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School segregation and the identification of tipping behavior☆

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ABSTRACT

We develop a method to empirically implement the Schelling model of segregation, and use it to study racial segregation in Los Angeles schools from 1995 to 2012. Our two-step method combines the estimation of parents' preferences for their children's peers with a counterfactual simulation analysis. We find substantial heterogeneity in the existence and locations of tipping points and stable equilibria. Schools are observed on equilibrium trajectories, but many remained out of equilibrium by 2012. We also introduce novel instrumental variables to identify preferences for endogenous peer groups that require no additional data and can be used in other educational settings.

1. Introduction

Birds of a feather flock together. Social forces draw similar peers to one another in diverse settings, often resulting in the segregation of individuals, which has important consequences for their behavior and well being. The Schelling model (Schelling, 1969, 1971) offers the seminal theoretical framework for the analysis of segregation in the social sciences. It has been used to study a variety of contexts, from racial segregation in neighborhoods and schools to gender segregation in occupations. In this paper, we develop a novel method to empirically implement the Schelling model, and we use it to study racial segregation among White, Black and Hispanic students in Los Angeles County public schools.

Dating at least as far back as the U.S. Supreme Court's landmark decision in *Brown v. Board of Education of Topeka* (1954), school segregation has occupied a prominent position in the public policy debate. Through the lens of the Schelling model, parents of different races respond differently to the prior observed racial compositions of schools when making enrollment decisions for their children. This may create a self-reinforcing, positive-feedback mechanism whereby the shares of minority students in schools change in each year as parents respond to the new racial composition. For example, if White parents have a stronger preference for White peers relative to minority parents, then there exists a threshold minority share above which a school will "tip" towards a stable equilibrium with a high share of minority students and below which a school will "tip" towards a stable equilibrium with a low share of minority students. This threshold is commonly referred to as a *tipping point*, and it represents an unstable equilibrium as even a slight perturbation around this point may lead to very different long-run racial compositions of the same school.

Despite considerable theoretical developments to the Schelling model (e.g. Becker and Murphy, 2000; Pancs and Vriend, 2007; Zhang, 2009), there have been few empirical developments in implementing this model to identify tipping behavior using observational data. An important reason for this disparity is the fact that the Schelling model obtains a concise explanation for segregation by assuming individual agents behave according to some plausible heuristics. Although the simplicity of this approach is appealing, it is not amenable to the traditional empirical tools that have been developed to identify preferences and equilibria in models of school and neighborhood choice beginning with McFadden (1973) (e.g., Bayer et al., 2007, 2004; Bayer and Timmins, 2005). However, these

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very empirical models of school and neighborhood choice may be inappropriate to analyze tipping behavior because they assume that households' choices are observed in equilibrium, i.e., in the absence of further shocks the racial composition of schools/neighborhoods will remain fixed. This assumption stands in contradiction to a central insight of the Schelling model that at any given point, schools and neighborhoods may be observed in the process of tipping – in disequilibrium, but converging to an equilibrium – rather than already having reached a stable, long run equilibrium.

Recently, Card et al. (2008a) have circumvented these issues with a reduced-form approach to identify tipping points in neighborhoods and schools as thresholds around which the flows of both Whites and minorities are qualitatively different. They argue that if the share of minority households (students) in a neighborhood (school) exceeds a tipping point, then it will experience relative outflows of White households (students), and vice versa.[1] However, the simplicity of this approach is not without cost, as any such reduced form identification strategy must assume that all schools or neighborhoods possess a common, fixed tipping point – an assumption that is generally invalid if schools or neighborhoods offer different or changing levels of amenities (Banzhaf and Walsh, 2013).[2] As a motivating example, we present the racial composition of two Los Angeles County schools over time in Fig. 1. Each school starts from a roughly equal composition of White and Hispanic students, but starting in 1990, their compositions evolve in different directions. Gardner Street Elementary becomes a predominantly White school while Fulbright Avenue Elementary becomes a predominantly Hispanic school. This disparity is inconsistent with the assumption that these two schools in the same city possess common tipping points.

In this paper, we provide empirical micro-foundations to the Schelling model by building upon the literature on neighborhood choice (e.g., Bayer and Timmins, 2005; Bayer and McMillan, 2010),[3] with the key difference that our method allows for individuals' choices to be observed out of long-run equilibrium. This is an empirically important feature, as the observed enrollment dynamics displayed in Fig. 1 are indicative of adjustment paths to new equilibria. Our empirical framework for studying tipping behavior offers four main innovations over existing approaches: First, we provide a method to infer race-specific preferences for the racial composition of peers from enrollment data. Second, we are able to identify all potential stable equilibria in addition to tipping points, which enables us to infer how far out of equilibrium the racial composition of each school is at any point in time. Third, our method allows for different schools to have different tipping points and stable equilibria. Schools with different characteristics, such as teachers, locations or funding levels, generally feature different tipping points and stable equilibria (Banzhaf and Walsh, 2013), so allowing for this heterogeneity lends credibility and realism to our estimates. Fourth, our method builds upon the discrete choice literature on neighborhood and school choice (e.g., Bayer and Timmins, 2005; Bayer et al., 2007; Bayer and McMillan, 2010), so it can flexibly accommodate many extensions to the Schelling model by easily borrowing tools from this well established literature.

Our framework is motivated by the idea that tipping behavior in a school can only be fully identified by analyzing the dynamic process of segregation from multiple initial states even though the racial composition of that school is only observed at a single initial state. This indicates a two-step structural approach that first estimates how the racial compositions of schools will evolve as a function of their initial states and subsequently simulates these trajectories from various counterfactual initial states. This allows us to uncover tipping behavior in the aggregate.

In the first step, we use school enrollment data to estimate separately White and minority parents' preferences for the racial composition of their children's schools.[4] This requires solving the widely known identification problem of isolating endogenous social effects from confounding effects (Manski, 1993), which we accomplish with a novel instrumental variables (IV) approach.

In the second step, we use these estimates to simulate the implied racial compositions of each school under different counterfactuals. For any counterfactual level of the share of minority students in a school in a given year, we compute the ensuing share of minority students that is implied under this counterfactual by allowing parents to re-sort holding all other school amenities constant. It is then straightforward to recover the unique tipping points and stable equilibria for each school in each year from the simulated schedules of their racial composition.[5] Unlike previous empirical approaches, our framework allows us to identify for each school and year the full trajectory of tipping behavior in the absence of external shocks, which can inform policies that aim to impact school segregation.

We perform our analysis on a sample of all students enrolled in public schools in Los Angeles County from 1995 to 2012 and find that race based tipping is a widespread and diverse phenomenon. Parents prefer peers of their own race, particularly in higher grades. Elementary schools rarely have tipping points, but most middle and high schools do with their locations ranging from a minority share of 20% to a minority share of 80% depending on the school's characteristics. All stable equilibria are highly segregated; one group of equilibria range from 0% to 20% minority, and another group of equilibria ranges from 80% to 100% minority. In high schools, social forces are so strong that two otherwise similar schools may converge to equilibria that differ by up to 100 percentage points. The minority shares of schools have moved closer to a stable equilibrium during the sample period; however, many schools had not yet converged to a stable equilibrium by 2012: about 20% of schools were observed out of equilibrium by at least 20 percentage points of their minority share of enrollment.

We extend our analysis by allowing parents to have heterogeneous preferences for Black and Hispanic peers. This more complex and realistic model implies higher-dimensional dynamic behavior and enables us to distinguish potential tipping to segregated Black equilibria from potential tipping to segregated Hispanic equilibria, even within the same school. Overall, we find that our baseline results provide an accurate, if simplified, portrayal of school segregation in LA County.

1 Pryor (1971) conducts a similar empirical exercise using a related approach.

2 Easterly (2009) takes an alternative reduced form approach to identify tipping behavior that also relies on the assumption that all neighborhoods possess a common, fixed tipping point.

3 As discussed in Bayer and Timmins (2005) and Bayer and Timmins (2007), one important difference between the neighborhood choice literature and the discrete choice social interaction literature (e.g., Brock and Durlauf, 2001a; Brock and Durlauf, 2001b; Blume and Durlauf, 2003) is that the former literature explicitly accounts for unobservable school amenities that are correlated across individuals, which are known to be empirically relevant to location choice (Bayer et al., 2007; Caetano, 2016). Because of this difference, these literatures generally apply to distinct economic environments. For instance, in the discrete choice social interaction literature, the number of choices is fixed and is often binary, whereas in the literature on school and neighborhood choice, asymptotic results require the number of options to be large.

4 Ioannides and Zabel (2008) estimate households' preferences for a variety of other social amenities in a nested model of neighborhood and house choice.

5 Bayer and Timmins (2005) present a different simulation technique to identify multiple equilibria in the context of social interactions under the assumption that choices are observed in equilibrium. Bayer and McMillan (2010) estimate an equilibrium model of school choice and provide a simulation technique to estimate measures of school competition, but they do not consider social interactions. In a computational study of residential segregation, Bruch and Mare (2006) simulate flows of White and minority residents between neighborhoods under a variety of assumptions, but they do not empirically identify tipping points or stable equilibria.