas and divisions in the U.S. using the recently released upward mobility data from the Equality of Opportunity Project[1] and the recently released compactness indices from *Measuring Sprawl 2014*.[2] We hypothesize three mediating (intermediate) variables between sprawl and upward mobility: social capital, racial segregation and income segregation. We then use structural equation modeling to evaluate these hypotheses and estimate the strengths of various connections between sprawl and upward mobility. While our example focuses on conditions in the U.S., we believe the principles apply to other parts of the world as well.

2. Urban sprawl and upward mobility

2.1. Upward mobility and the Equality of Opportunity Project

Large inequality reduces upward mobility, which limits potential development of children and maintains inequality for future generations. Intergenerational inequality and upward mobility have therefore generated huge concerns lately. However, the current knowledge on generational mobility remains limited, and often ignores urban form and geographical contexts (Rothwell & Massey, 2015).

A notable addition to our knowledge of upward mobility is "The Equality of Opportunity Project," which found that one of the key determinants of social mobility is geography; where a person grows up may dictate how likely that person is to move out of the social class into which he or she was born (Chetty, Hendren, Kline, & Saez, 2013). Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b) noted that upward mobility differs significantly across U.S. cities and some cities such as Salt Lake City and San Jose have rates of upward mobility similar to European countries while other cities such as Atlanta and Milwaukee have lower rates of mobility than any developed country. For example, the likelihood that a child starting in the bottom fifth of the national income distribution will reach the top fifth is 4.4% in Charlotte but 12.9% in San Jose (Chetty, Hendren, Kline, & Saez, 2014a; Chetty, Hendren, Kline, Saez, & Turner, 2014b).

What struck us immediately about these findings is a possible connection of upward mobility to sprawl. According to the metropolitan compactness/sprawl indices (Ewing, Pendall, & Chen, 2002), and a more recent study (Ewing & Hamidi, 2014), Atlanta and Charlotte are at the sprawling end of the scale, while Salt Lake City and San Jose are far more compact. This raises the question

[1] http://www.equality-of-opportunity.org/ Accessed August 5, 2014.
[2] http://gis.cancer.gov/tools/urban-sprawl Accessed August 5, 2014.

of whether metropolitan sprawl, and the poor accessibility it occasions, contribute to the low rates of upward mobility for lower-income classes in sprawling metropolitan areas.

Chetty et al. (2013), Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b) have tested for correlations between upward mobility and possible causal factors (via bivariate correlations). While they caution that their findings cannot be interpreted as causal effects, they do find strong correlations between upward mobility and six factors:

- Income growth – Commuting zones (analogous to metropolitan areas) with low levels of income growth have low rates of upward mobility.
- Racial segregation – Commuting zones with high levels of racial segregation have low rates of upward mobility.
- Income inequality – Commuting zones with high levels of income inequality have low rates of upward mobility.
- Quality of K-12 schools – Commuting zones with poor schools have low rates of upward mobility.
- Social capital – Commuting zones with low levels of social capital (poor social networks and low community involvement) have low rates of upward mobility.
- Family structure – Commuting zones with high levels of single parenting have low rates of upward mobility.

Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b) also speculate on a link between sprawl and upward mobility. They operationalize sprawl in terms of commute times to work, but that is as far as they go. "... we also find that upward mobility is higher in cities with less sprawl, as measured by commute times to work" (Chetty, Hendren, Kline, & Saez, 2014a; Chetty, Hendren, Kline, Saez, & Turner, 2014b). However, commute times to work is not a valid proxy for urban sprawl. Indeed, some of the most compact metropolitan areas have some of the longest commute times, by virtue of their size and heavy use of transit (which typically involves longer travel times than automobiles). For example, according to the American Community Survey 5-year estimates (2008–2012), the New York metropolitan area, one of the most compact metropolitan areas by many rankings (Ewing et al., 2002; Ewing & Hamidi, 2014; Galster et al., 2001), has the longest average commute time of all metropolitan areas in the U.S. So, in this study we use the recently released comactness/sprawl index (Ewing & Hamidi, 2014) as our measure of urban form to test the association between sprawl and upward mobility.

2.2. Urban sprawl index: measuring sprawl 2014

More than a decade ago, Ewing et al. developed compactness/sprawl indices for metropolitan areas and counties that placed compact development at one end of a continuum and urban sprawl at the other (Ewing, Pendall, & Chen, 2003a;Ewing, Schmid, Killingsworth, Zlot, & Raudenbush, 2003b;Ewing, Schieber, & Zegeer, 2003c). The compactness indices have been widely used in outcome-related research, particularly in connection with public health. Sprawl has been studied in relation to traffic fatalities, physical inactivity, obesity, heart disease, cancer prevalence, air pollution, extreme heat events, residential energy use, social capital, emergency response times, teenage driving, and private-vehicle commute distances and times. While most studies have linked sprawl to negative outcomes, there have been exceptions (see, in particular, Holcombe & Williams, 2010).

In a recent study, the county and metropolitan compactness indices were refined and updated to 2010 (Ewing & Hamidi, 2014). The refined indices, similar to the original indices, have four distinct dimensions-development density, land use mix, population and employment centering, and street connectivity. However, compared to metropolitan sprawl indices from the early 2000s, these new indices incorporate more variables and have more construct validity. The variables used in the refined indices are either substitutes for the original variables (refinements, it could be argued) or additions to fill in for omitted variables with intuitive relations to sprawl (Ewing & Hamidi, 2014).

We used the refined indices as our measure of compactness in this study. By these metrics, New York and San Francisco are the most compact regions while Hickory, NC and Atlanta, GA are the most sprawling. Compactness (sprawl) scores for metropolitan areas, counties, and census tracts in 2010 are posted on a National Cancer Institute (NCI) website.[3] Also posted is information on their derivation and validation.

2.3. Effects of sprawl on upward mobility

2.3.1. Job inaccessibility

The most obvious direct effect of sprawl on upward mobility is through inaccessibility of workers to jobs. After World War II, many wealthy Americans decentralized out of the core cities and moved to the suburbs. Shopping and ancillary services followed them, leaving poor and minority populations behind. In this regard, John Kain (1968) formulated the spatial mismatch hypothesis, arguing that poor black workers left in central cities were increasingly distant from and poorly connected to major centers of employment in suburban areas. They were constrained by discrimination in labor and housing markets and central city job shortages. The spatial mismatch hypothesis has important implications for inner city residents that are dependent on low-level entry jobs. Distance from work centers can lead to increasing unemployment rates among inner city residents and thereby increasing poverty outcomes for the region as a whole.

Many empirical studies tested the spatial mismatch hypothesis in the early 1970s, soon after the advance of the hypothesis by Kain. There was resurgent interest in the hypothesis in the early 1990s, when at least five review articles were published (Holzer, 1991; Ihlanfeldt, 1994; Jencks & Mayer, 1990; Kain, 1992; Moss & Tilly, 1991), and at least six more after 2000 (Blumenberg, 2004; Blumenberg & Manville, 2004; Chapple, 2006; Fan, 2012; Gobillon, Selod, & Zenou, 2007; Houston, 2005). The focus on African Americans has shifted to include other minorities, low-income single mothers, welfare recipients, and immigrants (Fan, 2012). A recent study further supports the importance of considering the shifting distribution of people and jobs to economic and social outcomes (Kneebone & Holmes, 2015). While the majority of studies conducted since then have found that the spatial mismatch hypothesis holds true 40 years after Kain's initial formulation, not all studies support the hypothesis (Blumenberg, 2004). Several alternative explanations have also been suggested, such as the "modal mismatch," which argues that employment is inaccessible to careless residents in cities with auto-oriented development patterns (Fan, 2012).

A further explanation expanding upon the initial hypothesis is that an information mismatch keeps inner city residents from landing a job. Networking and information spillovers are a major advantage in accessing information about potential job openings. Information access to jobs may hinder matches between inner city workers and suburban jobs. People who are living far from job centers are generally less knowledgeable about potential openings than individuals who live closer to job centers.

Horner and Mefford (2007) analyzed conditions for spatial mismatch controlling for race, ethnicity, and the mode of commuting.

[3] http://www.equality-of-opportunity.org/ Accessed August 5, 2014.

The results revealed how potential commute options differ across commuter groups and how minority job-housing opportunities are more spatially constrained. Their analysis confirmed that minority residential and employment patterns differ from their non-minority counterparts, and that these differences manifest themselves in a more spatially restricted pattern of residential location.

While the focus is different, the concept of jobs-housing balance is also related to spatial mismatch. Jobs-housing balance requires a match-up between the skill level of local residents and local job opportunities as well as between the earnings of workers and the cost of local housing (Cervero, 1989; Stoker & Ewing, 2014). The imbalance occurs because some parts of the metropolitan area are job-rich and housing-poor, others are housing-rich and job-poor, and few provide both residences and employment sites for roughly an equal number of people of comparable skill levels (Cervero, 1989).

Cervero and Duncan (2006) compared vehicle travel to jobs-housing balance and retail-housing mix. Using regression models they isolated the effects of vehicle miles traveled (VMT) against accessibility variables and control variables. The study showed that linking jobs and housing holds a significant potential to reduce VMT. Cervero and Duncan (2006, p. 488) suggest that "achieving jobs-housing balance is one of the most important ways land-use planning can contribute to reducing motorized travel." Similarly, Sarzynski, Wolman, Galster, and Hanson (2006) examined the influences of land use in 1990 on subsequent changes in commute times in 2000 for a sample of 50 large U.S. urban areas. They found that job-housing proximity was the only built-environment variable negatively and significantly associated with commute time.

2.3.2. Social capital

One indirect effect of sprawl on upward mobility may be through social capital. The central premise of social capital is that social networks have value. Just as a machine (physical capital) or an education (human capital) can increase productivity, so can social contacts. People with higher levels of social capital can leverage their relationships to find jobs, capture new opportunities, and benefit from community support.

The majority of studies on the relationship between sprawl and social capital have focused on factors such as trust and neighborhood ties (Brueckner & Largey, 2006; Freeman, 2001; Gottlieb & Glaeser, 2006; Leyden, 2003; Lund, 2003; Nguyen, 2010). Freeman (2001) noticed a negative relationship between the level of car usage and the level of social ties in neighborhoods. Leyden (2003) found that high neighborhood walkability resulted in a higher likelihood of establishing relationships with one's neighbors, generating social interaction, and enhancing political participation. Lund (2003) tested New Urbanist claims that placing amenities such as parks and retail shops within walking distance of homes will increase pedestrian travel and thereby increase interaction among neighbors.

However, some have demonstrated that social capital is not diminished by suburban sprawl. Using DDB Needham Lifestyle Survey data, Gottlieb and Glaeser (2006) found that the rates of four types of social-capital activities, like attending churches, volunteering for community projects, contacting public officials or other civic engagement, and registering to vote, are lower among residents of center cities.

Most recently, Nguyen (2010) related Ewing et al.'s original county compactness/sprawl index to social-capital factors from the Social Capital Community Benchmark Survey and found that urban sprawl may support some types of social capital while reducing others. So though the evidence on the effects of sprawl on social capital is clearly mixed, it certainly provides a pathway between sprawl and upward mobility.

2.3.3. Racial segregation

Another indirect effect of sprawl on upward mobility may be through racial segregation. Upward income mobility is negatively related to the percentage of African-Americans in the population (Chetty, Hendren, Kline, & Saez, 2014a; Chetty, Hendren, Kline, Saez, & Turner, 2014b). Even whites in areas with large minority populations have a smaller chance of upward mobility, implying that race matters at the community level. Economic disadvantages are exacerbated when races are segregated, thereby reducing exposure to role models, decreasing funding for public schools, or hindering access to employment (Cutler & Glaeser, 1997; Massey & Denton, 1993; Sanchez, Liu, Leathers, Goins, & Vilain, 2012; Wilson, 1987).

There is mixed evidence on how sprawl impacts racial segregation. Some studies point to the cost of housing/land as the main contributor to black-white residential segregation. Controlling for household income and racial segregation, Kahn (2001) has shown that sprawl closes the gap between rates of suburban homeownership for African-Americans and whites. Kahn also found that blacks tend to own larger homes in sprawling regions. This is presumably a result of more affordable housing in sprawling regions. Further evidence of the mixed relationship between sprawl and racial segregation comes from Ragussett (2014), who found that the relationship between black-white housing gaps varied substantially across metropolitan areas with varying levels of sprawl.

Galster and Cutsinger (2007) found a direct correlation between land use patterns and levels of black and white segregation in 50 U.S. metropolitan areas. They posited that "the dominant relationship observed is that, on several measures, more sprawl-like land use patterns are associated with less segregation" (p. 540). They further identified the housing price effect as the main mechanism through which sprawl influences racial segregation. In contrast, Nelson, Sanchez, and Dawkins (2004a) showed that growth management measures were effective at reducing racial segregation in metropolitan areas between 1990 and 2000. In a follow-up study, Nelson, Sanchez, and Dawkins (2004b) examined the result of locally adopted U.S. urban containment policies on the change in racial segregation among metropolitan areas during the 1990s and found areas that had adopted "strong" urban containment policy for 10 years experienced 1.4 percentage points less Anglo-African American segregation than those that did not. This is about one-third of the total increase in this segregation measure for all U.S. metropolitan areas during the 1990s (Nelson et al., 2004b). The mixed literature on urban form and racial segregation calls for an update on the interplay between sprawl, racial segregation and upward mobility.

2.3.4. Income segregation

A third indirect effect of sprawl on upward mobility may be through income segregation. Though income segregation is related to spatial mismatch and racial segregation, it is operationalized differently. As with racial segregation, economic disadvantages may be exacerbated when income classes are segregated, thereby reducing exposure to successful role models, decreasing funding for local public schools, or hindering access to employment (Wilson, 1987).

Margo (1992) argues that the movement of metropolitan populations in the U.S. toward suburban locales over the latter half of the 20th century can be linked, to a significant degree, to the rise in personal income. As individual income rose, so did the demand for land and housing among higher income individuals. As a result, higher-income households moved to the outskirts, while lower-income households remained within central cities. Patterns of income segregation may be more pronounced in sprawling metropolitan areas than compact areas.

According to Jargowsky (2002), this movement of higher-income households and isolation of lower-income households in

the central cities lead to concentrations of poverty and a lack of resources, such as employment and educational opportunities. Furthermore, he argues that "these spatial disparities increase poverty in the short run and reduce equality of opportunity, therefore contributing to inequality in the long run" (Jargowsky, 2002, p. 40).

Wheeler (2006) tested if urban decentralization and income inequality were associated with each other, and found an inverse relationship between urban density and the degree of income inequality within metropolitan areas, thereby suggesting that, as cities spread out, they become increasingly segregated by income (Wheeler, 2006).

3. Methods

3.1. Data and measures

We used data on upward mobility and covariates from the Equality of Opportunity databases of Chetty et al. (2013), Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b), and added a sprawl metric from the *Measuring Sprawl 2014* database for metropolitan areas (see Table 1). Our measure of upward mobility is the likelihood that a child born into the bottom fifth of the national income distribution reached the top fifth by age 30.

We posit three mediating variables connecting sprawl with upward mobility indirectly: social capital, racial segregation, and income segregation. The social capital index (SCI) from the Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b) database is our proxy for social capital. Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b) borrowed it from Putnam (2007) and Rupasingha and Goetz (2008). This index is made up of voter turnout rates, return rates on census forms, and various measures of participation in community organizations.

Racial segregation was borrowed from the Chetty et al. (2013) study for commuting zones and was computed based on census 2000 data. Finally, the segregation of poverty, as a proxy for income segregation, was also borrowed from Chetty et al. (2013) and is defined as the extent to which individuals in the bottom fourth of the population are segregated from those with higher incomes.

Our exogenous variables (that drive the system in this analysis) are the rate of income growth between 2000 and 2010, the share of families with kids with a female head of household and no husband in 2000, the mean school district expenditure per pupil in 1996, and the metropolitan compactness/sprawl index for 2010. In line with Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b), we would expect that upward mobility is positively related to the rate of income growth and school spending, and negatively related to the share of female headed households with children. We might also expect that upward mobility is related to metropolitan compactness, due (as discussed above) to differences in accessibility of workers to jobs.

Regarding the metropolitan compactness index, the exogenous variable of greatest interest, we would have preferred using an index for a year near the midpoint of the 30-year period over which upward mobility manifests itself, but did not have such an index. From a longitudinal analysis of changes in sprawl between 2000 and 2010 (Hamidi & Ewing, 2014), we know that urban form does not change dramatically from decade to decade. Again we use compactness indices from the *Measuring Sprawl 2014* project.

The indices are for metropolitan areas rather than commuting zones as defined by Chetty et al. (2013). Commuting zones include rural counties and sometimes more than one metropolitan area. In the latter case, we computed weighted averages of the metropolitan compactness/sprawl index, weighting by population. Because boundaries of commuting zones and metropolitan areas are not coincident, we dropped commuting zones from our sample if their populations differed from the combined metropolitan areas' by more than 25%. It is unfortunate that we lost observations in this manner, but we still had a sample of 122 commuting zones from which to estimate our models.

3.2. Analytical methods

We used structural equation modeling (SEM) to estimate both direct and indirect effects of urban sprawl on upward mobility. SEM seeks to evaluate theoretically justified models against data (Grace, 2006), wherein a set of equations is solved using maximum likelihood methods. There is an equation for each "response" or "endogenous" variable. These are modeled in terms of "drivers" or "exogenous" variables. SEM offers important, additional benefits over multivariate regression including various ways of dealing with multicollinearity (Grace, 2006).

We estimated our SE model of upward mobility with Amos 19.0 and maximum likelihood procedures. We analyzed data for 122 metropolitan areas and divisions that had no missing data.

As suggested by the literature, we included three plausible causal pathways connecting sprawl indirectly with upward

Table 1
Variables used to explain upward mobility (variables log transformed).

Variables		Data sources
Endogenous variables		
upward	The probability that a child born to a family in the bottom quintile of the national income distribution in 1980–1982 reaches the top quintile of the national income distribution in 2010–2011	EOP 2013
socialcap	Index of social capital that aggregates various measures identified by Putnam and collaborators including combining measures of voter turnout rates, the fraction of people who return their census forms, and measures of participation in community organizations	Rupasingha and Goetz (2008); EOP 2013
racialseg	Measure of how minorities are distributed across census tracts within a CZ. This is Thiel's H measure for the four groups: White alone, Black alone, Hispanic, and Other	EOP 2013
segpov	Measure of how evenly those in the lower income quartile are distributed across census tracts within a CZ	EOP 2013
Exogenous variables		
incgrowth	Annualized growth rate (2000–2008) in real household income per working age capita (16–64)	EOP 2013; Census 2000; ACS 2010
gini	Computed by EOP team using parents of children in the core sample, with income top coded at $100 million in 2012 dollars	EOP 2013
femkid	Share of families with kids with a female householder and no husband	EOP 2013; Census 2000
stratio	Average student–teacher ratio in public schools	EOP 2013
index	Metropolitan compactness index for 2010	Ewing and Hamidi (2014)

Table 2
Direct effects of variables on one another in the upward mobility model.

			Coefficient	Standard error	*p*-value
socialcap	<—	index	0.188	0.071	0.014
racialseg	<—	index	0.019	0.079	0.742
racialseg	<—	femkid	0.447	0.052	0.009
segpov	<—	femkid	0.306	0.097	0.005
racialseg	<—	incgrowth	−0.214	0.069	0.011
segpov	<—	index	0.182	0.081	0.012
segpov	<—	gini	0.109	0.091	0.167
socialcap	<—	gini	−0.647	0.061	0.013
socialcap	<—	stratio	−0.211	0.064	0.006
upward	<—	racialseg	−0.04	0.074	0.4
upward	<—	segpov	−0.156	0.056	0.008
upward	<—	incgrowth	0.345	0.056	0.004
upward	<—	femkid	−0.467	0.065	0.019
upward	<—	socialcap	−0.032	0.106	0.907
upward	<—	stratio	0.146	0.069	0.009
upward	<—	gini	0.003	0.093	0.864
upward	<—	index	0.308	0.071	0.005
Chi-square		1.9			
		degrees of freedom = 6			
		p-value = 0.93			
RMSEA		0			
		p-value = 0.97			
CFI		1.00			

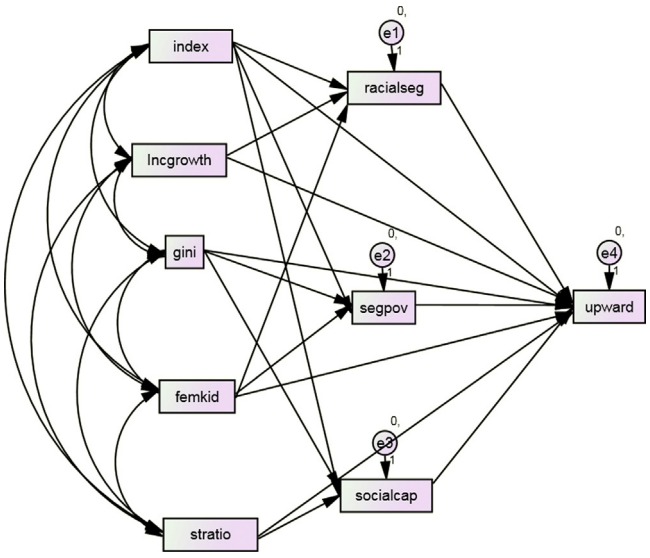

Fig. 1. Causal path diagram for upward mobility in terms of metropolitan/commuting zone compactness and other variables.

mobility – one through social capital, a second through income segregation, and a third through racial segregation. The fourth pathway between sprawl and upward mobility is direct, most likely reflecting job accessibility, spatial mismatch, and jobs-housing balance.

SEM evaluation was based on four factors: (1) theoretical soundness; (2) chi-square tests of absolute model fit; (3) root-mean-square errors of approximation (RMSEA), which unlike the chi-square, corrects for sample size; and (4) the comparative fit index (CFI). To obtain the best possible fit of the model to the data, we added directed arrows for causal pathways and bi-directional correlational arrows wherever modification indices suggested them. The causal pathways are self-explanatory. The correlational arrows simply allow for correlation among the exogenous variables, as in ordinary least squares regression. It is standard practice in SEM to permit correlations among exogenous variables to minimize the potential for confounding (Hoyle, 2012).

4. Results

The best-fitted model is shown in Fig. 1. For simplicity, some correlational arrows have been omitted from the figure but not the model. Direct relationships are presented in Table 2. Reported regression coefficients are standardized. Reported standard errors and significance levels were estimated using bootstrapping methods. Relationships are mostly significant and as hypothesized. Goodness-of-fit measures at the bottom of the table suggest that the model provides a good fit to the data. The upward mobility model in Fig. 1 has a chi-square of 1.9 with 6 model degrees of freedom and a *p*-value of 0.93. The low chi-square relative to model degrees of freedom and a high (>0.05) *p*-value are indicators of good model fit. The comparative fit index (CFI) value indicates that the model explains virtually all of the variation in the data.

The metropolitan compactness index has a strong direct relationship to upward mobility in the model. This is our most important finding. Let us consider each indirect effect in turn. The compactness index is inversely related to racial segregation, but not at a significant level. The compactness index is directly related to both social capital and poverty segregation. Of these two variables, poverty segregation has a significant negative relationship to upward mobility, as expected, while social capital has no relationship to upward mobility.

Of the other exogenous variables in the model, income growth is positively related to upward mobility, while the share of female headed households with kids is negatively related to upward mobility. Both income growth and female headed families have indirect relationships to upward mobility through the mediating variable, racial segregation. Income growth adds to upward mobility indirectly, while female-headed families detract from upward mobility indirectly. The Gini coefficient, which represents income inequality, is unrelated to upward mobility. The student–teacher ratio, which relates to school quality, is positively related to upward mobility, a largely unexpected result (though not entirely, see Gladwell, 2013, pp. 55–60).

Direct, indirect, and total effects of variables on one another are shown in Table 3. The net indirect effect of compactness on upward mobility is negative due to the increase in income segregation that accompanies compactness. However, the indirect effect of compactness through the mediating variable is small compared to the direct effect of compactness on upward mobility. Using upward mobility data from a credible source, and a validated compactness/sprawl index, we conclude that upward mobility is significantly higher in compact than sprawling metropolitan areas/commuting zones. The point elasticity of upward mobility with respect to compactness is 0.41. As the compactness index doubles (increases by 100%), the likelihood that a child born into the bottom fifth of the national income distribution will reach the top fifth by age 30 increases by about 41%. For the average poor kid in our sample, with an 8% chance of moving up into the top quintile, this represents an increase of 3.2% in absolute terms, well within

Table 3
Standardized direct, indirect, and total effects of the metropolitan compactness index and other variables on upward mobility.

	racialseg	segpov	incgrowth	femkid	socialcap	stratio	gini	Index
Direct effect	−0.04	−0.156	0.345	−0.467	−0.032	0.146	0.003	0.308
Indirect effect	0	0	0.009	−0.066	0	0.007	0.004	−0.035
Total effect	−0.04	−0.156	0.353	−0.533	−0.032	0.153	0.007	0.273

the range of upward mobility differences from metropolitan area to metropolitan area. The extreme values in our sample are a 2.6% chance of upward mobility in Memphis, TN, and 14.0% in Provo, UT.

5. Discussion and conclusion

Altzinger et al. (2015) state that there are four methods that, if utilized together, would be effective at addressing social mobility and intergenerational persistence:

- "Universal and high-quality child care and pre-school programs;
- later tracking and more access to vocational training, with a focus on avoiding skill mismatch and facilitating technology development;
- integration programs for migrants;
- a two-pronged government spending approach: investment should target education and social support policies at the same time." (p. 26)

To these we add a possible fifth method, implementation of programs that discourage sprawl and encourage compact development.

In our paper title, we asked: Does sprawl hold down upward mobility? Using the best available measures of both sprawl and upward mobility, we examined potential pathways through which sprawl may have an effect on mobility. Our examination reveals that sprawl has an effect through some, but not all, of the posited causal pathways.

Our results are generally consistent with those of Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b), who looked at simple correlations between upward mobility and seven potential causal factors: income growth, family structure, school quality, racial segregation, poverty segregation, social capital, and sprawl (represented by commute times). Our results indicate that income growth has a direct positive relationship to upward mobility, which is consistent with Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b). So is the finding about family structure, represented by the share of single female-headed households with children, which has a negative relationship to upward mobility. Racial segregation and poverty segregation also have strong negative relationships to upward mobility, which supports Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b). Where we do not find evidence of significant relationships, in contrast to Chetty et al., is in social capital (represented by a social capital index). We also find an unexpected positive relationship between the student–teacher ratio and upward mobility, which is either spurious or an indication that the student-teacher ratio is not a good measure of school quality.

Most important are the relationships between sprawl and upward mobility. Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b), report a negative correlation between commute times, their proxy for sprawl, and upward mobility. We have gone a step further, measuring sprawl explicitly and then examining both direct and indirect causal pathways between sprawl, as measured, and upward mobility. The direct effect, which we attribute to better job accessibility in more compact commuting zones, is stronger than the indirect effects. Of the indirect effects, only one, through the mediating variable of poverty segregation, is significant. Commuting zones with high levels of compactness are, in fact, more segregated in terms of income, and that segregation does, in fact, suppress upward mobility.

We would like to acknowledge a few limitations of this study, which provide potential directions for future research. First, the data employed are highly aggregated, which introduces the possibility of aggregation bias. Spatial inequality is sensitive to geographical scale (Wei, 2015) and upward mobility likely relates to neighborhood circumstances (Rothwell & Massey, 2015). Do youth, for example, living in a neighborhood that is compact and job accessible experience greater upward mobility, even though their metropolitan area may not be compact? Do residents living in a neighborhood that is segregated, going to a school with a high student-teacher ratio, and having weak ties to their neighbors, experience lower upward mobility even though the metropolitan area as a whole may not have these characteristics? Due to the ecological fallacy, the relationships we estimate at the aggregate level may not apply to individuals. Thus, we would recommend that future research on sprawl and upward mobility use less highly aggregated data and more rigorously evaluate the effects of neighborhood conditions on intergenerational mobility.

A second limitation of this study is that the measure of upward mobility developed by Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b) does not capture the upward mobility of residents that ascend only one or two income quintiles. In order for residents to be considered upwardly mobile by their measure, they must move from the lowest quintile to the highest. This is a high bar to achieve. Surely, many residents move up one, two, or three quintiles, yet our study does not record them as upwardly mobile. Comparison of household income in adulthood with family income in childhood has also been used to study intergenerational mobility.

A third limitation has to do with the control variables used in this study. As a follow up to the Chetty et al. study, we used the same control variables as they did. Some of their control variables such as poverty segregation and racial segregation are computed by Chetty and his team; others come from other sources such as the social capital index which was borrowed from Rupasingha and Goetz (2008). We are unable to confirm the validity and reliability of these variables and the way they are operationalized. More control variables can also be included in future studies so that more complete sources of inequality could be revealed.

A fourth limitation relates to the time period to which different variables apply. Upward mobility is an intergenerational phenomenon, measured by comparing incomes of parents in 1980–82 to their children in 2010. Most of the independent variables from Chetty, Hendren, Kline, and Saez (2014a), Chetty, Hendren, Kline, Saez, and Turner (2014b) are measured near the midpoint of the period, reflecting conditions when the children were teenagers. Yet, the compactness measure used to operationalize sprawl applies to the end of the period, 2010. This isn't necessarily where the children were living during their teenage years, and even if it is, the characteristics of the area could have changed somewhat between their teenage years and their adult years. We take some solace in the fact that urbanized areas change slowly over time (Hamidi & Ewing, 2014).

Our findings shed light on the built-environmental dimension of upward mobility. Its strong direct relationship to the compactness index carries important consequences for planners and development strategies. Higher density/mixed-use development has been shown to generate incrementally more jobs, higher wages, economic resilience, and lower unemployment rates, all of which advance upward mobility (Glaser, 2011).

Our findings can also shed light on international comparisons, which are clearly needed to better understand the nature of intergenerational mobility and the effect of the built environment. Income mobility tends to be higher in Europe especially Nordic countries, which are placed at the top of the mobility ranking, than the United States (e.g., Corak, 2004; Blanden, 2013), and studies are needed to evaluate the effect of urban form and built environments since European cities are in general compact cities. Moreover, many developing countries, especially China, are undergoing rapid

urbanization and urban land expansion, which has been called urban sprawl (Li, Wei, Liao, & Huang, 2015). If our finding holds true in developing countries, then we would expect cities there will have increased sprawl indexes and declining intergenerational mobility over time. This raises a global concern for equitable and sustainable development since many developing countries, especially China and Brazil, already have high-income inequality. Planners in both developed and developing countries therefore have to explore ways to address the problems of intergenerational mobility.

While aiming directly for upward mobility can appear as a distant target, the management of the built environment is at heart of planners' everyday agenda. Policies proposed to improve intergenerational mobility tend to emphasize education and health care (Corak, 2013), rarely considering neighborhood and urban form (Rothwell & Massey, 2015).

Our study invites planners and policymakers to adopt a comprehensive framework of action in investing in urban form as a venue to enhance upward mobility. Such efforts are particularly important in affordable housing allocation and transportation investments.

Our findings suggest that careful consideration should be given to the physical (compactness index variable) and socioeconomic landscape while considering locations for affordable housing projects. For instance, the Low-Income Housing Tax Credit program incentivizes developers to locate their projects in lowest-income census tracts or areas having poverty rates of 25% or more. Our results suggest that careful attention should be devoted to improve access to jobs and avoid promoting residential segregation by race or income (poverty and racial segregation variables). This could inhibit upward mobility.

Also our findings suggest that investments in our transportation systems should go beyond functionality and mobility concerns. Transportation infrastructures should be planned as 'enablers'. The imperative is to ensure a sound spatial coordination of land-uses and transportation infrastructures to create an 'enabling' physical environment for low incomes to improve their social and income status. Planners and policymakers could ensure that the development/extension of a transit line is best leveraged by supporting policies for mixed-use development and not furthering sprawl.

There is clearly a need for more research to further tease out the nature of these relationships. Nevertheless, the findings of this study suggest that communities influence the chances for economic advancement of the people who live there. Given the complexity of the relationship, more planners and geographers should engage in the study of intergenerational mobility, especially the effects of neighborhood and urban form. Urgently needed are also international comparative studies, given the rapid urbanization and emerging trend of urban sprawl in developing countries.

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