# Ethnic segregation of friendship networks in school: Testing a rational-choice argument of differences in ethnic homophily between classroom- and grade-level networks

Lars Leszczensky*, Sebastian Pink

*Mannheim Centre for European Social Research (MZES), Graduate School of Economic and Social Sciences (GESS), University of Mannheim, Germany*

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## ABSTRACT

Adolescents' school-based friendship networks tend to be segregated along ethnic lines. But few studies have examined whether variation in network boundaries affects the degree of ethnic friendship segregation. We use rational-choice theory to argue that ethnic homophily is more pronounced for friendships between classrooms than for those within classrooms. We empirically test this hypothesis using two-wave German panel data ($N = 1258$) and stochastic actor-oriented models (RSiena). In line with our theoretical argument, we find that the tendency to form same-ethnic friendships is indeed stronger at the grade level, which translates into stronger ethnic segregation in friendship networks at the grade level than at the classroom level. Implications for research on ethnic segregation in school-based friendship networks are discussed.

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## 1. Introduction

Ethnic segregation is a persistent feature of friendship networks in general, and of adolescent friendship networks in particular (e.g., McPherson et al., 2001; Quillian and Campbell, 2003; Smith et al., 2014; Vermeij et al., 2009). This is an important finding, as the ethnic segregation of friendship networks is often seen as a major obstacle to the integration of immigrants and their descendants. For example, a lack of native friends prevents immigrants from developing host-language proficiency (Chiswick and Miller, 2001; Espinosa and Massey, 1997), decreases their labor market performance (Kalter, 2006; Kanas et al., 2011), and precludes the benefits of interethnic friendships for reducing prejudices and discrimination (Binder et al., 2009; Pettigrew and Tropp, 2006).

These negative consequences of ethnic friendship segregation in adulthood may be caused by ethnically segregated friendship networks at earlier stages of the life-course. Since adolescents often meet new people through their friends (Grossetti, 2005), if they have friends from different ethnic backgrounds they are more likely to form additional interethnic friendships (Ellison and Powers, 1994; Martinovic et al., 2011). Thus, ethnic friendship segregation may reinforce itself over time. It is therefore not surprising that

numerous studies have focused on explaining ethnic segregation in adolescents' friendship networks, as this stage of life sets lifelong patterns.

Many studies empirically measure ethnic segregation within adolescents' *school-based* friendship networks (e.g., Baerveldt et al., 2004; Currarini et al., 2009; McFarland et al., 2014; Moody, 2001; Mouw and Entwisle, 2006; Stark and Flache, 2012; Smith et al., 2014; Vermeij et al., 2009). This is reasonable since school is arguably the most important meeting place for adolescents, and most friendships originate there (George and Hartmann, 1996). Yet, meeting opportunities within schools differ along sub-contexts like classrooms, grades, courses, tracks, or extracurricular activities (Frank et al., 2013; Hallinan and Williams, 1989; Kubitschek and Hallinan, 1998; Moody, 2001). Thus the question arises how to specify the *boundary* of school-based networks (see Laumann et al., 1983). Many studies surveying friendship networks measure these networks at the classroom level (e.g., Geven et al., 2013; Stark and Flache, 2012; Smith et al., 2014; Vermeij et al., 2009), and other studies extend their measurement to the grade level (e.g., Goodreau et al., 2009; Moody, 2001). However, while the boundary specification problem is widely acknowledged in social network analysis, empirical evidence of how variation in school-based network boundaries affects the ethnic composition of networks remains scarce (see Valente et al., 2013 for an exception).

Based on a rational-choice perspective on interethnic friendship formation (Windzio and Bicer, 2013), we expect different

network boundaries (i.e., classroom or grade level) to affect the degree of ethnic segregation in adolescents' school-based friendship networks. Using the example of Germany, we argue that friendships in school are primarily formed within classrooms, because the classroom constitutes a low-cost situation in which students frequently and repeatedly interact.[1] Engaging in grade-level friendships (i.e., with students *outside* one's classroom), by contrast, requires additional time and effort – and therefore particularly strong preferences to compensate for the higher-cost situation in which these friendships are formed. Suggesting that the preference for same-ethnic friends, i.e., ethnic homophily, constitutes a strong enough preference, we hypothesize that there is more ethnic segregation in grade-level than in classroom-level friendship networks, because grade-level friendships are more costly and ethnic homophily is more pronounced in high(er)-cost situations.[2] If this hypothesis holds, measuring ethnic segregation at the classroom level would systematically *under*estimate the degree of ethnic segregation in adolescents' overall school-based friendship networks. Put differently, the degree of ethnic segregation measured in adolescents' school-based networks would then partly depend on how network boundaries are specified by researchers.

Our contribution is both substantive and methodological. On the one hand, we test a rational choice-based mechanism that explains adolescents' friendship selection within ethnically diverse schools. On the other hand, we demonstrate how this mechanism translates into differences in the degree of observed ethnic segregation in school-based friendship networks depending on how network boundaries are defined. This has important implications for the growing body of research measuring the ethnic segregation of adolescents' school-based friendship networks.

## 2. Theory and hypotheses

We first present a rational-choice argument for why ethnic homophily (i.e., the preference for same-ethnic friendships) should differ between low- and high-cost situations. Then we apply this argument to the school context by distinguishing between classroom-level and grade-level friendship networks as low- and high-cost situations, respectively. We deduce three hypotheses from our theoretical considerations.

### 2.1. Ethnic homophily in low- and high-cost situations

Friendship, above all, is a choice that involves the pursuit of individual preferences within given opportunities (Zeng and Xie, 2008). Arguably the most important preference is *homophily*, the preference for friends who are similar to oneself on salient attributes (Lazarsfeld and Merton, 1954; Kandel, 1978; McPherson et al., 2001). Research has repeatedly shown that ethnicity is one of the most crucial sources of homophily in Western societies (Smith et al., 2014; Wimmer and Lewis, 2010). And indeed, adolescents report a stronger preference for same-ethnic than for interethnic friends (Brüß, 2005; Phinney et al., 1997; Verkuyten and Kinket, 2000).

Rational-choice theory provides a way of understanding the importance of ethnic homophily. While initiating and maintaining friendship ties generally requires *costs* in the form of investment in time and effort, interactions with similar others lower these transaction costs and are more rewarding (Block and Grund, 2014; Völker et al., 2008: 327). For example, same-ethnic peers are more

likely to share similar experiences, attitudes, and values. This leads to increased mutual understanding and shared interests, and thus to stronger emotional support and social affirmation (Lazarsfeld and Merton, 1954; Martinovic et al., 2009). As a result, same-ethnic friends tend to spend more time together (Kao and Joyner, 2004), and same-ethnic friendships are characterized by greater intimacy and closeness (Aboud et al., 2003; Schneider and Udvari, 2007). Interethnic friendships, by contrast, may not only be less rewarding but may also be more costly, because actors have to cross ethnic boundaries (e.g., Alba, 2005; Wimmer, 2008).

Applying a simple version of rational-choice theory, Windzio and Bicer (2013) suggest that ethnic homophily is more pronounced in *high-cost* than in *low-cost situations*. For instance, it is more costly to visit a classmate at home than to only spend time with him or her in school. Meeting outside school requires an active effort and more time, whereas students meet on a daily basis in class anyway. Visiting at home may also require parental consent, which might pose an additional burden in the case of ethnic boundaries (Edmonds and Killen, 2009; Munniksma et al., 2012). While befriending same-ethnic peers is generally more rewarding than befriending interethnic peers, this preference may become particularly important in situations in which additional costs are imposed. Forming friendships in high-cost situations (i.e., visiting friends at home) thus requires particularly strong individual preferences, like ethnic homophily, to compensate for their increased costs.

Following this argument, ethnic segregation should generally be greater in high-cost (e.g., visiting other students at home) than in low-cost friendship networks (e.g., seeing them only in the classroom). Providing empirical evidence that this is indeed the case, Windzio and Bicer (2013: 139) point to the macro-level implications of this mechanism by concluding "that focusing only on friendship networks could lead to an underestimation of actual segregation in everyday social reality." While their study investigates different types of *social relations*, the underlying argument derived from rational-choice theory is in fact much more general. Using the example of friendship networks in school, we apply this theoretical approach to variations in network boundaries, i.e., to different types of *social settings* rather than to different types of social relations.[3]

### 2.2. Classroom- and grade-level networks as low- and high-cost situations in school

Schools are the main place that adolescents form friendships (Cotterell, 2007; Khmelkov and Hallinan, 1999). However, schools are not monolithic blocks. Students are clustered into classrooms and grades, which is why most studies investigate friendship formation either at the classroom level (e.g., Geven et al., 2013; Stark and Flache, 2012; Smith et al., 2014; Vermeij et al., 2009) or at the grade level (e.g., Goodreau et al., 2009; Moody, 2001; Mouw and Entwisle, 2006; Quillian and Campbell, 2003).

Studying classroom- or grade-level friendship networks makes it possible to distinguish between individual preferences, like ethnic homophily, and opportunity effects, like group size (see Wimmer and Lewis, 2010). Many studies find a tendency toward same-ethnic friendships even when controlling for the school's ethnic composition (Quillian and Campbell, 2003; Vermeij et al., 2009). More recent studies that additionally control for relational mechanisms like reciprocity or transitivity often interpret this residual

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[1] In Germany, as in many other European countries, students are mainly taught inside classrooms.

[2] Researchers use the term "homophily" quite differently. We follow Wimmer and Lewis (2010: 588) and reserve the term for individual preferences for similar others, i.e., the tie-generating mechanism (also see McFarland et al., 2014: 1091).

[3] While the general argument of Windzio and Bicer (2013) can be extended to network boundaries, costs are produced somewhat differently in this case. For example, parents' preferences affect the perceived costs of students' maintaining cross-ethnic relations more strongly for some types of social relations (e.g., visiting at home) than for others (e.g., meeting in school only). In our application, *within*-school, by contrast, cost differences follow from different types of social settings themselves rather than from different degrees of third-party influences in different types of social relations.

effect as evidence of ethnic homophily (see Smith et al., 2014; Stark and Flache, 2012; Wimmer and Lewis, 2010).

However, very few studies have examined whether *defining the boundaries* of friendship networks within a school differently is related to the degree of measured ethnic segregation in adolescent friendship networks. From a more technical point of view, Valente et al. (2013) showed that in exponential random graph models (ERGM), grade-level friendship networks return significant effects for ethnic homophily more often than classroom-level networks. They suspect that due to the smaller network size of classrooms, relational mechanisms like reciprocity or triadic closure may overshadow homophily, or that there simply may not be enough potential friends with similar attributes in classrooms to estimate homophily parameters. Controlling for relational mechanisms, however, Smith et al. (2014) recently provided compelling empirical evidence of ethnic homophily in 625 classrooms in England, Germany, the Netherlands, and Sweden.

In contrast, based on the theoretical considerations outlined above, we argue that *ethnic homophily is more pronounced in grade-level than in classroom-level networks*. We consider classrooms to be *low-cost situations* for students to initiate and maintain friendship ties, because the classroom constitutes a focal point, i.e., an "entity around which joint activities are organized" (Feld, 1981: 1016). Within classrooms, access to and daily interaction with classmates are very easy. Individuals who share a common focus are generally more likely to share similar experiences, and are thus more likely to become friends (Hallinan and Williams, 1989). This situation clearly applies to classrooms, where students not only attend daily lessons together but are also exposed to the same obligations, have to tackle the same tasks (e.g., do the same homework), and share experiences related to class trips or other joint activities. Focal points also reduce the transaction costs of identifying potential friends, because they give students the relatively cost-free opportunity to explore the pool of potential friends (Frank et al., 2013). This also applies to classrooms in which students encounter each other regularly – irrespective of whether they prefer to do so (Smith et al., 2014: 44).

Grade-level networks, by contrast, constitute a *high-cost situation* for the formation of friendships within school. Students in the same grade who do *not* share a classroom have fewer opportunities to meet, and share fewer common experiences than those who are bound together by a joint classroom. Within school they can meet during breaks, but while classmates can be contacted quite easily before and after lessons, contact with schoolmates in other classrooms requires more of an active effort (e.g., walking to other classrooms, waiting for students, or encountering other students who one barely knows). As a consequence, a student may only invest in a relatively costly cross-classroom friendship if he or she perceives this friendship to be particularly beneficial. Ethnic homophily may thus result in a higher percentage of same-ethnic friendships at the grade level than at the classroom level.

There is an alternative mechanism, however, that may lead to a higher percentage of same-ethnic friendships at the grade level. Having same-ethnic grade-level friends may also be a consequence of ethnic minorities living in, and knowing each other from, densely integrated ethnic enclaves. Ethnic enclaves can be regarded as an additional focal point in which same-ethnic friendships are formed *outside* the school context. Students of the same ethnic group who attend different classrooms may therefore be friends because they have already been friends due to residential proximity (see Mouw and Entwisle, 2006).

### 2.3. Hypotheses

To conclude, we expect adolescent students to generally prefer same-ethnic friends since same-ethnic friendships are more

rewarding than interethnic friendships. Friendships should also generally be formed more frequently within classrooms than within grades, because grade-level friendships are more costly than classroom-level friendships (Frank et al., 2013). Finally, as forming a grade-level friendship requires particularly strong individual preferences to compensate for the higher costs of acquiring and maintaining such a friendship, same-ethnic friendships should be relatively more frequent among grade-level friendships than among classroom-level friendships. Our three hypotheses are thus:

**H1.** Ethnic homophily holds (i.e., students prefer to befriend same-ethnic students).

**H2.** Friendships are more likely to occur within classrooms than between classrooms.

**H3.** Ethnic homophily is *particularly* pronounced for grade-level friendships than for classroom-level friendships.

## 3. Data and methods

### 3.1. Data

We exploit two waves of data collected from the project "Social Networks and Ethnic Identifications of Young Immigrants", which is a longitudinal study of grade-level friendship networks involving more than 2000 students in Germany (Leszczensky et al., 2014). The data provide information on students in the 5th, 6th, and 7th grades at nine schools in nine towns in the German federal state of North Rhine-Westphalia. In each school, all students from all classes of the three grades were surveyed.

Sampling of schools was restricted to lower secondary, intermediate secondary, and comprehensive schools with a higher share of foreign students. Nine schools were randomly chosen within predefined strata regarding different numbers of non-native students.[4] Although the school response rate was only about 10%, probably due to increasing inquiries by researchers in recent years, our results replicate common findings of previous studies with higher response rates and larger samples.

A total of 26 grades were surveyed. Most grades consisted of three or four classrooms. Overall, 85 school classes took part in the study. On average, in the first wave 26.4 ($SD = 4$) students shared a classroom, and 85.2 ($SD = 29.9$) shared a grade.

The first wave of data was collected in May 2013 and the second wave in February 2014. Written parental consent was required for students' participation in the study, which was voluntary. The paper-and-pencil questionnaires were filled out in the classroom during two lessons of 45 min each. The questionnaire took an average of 45 min to complete, and was supervised by researchers who instructed the students beforehand. After completing the questionnaire, every participating student received a €5 cash incentive.

Students' overall participation rate was 76.5% in the first wave and 83.3% in the second. Students were aged 9–17 ($M = 12.8$; $SD = 1.1$) in the first wave, and 65% have a migration background, i.e., they or at least one of their parents or grandparents were born abroad.

For the analysis, we excluded grades with participation rates of less than 77% in either wave. This threshold was identified empirically as providing the best trade-off between conventionally

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[4] The nine participating schools belong to three strata with different ethnic compositions. For each stratum, one lower secondary school, one intermediate secondary school, and one comprehensive school were sampled. Based on federal registers, the strata were defined as follows: (1) 10–15% of students hold Turkish citizenship; (2) more than 15% of students hold Turkish citizenship; (3) less than 10% of students hold non-German citizenship and less than 5% of students hold Turkish citizenship. For further information on sampling, see Leszczensky et al. (2014).

**Table 1**
Grade-level network characteristics.

| Grade-level network | Size | Classrooms | Jaccard index | Actors | | Average degree | | Response rate | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Left | Joined | Wave 1 | Wave 2 | Wave 1 | Wave 2 |
| 1 | 69 | 3 | .386 | 8 | 9 | 6.35 | 6.41 | 90.0 | 85.2 |
| 2 | 72 | 3 | .325 | 8 | 9 | 5.62 | 5.29 | 79.4 | 77.8 |
| 3 | 66 | 2 | .415 | 5 | 3 | 7.44 | 6.74 | 87.9 | 86.9 |
| 4 | 70 | 2 | .326 | 4 | 15 | 5.63 | 6.05 | 78.6 | 92.3 |
| 5 | 88 | 3 | .372 | 9 | 5 | 7.59 | 7.47 | 81.8 | 86.1 |
| 6 | 100 | 3 | .339 | 8 | 6 | 6.84 | 6.65 | 91.8 | 90.7 |
| 7 | 85 | 3 | .332 | 6 | 5 | 5.63 | 4.76 | 87.5 | 88.6 |
| 8 | 119 | 4 | .382 | 2 | 4 | 7.23 | 7.04 | 77.2 | 86.2 |
| 9 | 134 | 5 | .374 | 5 | 1 | 6.80 | 6.72 | 87.9 | 83.7 |
| 10 | 123 | 4 | .441 | 3 | 2 | 6.81 | 6.65 | 82.6 | 90.0 |
| 11 | 111 | 4 | .406 | 4 | 6 | 6.42 | 6.07 | 79.4 | 91.6 |
| 12 | 114 | 4 | .386 | 2 | 6 | 6.94 | 6.80 | 85.2 | 89.9 |
| 13 | 107 | 4 | .386 | 3 | 6 | 6.55 | 5.78 | 87.0 | 88.5 |

accepted shares of unit non-response in social network analysis (e.g., Cillessen, 2009; Huisman and Steglich, 2008; Kossinets, 2006; Kossinets and Watts, 2009) and the amount of information available to conduct meaningful statistical analyses.[5] As a result, the following analyses are based on 13 grades in which a total of 1145 students participated in either wave. Table 1 provides an overview of the central characteristics of the 13 grade-level networks.

### 3.2. Variables

*Friendship networks* were obtained by asking students to nominate up to ten best friends in their grade. Students chose their friends from a roster printed in landscape format that listed alphabetically by first name all their schoolmates from their own grade, separated visually by classrooms (i.e., next to each other horizontally).[6] Students who did not fill out the questionnaire could nevertheless be nominated so that their ingoing friendships were still recorded.

We defined the *ethnic background* of students by using information on the country of birth of the student as well as that of their parents and grandparents. Students were defined as native German if they, their parents, and their grandparents were born in Germany. By contrast, students who were born abroad, or who had at least one parent or grandparent born abroad, were defined as ethnic minority students.[7] Based on the country of origin of the students' family we distinguished the largest ethnic groups (see Smith et al., 2014 for a similar approach).[8] These include Germany (349 students),

Turkey (290), Poland (82), Southern Europe (67), the former Soviet Union (122), former Yugoslavia (61), the Middle East (81), Western countries (37), and non-Western countries (33). To capture ethnic homophily we created a dyadic covariate called *same ethnic background*, which was coded 1 if a pair of students shared the same ethnic background as defined above, and 0 otherwise.[9]

*Different classroom* is a dyadic covariate that was coded 1 if a pair of students was in different classrooms, and 0 otherwise. *Sex* is coded 1 for girls and 0 for boys. The dyadic covariates *same neighborhood* and *same elementary school* control for additional focal points in which same-ethnic students may have befriended each other; they were coded 1 for yes and 0 for no. In particular, the "same neighborhood effect" at least partly controls for the theoretical mechanism of ethnic enclaves. Neighborhood was assessed by a numerated list of all districts of the city in which the school was located, and students wrote down the name of the elementary school they attended.[10]

Item-based missing information is negligibly low. Missing information on migration background is 1.3%, on sex 0.1%, on elementary school 0.9%, and on neighborhood 4.2%.[11]

### 3.3. Analytical strategy

We use stochastic actor-oriented models (SAOM; Snijders, 2005; Snijders et al., 2010) for two reasons. First, the actor-oriented approach neatly aligns with our theoretical argumentation by directly focusing on individual friendship choices. In contrast to

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[5] Robustness checks (not presented here but available upon request) did not alter the substantive conclusions. Analyses based on using 70% minimum response (17 grade-level networks, 1596 students) as the lower cut-off criterion and 85% (6 grade-level networks, 472 students) as the upper one yielded very similar parameters compared to those presented below. In both specifications, convergence was achieved in all cases (i.e., all *t*-ratios were smaller than 0.1; see Ripley et al., 2014).

[6] The individual position on the roster might bias the amount of ingoing friendship nominations if students with surnames that come earlier in the alphabet were nominated more often. We tested this contention by estimating two OLS regressions (one for each wave) predicting the number of received friendship nominations by the students' position on the classroom-specific rosters. There was no statistical association between the number of a student's ingoing ties and their position on the alphabetically sorted list.

[7] As a further robustness check (not presented here but available upon request), we also estimated our models using a more narrow definition of ethnic minority background that included only first- and second-generation immigrants (i.e., that did not consider grandparental country of birth as well). The substantive conclusions did not change.

[8] Our coding of ethnic background generally follows the approach suggested by Dollmann et al. (2014). For example, if one parent was German and one parent non-German, the student was coded as belonging to the non-German ethnic group. If both parents were born outside Germany but in different countries, the student was coded as belonging to the maternal country of origin.

[9] Excluding ego and alter effects for the different ethnic groups may bias the estimate of the respective dyadic effect (see Goodreau et al., 2009; Wimmer and Lewis, 2010). Many studies that focus on ethnic groups exclude these effects due to convergence issues resulting from including the necessarily large amount of additional model parameters (e.g., Block and Grund, 2014; Stark and Flache, 2012). Technically, in our case, including ego and alter effects for all ethnic groups (except the reference category) did not result in major convergence issues. Only the effects for the smallest minority group (non-Western immigrants) did not converge in four models. Substantively, including these effects did not change our conclusions as the different classroom effect, the same ethnic background effect, and their interaction effect did not substantively alter. Nevertheless, even though the convergence problems can be regarded as minor, we report the more parsimonious model specification without the ego and alter effects.

[10] The lists with neighborhood districts were provided by the statistical offices of the cities. On average, these urban districts were inhabited by 6768 people (SD = 5776). Note that for the same neighborhood and the same elementary school variables, it would also be desirable to include related ego and alter effects to avoid bias in the dyadic effect. Unfortunately, we were not able to do so because the number of neighborhood districts and attended elementary schools are too large.

[11] As it is not possible to include effects of time-varying covariates with two waves (Ripley et al., 2014), we treat all covariates as time-constant. If information was not available for both time points, we relied on the information that was available. In the case of divergent information (i.e., changes from the first to the second wave), we used the information provided at the first observation.

tie-based approaches like ERGM (Goodreau et al., 2009; Wimmer and Lewis, 2010), the way actors' decisions are modeled in SAOM also closely resembles the logic of rational-choice theory, as actors myopically optimize their so-called objective function (Snijders, 2005). Second, unlike cross-sectional approaches such as ERGM, SAOM do not assume that the observed network is in a temporary state of equilibrium (Snijders et al., 2010: 57, see also Block and Grund, 2014: 198). Rather, SAOM simulate the dynamic process of network evolution by explicitly modeling actors' decisions, taking into account the creation and termination of ties as well as their stability.

SAOM further allow us to control not only for individual preferences, such as ethnic or sex homophily, but also for relational mechanisms (i.e., structural effects of the network itself) and proximity mechanisms (i.e., opportunity structure). This is essential, since friendship choices are affected not only by individual preferences (i.e., selection processes) but also by proximity and relational mechanisms (Rivera et al., 2010). For example, a common feature of adolescent social networks is that friendships tend to be reciprocated and transitive (Wimmer and Lewis, 2010). Controlling for these structural effects is important in order to avoid bias in the estimation of selection effects (Snijders, 2001; Snijders et al., 2010).

Computation was carried out using RSiena 1.1 (Ripley et al., 2014). Missing values for individual attributes were treated as non-informative in the estimation process (Huisman and Steglich, 2008). We rely on the Jaccard index to measure the amount of change between two waves.[12] Since the Jaccard index is greater than 0.3 for all grade-level networks, each of the 13 networks provides a sufficient amount of change to apply SAOM (Snijders et al., 2010). To account for compositional changes (i.e., students who joined or left between waves), we employed the method of joiners and leavers suggested by Huisman and Snijders (2003; also see Ripley et al., 2014).

We analyzed all 13 grade-level networks separately and then combined the results into a SIENA meta-analysis, following the approach proposed by Snijders and Baerveldt (2003). As the number of networks under study is rather small, we applied Fisher's combined one-sided tests (Hedges and Olkin, 1985) to test the statistical significance of the mean parameter estimates from the meta-analyses (Ripley et al., 2014). Following Steglich et al. (2012), the direction of each test corresponds to the direction of its respective estimate.

To test our three hypotheses, we estimated two models. Both models control for three structural effects capturing relational mechanisms that have been consistently found in studies on adolescent friendship networks. First, the *outdegree effect* reflects how many friends students nominate on average. Second, the *reciprocity* effect indicates the degree to which students reciprocate friendship choices. Third, we used the *transitive triplets* effect to control for the tendency of students to become friends with the friends of their friends. As further controls, we added *ego*, *alter*, and *same-sex* effects to account for a preference for same-sex friends that has consistently been found in research on adolescents' school-based friendship networks (e.g., Block and Grund, 2014; Cheadle and Schwadel, 2012; Geven et al., 2013; Stark and Flache, 2012; Vermeij et al., 2009). Finally, we included two additional dyadic covariates, *same neighborhood* and *same elementary school*, to control for whether students knew each other from contexts other than their current school, as this would be an alternative mechanism that may result in the emergence or durability of grade-level friendships (Mouw and Entwisle, 2006; Vermeij et al., 2009).

We empirically test our three hypotheses in two steps. In Model 1, we simultaneously test the first and second hypotheses. We included the dyadic covariate *same ethnic background* to assess whether students with the same ethnic background have a stronger tendency to form friendships than those from different ethnic backgrounds (H1). We also included the dyadic covariate *different classroom* to test whether friendships are more often formed within, rather than between, classrooms (H2). As the covariate is coded 0 if both students are classmates, a negative estimate would indicate that friendship occurs more often within classrooms.

In Model 2, we added the *interaction between same ethnic background and different classroom* to test whether ethnic homophily is more pronounced in friendships at the grade level than in those within classrooms (H3). Our hypothesis would be confirmed if this interaction effect is positive. This would indicate that same-ethnic friendships are more often formed between students across classrooms (i.e., at the grade level) than within classrooms (i.e., at the classroom level).

Testing hypotheses about ethnic homophily (as in H1 and H3) is only meaningful if students have the opportunity to befriend same-ethnic schoolmates. Therefore, we provide methodological clarification on how SAOM control the opportunity structure when estimating homophily parameters. Two scenarios are conceivable. First, the opportunity to befriend same-ethnic schoolmates simply is absent for students without same-ethnic class or schoolmates. Second, the relative size of different ethnic groups might influence the size of the parameter estimates.

The *absence of an opportunity to befriend same-ethnic peers* does not contribute to the final estimates of the model parameters at all, because the estimation of model parameters within SAOM is generally based on differences in their underlying model statistics. These differences pertain to the iterative (or sequential) updating of model parameters between simulated networks brought about by a set of parameter estimates that is temporarily fixed to the previously calculated model statistics of the network that is to be explained (Snijders, 2005). The model statistics we are particularly interested in are the 'sum of same-ethnic ties' and the 'sum of same-ethnic ties between classrooms.' After each run of the simulation, the model statistics calculated on the basis of the current simulated network are compared to those of the observed network state of the second wave. A student who lacks the opportunity to befriend same-ethnic peers within the network cannot influence this difference because he or she cannot change either model statistic (whether upwards or downwards), as he or she cannot create or dissolve a same-ethnic tie. Therefore, 'not having the opportunity' is controlled for in the estimation procedure of the parameters. At a more general level, this means that estimates of model parameters only reflect those with the opportunity to change them.

Nor does the *relative size of different ethnic groups* inside a school affect parameter estimates, because the estimated decision models based on which actors decide are multinomial logit models. Hence, the probability that an actor decides on a particular network state is calculated conditional on all other possible network states (Snijders, 2005). Thus, similar to ERGM (e.g., Wimmer and Lewis, 2010), the decision model controls for the opportunity structure in terms of relative group size (also see Block and Grund, 2014: 198).

## 4. Results

### 4.1. Descriptive results

Although the majority of observed friendships were between students who are in the same classroom, friendships between students in different classrooms were by no means exceptional. In both

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[12] The Jaccard index is defined by $N_{11}/(N_{11} + N_{01} + N_{10})$, where $N_{11}$ is the number of ties that exist in both waves, $N_{01}$ is the number of newly initiated ties, and $N_{10}$ is the number of dissolved ties (Snijders et al., 2010: 49).

**Table 2**
Percentage of same-ethnic friendships across students of different ethnic backgrounds.

| | Wave 1 | | Wave 2 | |
| --- | --- | --- | --- | --- |
| | Within | Between | Within | Between |
| Germany | 47.8 | 56.8 | 47.2 | 52.8 |
| Turkey | 51.0 | 66.4 | 50.6 | 66.9 |
| Poland | 7.6 | 9.0 | 8.3 | 14.8 |
| Southern European | 8.0 | 13.0 | 8.9 | 15.6 |
| Former Soviet Union | 21.7 | 26.0 | 21.2 | 30.7 |
| Former Yugoslavia | 8.7 | 9.1 | 8.8 | 13.4 |
| Near East | 24.1 | 24.9 | 22.0 | 24.5 |
| Non-Western | 2.7 | 6.6 | 1.8 | 7.5 |
| Western | 4.8 | 0.0 | 7.6 | 5.0 |
| Number of students | 922 | | 959 | |

waves, roughly 17% of all friendship nominations span between classrooms. These grade-level friendships were more ethnically homogenous than the observed classroom-level friendships. In Wave 1, the share of same-ethnic friendships was 33% within classrooms and 39% between classrooms; in Wave 2 the difference was somewhat more pronounced: 33% and 41%, respectively.

Table 2 shows the percentage of same-ethnic friendships within and between classrooms for different ethnic groups in both waves. The difference in ethnic homogeneity between classroom- and grade-level friendship networks is especially pronounced for Turkish students. While in both waves half of the Turkish students' friends in the same classroom are also Turkish, almost two-thirds of their friends at the grade level share their ethnicity. We find the same tendency, albeit less pronounced, for almost every other ethnic group – including native German students. These patterns provide descriptive empirical evidence that ethnic homophily may indeed be more pronounced in grade-level than in classroom-level friendship networks.

### 4.2. Multivariate analyses

Table 3 contains the results of the RSiena meta-analyses, displaying the mean estimate over all separate models as well as the respective standard errors. Convergence for all models was achieved; all t-ratios were smaller than 0.1 in absolute value for each parameter estimate (Ripley et al., 2014).

**Table 3**
Meta-analysis of friendship dynamics.

| | Model 1 | | Model 2 | |
| --- | --- | --- | --- | --- |
| | Mean est. | SE | Mean est. | SE |
| Outdegree | −2.02 | .09* | −2.03 | .05* |
| Reciprocity | 1.02 | .07* | 1.05 | .08* |
| Transitive triplets | .21 | .01* | .22 | .01* |
| Sex | | | | |
|   Alter | .07 | .05* | .09 | .05* |
|   Ego | −.10 | .07* | −.09 | .07* |
|   Same | .65 | .07* | .63 | .07* |
| Same elementary school | .15 | .05* | .14 | .05* |
| Same neighborhood | .01 | .03 | −.01 | .03 |
| Same ethnic background | .16 | .06* | .07 | .07* |
| Different classroom | −.76 | .08* | −.82 | .09* |
| Different classroom × same ethnic background | | | .29 | .08* |
| Number of grades | 13 | | 13 | |
| Number of students | 1258 | | 1258 | |

*Note*:

* $p < .001$. Statistical significance is based on Fisher's combined one-sided tests in the direction of the respective mean estimate. Covariates are not centered. Estimation algorithms for all 26 models converged.

*Model 1* replicates common findings from research on adolescent students' friendship networks. Friendships tend to be reciprocated, transitive, and more frequently formed between students of the same sex (e.g., Cheadle and Schwadel, 2012; Geven et al., 2013; Smith et al., 2014; Stark and Flache, 2012). We also find that friendships are more frequently formed between students who attended the same elementary school. Residing in the same neighborhood, by contrast, does not increase the likelihood of two students being or becoming friends. This speaks at least partially against the ethnic enclave mechanism. Most importantly, we find that having the same ethnic background has a strong positive effect, which indicates that same-ethnic students are more likely to be friends than those with different ethnic backgrounds. In other words, students seem to prefer having same-ethnic friends. Thus, the hypothesis of ethnic homophily (H1) holds in our data, as it does in numerous other studies (e.g., Smith et al., 2014; Wimmer and Lewis, 2010). In addition, being in a different classroom has a strong negative effect on the likelihood of two students being or becoming friends. This finding confirms our hypothesis that friendships are more likely to occur within, rather than between, classrooms (H2).

*Model 2* adds the interaction effect between being in a different classroom and having the same ethnic background. As hypothesized (H3), this interaction is positive and significant. This finding indicates that at both the classroom and grade levels, students prefer to have same-ethnic friends rather than friends with a different ethnicity – but at the grade level this preference is more pronounced. With respect to the control variables, the results of Model 2 are virtually identical to those obtained by Model 1.

In addition to solely interpreting the mean estimates, we calculated this difference in preferences explicitly (for a similar calculation, see Snijders et al., 2010: 52).[13] Four preferences are of interest: creating same-classroom-same-ethnicity ties, same-classroom-different-ethnicity ties, different-classroom-same-ethnicity ties, and different-classroom-different-ethnicity ties. We identify the joint contribution of the respective effects by inserting their estimated mean parameters into the objective function. We denote the mean estimate of the different-classroom effect ($v_i \neq v_i$) by $\beta_c$, the same-ethnicity effect ($\omega_i = \omega_i$) by $\beta_e$, and the interaction between these two effects ($v_i \neq v_i$ and $\omega_i = \omega_i$) by $\beta_{ce}$. The joint contribution of these effects is thus:

$$\beta_c \sum_j \chi_{ij} I\{v_i \neq v_j\} + \beta_e \sum_j \chi_{ij} I\{\omega_i = \omega_j\}$$

$$+ \beta_{ce} \sum_j \chi_{ij} I\{v_i \neq v_j\} I\{\omega_i = \omega_j\},$$

where $I\{v_i \neq v_i\} = 1$ if $v_i \neq v_i$ and 0 otherwise, and where $I\{\omega_i = \omega_i\} = 1$ if $\omega_i = \omega_i$ and 0 otherwise. The contribution of a tie between any $i$ and $j$ ($\chi_{ij} = 1$) to the objective function (considering only the three effects we are interested in) is therefore:

$$-0.82 I\{v_i \neq v_j\} + 0.07 I\{\omega_i = \omega_j\} + 0.29 I\{v_i \neq v_j\} I\{\omega_i = \omega_j\}.$$

The resulting contributions to the objective function are 0.07 for same-classroom-same-ethnicity ties, 0.0 for same-classroom-different-ethnicity ties, −0.46 for different-classroom-same-ethnicity ties, and −0.82 for different-classroom-different-ethnicity ties. Accordingly, the difference in preferences for same-ethnic friendships compared to interethnic friendships at the grade level is, at 0.36 (−0.46 − (−0.82)), more pronounced than the respective preferential difference at the classroom level at 0.07 (0.07–0.0).

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[13] Note that contrary to Snijders et al. (2010) the mean estimates of our meta-analysis are not based upon centered covariates.

To conclude, having the same ethnic background is *more* important for friendship selection if two students are *not* in the same classroom. Our main hypothesis that ethnic homophily is more pronounced for grade-level than for classroom-level friendships (H3) is therefore confirmed by the data.

## 5. Discussion

In this study we examined whether variations in network boundaries affect the degree of ethnic homogeneity in adolescents' school-based friendship networks. From a rational-choice perspective we argued that friendships in school are primarily formed within the same classrooms, because classrooms constitute low-cost situations of repeated interactions between students. By contrast, costs are higher for befriending schoolmates outside one's own classroom (i.e., at the grade level). We suggested that particularly strong individual preferences are required to compensate for these higher costs. Arguing that ethnic homophily is such a strong preference, we hypothesized that ethnic homophily should be more pronounced for grade-level than for classroom-level friendships.

The results support our hypotheses, showing that friendships are more often formed between students who share the same ethnic background and who are in the same classroom. As hypothesized, however, while adolescents generally prefer to befriend same-ethnic schoolmates, this tendency is stronger for friendships at the grade level than for those at the classroom level. This means that friendships between same-ethnic students are indeed formed relatively more often between classrooms than within classrooms. This finding holds despite two technical issues that may have threatened our conclusions about this preferential difference (see Valente et al., 2013). In fact, the number of same-ethnic peers in classrooms is sufficient to identify ethnic homophily at the classroom level. This holds true even when controlling for reciprocity and transitivity, which, in principle, may overshadow homophily effects.

Although our findings are consistent with observable implications derived from rational-choice theory, our study did not include direct measurements of central theoretical constructs such as individual preferences or perceived costs. Like virtually all other studies on ethnic friendship segregation, we had to infer the preference of ethnic homophily from the observed tendency to form same-ethnic friendships that remains after controlling for competing mechanisms (e.g., Moody, 2001; Quillian and Campbell, 2003; Smith et al., 2014; Vermeij et al., 2009). However, this tendency might still be explained by mechanisms other than a genuine preference for same-ethnic friends. For example, ethnicity may be related to certain values or attitudes that may actually drive the effect (Stark and Flache, 2012). Another alternative explanation of our findings may be that ethnicity loses its importance if students are in the same classroom. These alternative explanations seem rather unlikely, though, as the large-scale study by Smith et al. (2014) finds evidence of ethnic homophily in European classrooms even when controlling for alternative sources of homophily like cultural or socioeconomic similarity. In addition, as mentioned above, we also found an increased tendency to form same-ethnic friendships within the same classroom, which indicates that ethnicity does matter in classrooms. Finally, however, even though living in the same neighborhood district as a proxy for ethnic enclaves did not affect students' friendship choices in our sample, we cannot completely rule out the possibility that ethnic enclaves play a role in the formation of grade-level friendships. Future research may use more detailed geo-locational data to specify the spatial areas of ethnic enclaves in order to study whether and how they affect friendship choices.

Our study has theoretical implications for examining adolescent friendship networks. Most studies distinguish between individual preferences and structural opportunities (e.g., Wimmer and Lewis, 2010; Zeng and Xie, 2008) – and this distinction is obviously crucial. Yet, while researchers often treat separating preferences from opportunity mechanisms as predominantly a methodological challenge (e.g., Wimmer and Lewis, 2010), the interplay between preferences and opportunities is also of theoretical concern. Based on rational-choice theory, one may assume that strong individual preferences like ethnic homophily lead adolescents to actively expand their opportunity structure if their current opportunity structure does not allow them to satisfy their preference for (a certain number of) friends with a certain characteristic. This is particularly likely for students who belong to a small ethnic group, for they may have to look for same-ethnic friends outside their classroom in order to maintain a friendship network with several same-ethnic friends (Quillian and Campbell, 2003). Using more direct measures of theoretical constructs, future studies may test this hypothesis and provide more insight into how exactly preferences, different sources of homophily, and costs interact to shape adolescents' friendship selections.

Our findings also have important practical implications for the rapidly growing research on school-based friendship networks. Students in school are nested within classrooms, grades, courses, tracks, and extracurricular activities. As our study shows, measuring ethnic friendship segregation only at the classroom level may *under*estimate the extent of ethnic segregation in larger school-based friendship networks. This is the case for two reasons. First, as argued above, ethnic homophily is likely to be a preference that is strong enough to lead students to befriend peers outside the bounds of their classroom. Second, in relatively small networks like classrooms, students from small ethnic groups may not have the opportunity to engage in same-ethnic friendships. This insufficient opportunity would then systematically introduce a downward bias into the resulting measure of ethnic friendship segregation (i.e., the percentage of same-ethnic friends in the overall friendship network), especially for smaller ethnic groups but also due to aggregation for overall measures of ethnic segregation. Researchers who are interested in measuring ethnic segregation in school-based friendship networks should therefore be aware that how they specify network boundaries may affect their measurements of the extent of ethnic friendship segregation in school.

Finally, our study has policy implications as well. On the one hand, it adds to the large body of research showing that opportunities are crucial for adolescents' interethnic friendship formation (e.g., Moody, 2001; Mouw and Entwisle, 2006; Quillian and Campbell, 2003; also see Janmaat, 2014). After all, the vast majority of students' friendship ties were based *within* rather than between classrooms, indicating that having different ethnic backgrounds does not prevent students from befriending each other if they have close contact on a daily basis. Distributing ethnic minority students equally across classrooms thus seems to be reasonable if one intends to decrease ethnic friendship segregation. On the other hand, going beyond earlier studies, we demonstrated that ethnic homophily may still lead students to befriend same-ethnic rather than interethnic peers *outside* their classrooms. Like researchers, policy makers and school administrators thus have to acknowledge that friendships within classrooms are only part of students' larger school-based friendship networks (and of friendship networks outside the school context, for that matter), in which ethnic segregation is more pronounced than within classrooms. Promoting interethnic friendships within classrooms may therefore best be viewed as a necessary but not a sufficient condition for limiting ethnic friendship segregation. Following our rational-choice argument, schools may attempt to reduce costs for students to contact, and ultimately befriend, peers outside their own

classrooms in order to further decrease ethnic friendship segregation. For example, schools may organize regular grade-level activities in which students may discover shared interests such as musical preferences, sports, or other leisure time activities at a lower cost. If these shared interests are not related to ethnicity (Stark and Flache, 2012), they may provide a basis for grade-level friendships that are not based on a shared ethnic background.

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