How did reclassification contribute to the recent urban growth in the US? (extended abstract)

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1. Introduction

While the world has been increasingly more urbanized since 1800 (Davis 1955) and urbanization projections show no sign that the global trend of urban growth will be either stopped or reversed (UN 2018; Jiang and O'Neill 2017), future cities cannot be assumed to retain the same urban forms of today and future urban growth may not be determined by the same sociodemographic factors (Smith 1996; Hall and Pfeiffer 2000; Keiner et al 2005). The lack of adequate knowledge and misinterpretation of the major driving forces of urban growth often lead to some policy pitfalls – e.g. governments in some developing regions often implemented rural-urban migration control regulations to reduce urban population even through evidence shows urbanward migrations are not the main source of urban growth (UN 2000). Understanding the causes of present and future urban growth is fundamental to global, national, and local socioeconomical plans and to designing sustainable development policies (Seto et al. 2012; O'Neill et al. 2012; California Recourses Agency 2011).

Urban research communities have long identified the proximate determinants of urban population changes as natural growth resulted from the differences between fertility and mortality in the urban areas, migratory growth due to rural-urban migration flows, and reclassification because of expansion or extraction of urban land extent (Preston 1979). While the former is better measured and understood, we know less about the latter (especially reclassification) because of lacking data and difficulties for analysis (Chen et al. 1996; UN 2000). Our recent paper reviews literature and finds that while the impacts of reclassification on urban growth may increase as a country moving up the stages along demographic and mobility transitions (Zlinsky 1971), the uncertainty of its relative contribution to urban growth becomes larger (Jiang and O'Neill 2018). The increasing uncertainties in reclassification is not only due to changing urban definitions under the major sociodemographic, economic, technological and institutional transformations, it is also often driven by some political games – politicians use reclassification as a tool to increase political capital (Kulscar and Brown 2011). Empirical studies of urban growth caused by various types of reclassification are needed to gain better understanding of the nature of urban transition and to more accurately project the trends of future urbanization.

Demographers often decompose the demographic factors of urban growth through either modeling the effects of fertility and mortality (as natural growth), treating the combined effects of migration and reclassification as residual (Chen et al. 1996; UN 2000), or modeling both natural growth and migratory growth when migration data is available, treating the effect of reclassification as residual (Jiang and O'Neill 2018). These accounting strategies, especially latter, provide useful information to assess the possible contribution of reclassification to urban growth when no data on reclassification is available. However, we do not learn with good certainty from these analyses how much reclassification actually affect the changes in population sizes and compositions in the urban areas.

Taking advantage of the recently available spatial data on reclassification, this paper explicitly explores the net effects of reclassification on urban population growth in the US for the period 1990-2010. Adopting a multiregional rural-urban projection model, we decompose the US urban population changes into natural growth, migratory growth, and reclassifications for both the periods of 1990-2000 and 2000-2010.

2. Data and Methods

Two types of spatial data are deployed in this analysis; census units and remotely sensed measures of the built environment (the former is in vector format, and the latter is raster data). Census units are the primary data source for the analysis, while the remotely sensed data are used to enhance our understanding of dynamic change in census classifications.

In the US censuses, census blocks are the smallest spatial units over which basic demographic data are compiled (population counts, age-structure, race, and gender). The population contained within the census blocks are defined as urban or rural at each decennial census according to multiple criteria that have changed over time (Ratcliffe 2015), therefore provides good measurements of spatial rural-urban population changes. However, to use the data at the census block level we need to overcome the problems due to the changing designation of census blocks and alternating block boundaries.

To do so we overlay the block boundary layers from the beginning and end point of each period (e.g., 1990 and 2000) and derive the spatial union, resulting in a new layer that respects the boundaries of both periods. This process has the effect of dividing many blocks into smaller sub-block units which we term "block bits". We then populate the blocks and block bits in this new spatial layer by allocating population counts and urban/rural status from both the beginning and end point of each period (e.g., 1990 and 2000) to each unit in the new layer. In cases where the union function created block bits, we allocate population proportionally according land area and urban/rural status according to the status of the parent block from each time period. We carry out this process twice (1990-2000 and 2000-2010) resulting in two new spatial from which we can analyze transitions over the first (1990-2000) and second (2000-2010) census periods. For each period, we classify blocks and block bits into one of four categories based on urban/rural status at the beginning and end of each period: (1) transition from urban-to-rural, (2) transition from rural-to-urban, (3) remained urban, and (4) remained rural. We then aggregate the population in each class from blocks/block bits up to national urban and rural population and compare both population totals and population change over each census periods. Additionally, we produce maps to assess spatial patterns in the distribution of classes as well as population change within and across classes, focusing in particular on major urban areas and their hinterlands (areas likely to exhibit evidence of transitions between rural and urban classes over time). To add to this analysis, we considered the degree to which blocks and block bits are "built-up" using the GHSL data (Pesaresi et al., 2013, 2016a, 2016b, 2016c). For each spatial unit we calculate the average GHSL value, and from there the range, mean, and median GHSL value for each class at different spatial scales, again paying attention to both values at the beginning and end of each period and change over time.

Figure 1 displays the population changes in areas remained as urban, remained as rural, reclassified from rural to urban, and reclassified from urban to rural during the two periods of 1990-2000 and 2000-2010. Analysis also reveals that the aggregated numbers from the spatial data match well the statistics of the census report in both total rural and urban population and population by ages.

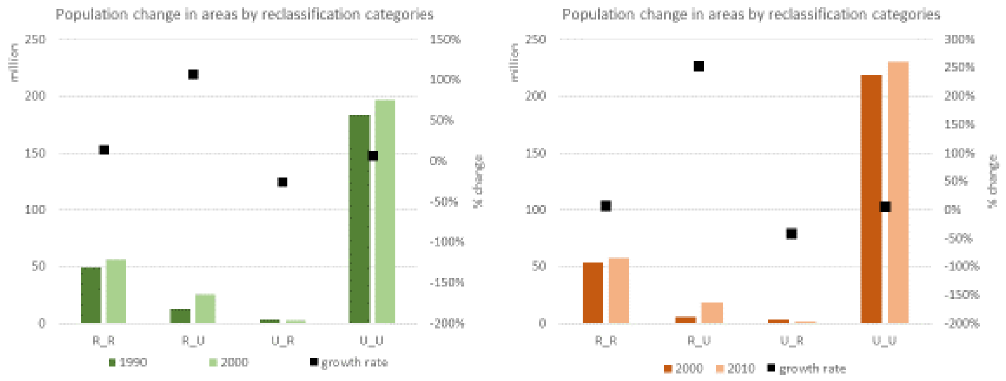


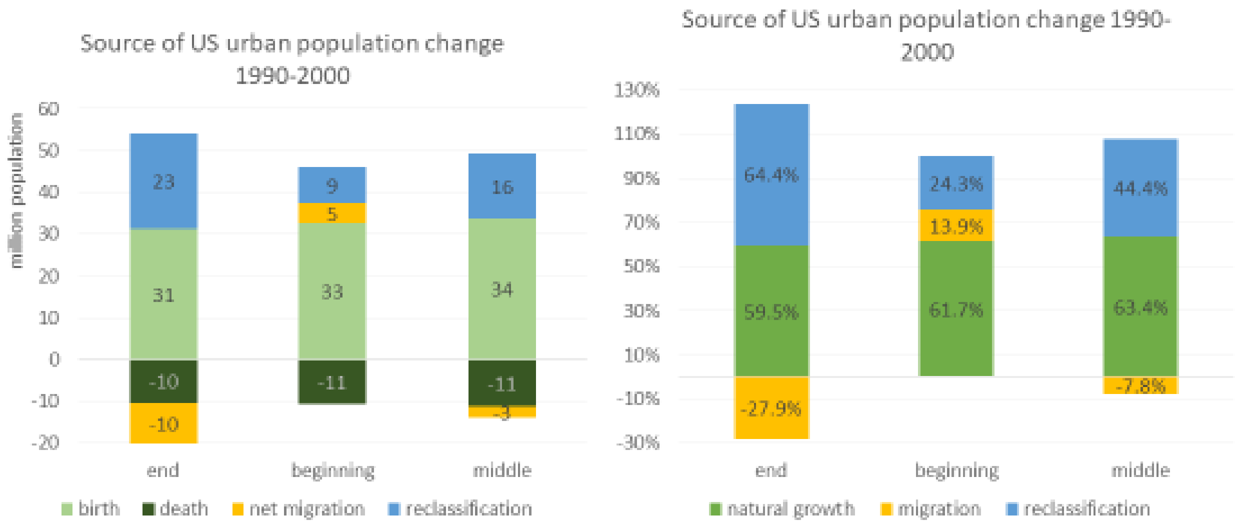
Figure 1 Population changes in areas by categories of rural-urban reclassification

To decompose the urban total population growth into natural growth, migratory growth, and reclassification, we use the multiregional population projection model to carry out the analysis (Jiang and O'Neill 2018). To derive the input data for the decomposition analysis, we use IPUMS USA to obtain the rural and urban population by age and gender, the age-specific fertility rates of the rural and urban areas for the two periods of 1990-2000 and 2000-2010. Using the microdata of 2000 and 2010 censuses, we also derive the age and gender specific migration rates between rural and urban areas for the period of 2000-2010. Because there is no information on the rural and urban status of the origins of the migrants in the microdata of 1990 Census, we could not calculate the rural-urban migration rates for the period of 1990-2000 and therefore need to treat migration as residual in the decomposition analysis. From the microdata of IPUMS USA, we also calculated the number of international migrants moving into rural and urban areas as well as their age and gender frequency distribution. We find out that more than 90 percent of immigrants moving into the urban areas, contributing to the urbanization. From the Human Mortality Database, we derive national age- and gender-specific mortality rates for the two time periods and apply them to both rural and urban population.

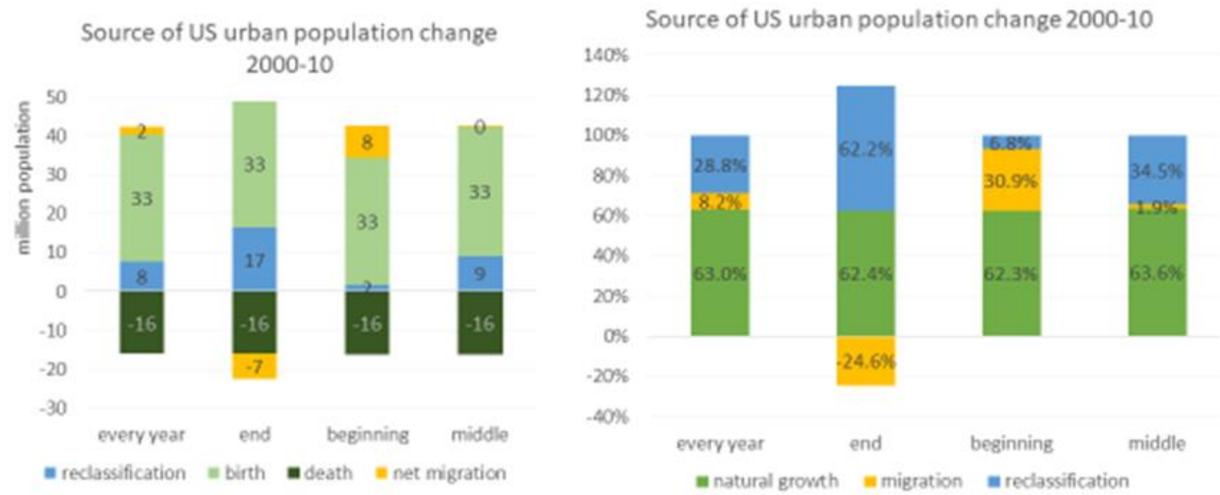
3. results

Using the multiregional projection model and based on the input data, we simultaneously backcast the rural and urban population within each intercensal period in single year step so that we could decompose the changes in urban population due to natural growth, migration, and reclassification. To account for the impacts of reclassification, we add population in the area reclassified from rural to urban during the intercensal period to the urban population, and extract population in the area reclassified from urban to rural from the urban areas, and do the same to derive the rural population. Because there is no information on when the reclassification occurred during the intercensal period, we assume the reclassification occur: (1) at the beginning of the intercensal period; (2) in the middle of the intercensal period; (3) at the end of intercensal period. The results show that in both periods of 1990-2000 and 2000-2010, natural growth contributed to about 60% of urban growth. When data on reclassification is available and migration is treated as residual, the relative contributions from reclassification and migration differ quite a lot depending on the timing of reclassification is assumed. The contribution from reclassification ranges from 24.3% (classification assumed to occur at the beginning of the period) to 64.4% (reclassification assumed to occur at the end of the period) during 1990-2000; and the range is even bigger (from 6.8% to 62.2%)

during 2000-2010.



(a)



(b)

Figure 2 Absolute changes (left panel) and relative contribution (right panel) of urban population growth due to natural growth, migration and reclassification for the period of 1990-2000 (a) and 2000-2010 (b)

4. Discussions and conclusions

This paper presents the first set of decomposition analysis of the US urban population growth during 1990-2010 due to natural growth, migration and reclassification, based on detailed spatial data on urban-rural reclassification. Using multiregional population projection model, the results show a large rang of uncertainty on the relative contribution from reclassification and migration when migration is treated as residual, due to the fact that information on the timing of reclassification is unavailable. Comparing the differences in the results (not show here because of space limitation) between treating reclassification as residual (when migration data is available) and treating migration as residual (when migration data is unavailable), we are able to evaluate how well the existing studies of urban growth attribution provide useful information for understanding sociodemographic driving forces of urban growth.

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